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DEVELOPMENT OF MANAGEMENT INFORMATION SYSTEM SOFTWARE FOR TENNESSEE RURAL TRANSIT SERVICE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Liyang Feng

August 1991

DEDICATION

This thesis is dedicated to my parents
Mr. Chi-fang Feng and Ms. Yu-chu Wang
who have given me invaluable help and great encouragement
toward my pursuit for a better education.

谨以此论文献给我的双亲，
冯志方先生和王豫初女士，
在我追求一个较好教育机会的道路上，
他们曾经给予我极大的鼓励。

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ABSTRACT

This research attempted to develop a Rural Transit Management Information System (RTMIS) software for Tennessee's Section 18 rural public transportation operators. A standard software development procedure was followed during the research. Three aspects in developing RTMIS were discussed: 1) the relationship between transit performance measures and RTMIS software structure; 2) the selection of an appropriate programming language; 3) RTMIS design consideration and data processing procedures which included data input, processing, and output.

It was concluded that it was appropriate to develop a practical and small size information system through the use of Lotus 123 software. The structural programming technique was an important aspect of using Lotus 123 to develop RTMIS. The application of system approach allowed RTMIS to be developed with a data structure that fit the existing record-keeping requirement of Tennessee rural transit operations.

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CHAPTER 1
INTRODUCTION

With the rapid progress of the microelectronic technology over the last ten years, the adoption of microcomputers has become more common in the public transportation area, especially in rural public transportation operations. More state transit authorities and rural transit operators are using microcomputers and management information systems to deal with decisions concerning daily operations, program management, planning, and evaluation. In order to enhance the application of a microcomputer based management information system, a research project named " Development of a Generic Management Information System for Tennessee Section 18 Operators" sponsored by Tennessee Department of Transportation (TDOT) was conducted by the Transportation Center, University of Tennessee.

Section 18 of Urban Mass Transportation Act was passed in 1978. This grant program provides financial resources to support transportation services in non-urban areas. Funds for capital assistance, operating assistance, and project administration are provided. Currently, all of the Tennessee's eleven rural transportation programs receive Section 18 funding. In Tennessee, the Section 18 program is administered by the Tennessee

Department of Transportation. In 1989, these eleven agencies provided 1.23 million passenger trips and operated 362 vehicles in 93 of the state's 95 counties[13].

The main purpose of this research project was to assist rural transit managers and state transit officials to:

1. Evaluate existing transit programs;
2. Support financial planning;
3. Suggest how to provide more service for available resources; and,
4. Provide better management information with daily transit operation.

With these objectives, the goals of the research project were to[1]:

1. Assess potential application of microcomputers for rural transit programs;
2. Define appropriate performance measures;
3. Develop and test "generic" software capable of addressing the need of rural transit operators and the state transit agency in Tennessee.

The emphasis of this thesis is on the third goal of the project, and it explored the application of a commercial spreadsheet software to develop a small size information management system which can be used by Tennessee's Section 18 Public Transportation operators. The software developed in this thesis is named the Rural Transit Management Information System (RTMIS).

CHAPTER 2
LITERATURE REVIEW

The Rural Transit Management Information System (RTMIS) developed for Tennessee's Section 18 operators was designed to meet the following two goals:

1. To find an appropriate transit performance measure structure and apply it to the data processing procedure in order to establish a clear, and easily understood data structure.
2. To select an appropriate programming language to meet the reporting functions required by TDOT and rural transit operators. The literature review addresses these two major purposes.

Performance Measures

There are different transit systems, such as heavy rail and light rail systems, bus systems, para-transit systems, etc. Different performance measures are used for the different systems. e.g. a light rail system may use different performance measures than a conventional bus system. A para-transit service may use yet another set measures to describe its performance. Likewise, performance measures used for urban transit could be different

from those used for rural transit. Creating a well defined and definite structure to the grouping and presentation of performance measures is important to the development of a data structure which will facilitate and simplify the development of a computer program. With the processing of a large amounts of data, the "structure" is vital to the design of the program.

There are several references which discuss how to evaluate transit system through performance measures. Some of them also discuses the structure of the performance measures. For example, the paper "Urban Public Transportation: Systems & Technology" by Vuchic[2] discusses different performance measures used by various urban transit systems. Transit system performance measures consist of quantitative elements or indicators. These measures are used to evaluate the system performance and they are closely related to a transit system's service characteristics and its usage. System performance refers to the entire set of performance elements. The most important ones being:

1. *Service frequency*: the number of transit vehicle departures per hour.
2. *Operating speed*: speed of travel experienced by passengers traveling on a transit route.
3. *Reliability*, expressed as a percentage of vehicle arrivals at a transit stop within a specified range of deviation from the scheduled arrival time.

4. *Safety*: measured by the number of fatalities, injuries, and property damage per 100 million passenger-km, or similar unit.
5. *Line capacity*: the maximum number of spaces or persons transit vehicles can carry past a point along the line during one hour.
6. *Productive capacity:* the product of operating speed and capacity of a line. As a composite indicator incorporating one basic element affecting passengers (speed) and one affecting operator (capacity), the productive capacity is a very useful performance indicator for modal comparisons.
7. *Productivity*: the quantity of output per unit of resource (e.g., vehicle-km, space-km per unit of labor, operating cost, fuel, etc.
8. *Utilization*: a ratio output to input, for example, person-km/space-km offered.

Further, the paper discusses transportation work and productivity, transit system efficiency and other utilization measures. Among the measures, the most common units that are used are the following:

9. *Fleet capacity*: total capacity of all vehicles in the fleet.
10. *Number of vehicles/Fleet size.*
11. *Annual number of passengers:* number of trips served by the system during one year (or a period of time).
12. *Number of lines or network length.*

13. *Annual vehicle-kilometers*: is the sum of distance traveled by all vehicles in a transit fleet during one year.
14. *Annual space-kilometers*: the product of annual vehicle-miles and average vehicle capacity, representing the total quality of service offered by the transit system during one year.
15. *Annual passenger-kilometers*: the product of the number of passenger carried and average trip length.
16. *Transit line productivity*: is the product of the number of vehicles operating on a line and their average speed, it can be expressed in veh-km/hour or passenger-km/hour.
17. *Vehicle-kilometer/vehicle/year*: the total annual veh-km operated divided by fleet size, and indicates the efficiency of vehicle use for a transit service.
18. *Passengers/veh-km*: the ratio of annual passengers to annual veh-km operated, is a measure of the intensity of transit service use.
19. *Passenger/vehicle/year*: indicates how efficiently vehicles are used, how many passenger trips per year are served by each vehicle.
20. *Passenger-km/vehicle/year*: indicates how much work each vehicle performs per year.
21. *Daily passengers/employee*: the ratio of weekday ridership to employees, is a indicator of labor efficiency or productivity.

22. *Operating Cost/passenger*: shows the average cost per served trip.
23. *Operating cost/veh-km*: indicates the cost of transit per unit of offered service.
24. V*eh-hours/vehicle/day*: is a common indicator of vehicle utilization.
25. *Scheduled vehicles/fleet size ratio*: shows both the efficiency of vehicle scheduling and the technical condition of vehicles.

As presented in this reference, the performance measures are not categorized for developing a clear data structure, It would be difficult to interpret the performance measures and more difficult yet to design a computer program without a clear structure.

The second report that was reviewed was prepared by Carter-Goble Associates. It discussed a five step procedure in evaluating a rural transit system and the steps include the following[3]:

1. Establish goals and objectives;
2. Select functions and measures to use;
3. Collect data and calculate measures;
4. Analyze and interpret performance measures; and
5. Take corrective actions.

Among these five steps, steps 2 and 3 are related to RTMIS software development. Steps 1, 3, and 5 are important to the evaluation procedure or the use of the program; however, they have little importance in the programming procedure. In order to use this procedure effectively, a very clear structure of performance

measures must be established. Generally, transit performance can be divided into two major parts: financial performance and non-financial performance. In each category, the performance measures could further be divided into several sub-categories. In these sub-categories, performance measures could be divided into general measures and supplemental measures. A summary of typical performance measure structure is shown in Tables 2-1 and 2-2.

The logic of this process provides a clear performance measure structure which can be integrated with both evaluation procedure and software development procedure. Unfortunately, this structure proposed by Carter-Goble Associates can not be applied to RTMIS for Tennessee Section 18 transit operators because the structure does not fit the existing record-keeping procedure used by the State of Tennessee. In fact, it was required that the existing record-keeping structure be used as the input structure of RTMIS.

The performance measure structure recommended by G. J. Fielding[4] is a third example. This structure was adopted by Virginia Department of Transportation to analyze performance of urban and rural transit systems in the State of Virginia. The evaluation process focuses on three performance concerns[5]:

1. *Resource efficiency* represents a concern for the amount of public transportation service produced for the community in relation to the resources expended. This addresses the question, "How much public transportation service is produced per dollar or resource expended?" The amount of service produced is measured in terms of service output such as vehicle hours or vehicle miles. Resources expended include a mix of labor, capital, materials and services. The

Table 2-1 Performance Measure Structure (Financial Performance)[3]

	Financial Performance Measures
Expense	General Measures: 1. Expense per vehicle-mile 2. Expense per vehicle-hour 3. Expense per passenger trip
	Supplemental Measures: 5. Expense per revenue veh-mile 6. Expense per revenue veh-hour 7. Expense per passenger trip
Revenue	General Measures: 8. Revenue per revenue veh-mile 9. Revenue per revenue veh-hour 10. Revenue per passenger
	Supplemental Measures: 11. Passenger revenue per revenue veh-mile 12. Passenger revenue per revenue veh-hour 13. Passenger revenue per passenger 14. Percent of passenger revenue in total expense 15. Percent of passenger revenue in total revenue
Subsidy	General Measures: 16. Percent of revenue in total expense 17. Subsidy per veh-mile 18. Subsidy per veh-hour 19. Subsidy per passenger

Table 2-2 Performance Measure Structure (Non-Financial Performance)[3]

	Non-Financial Performance Measures
Ridership	General Measures: 1. Passenger trips per vehicle-mile 2. Passenger trips per vehicle-hour
	Supplemental Measures: 3. Percentage of Fare-paying passengers 4. Percentage of elderly passengers 5. Annual percentage passenger increase
Service Quality	General Measures: 6. Percentage of on time stops 7. Complaints per driver
	Supplemental Measures: 8. Percentage stops with signs 9. Vehicle-miles per road call
Level of Service	General Measures: 10. Revenue miles per revenue hours 11. Vehicle-miles per year 12. Vehicle-hours per year
Safety	General Measures: 13. Vehicle miles per revenue vehicle accident
	Supplemental Measures: 14. Non-vehicle accident per year 15. Avoidable accident per driver 16. Vehicle accidents per route 17. Vehicle accidents per vehicle

more service produced per resource expended, the greater the resource efficiency of the public transportation service.

2. *Service effectiveness* represents a concern for the usage or consumption of public transportation service in relation to the amount of service available. This address the question, "How much public transportation service is used or revenue received, at an established fare, in relation to the amount of service available?" The more service consumption or passenger revenue in relation to service output or availability, the higher the level of service effectiveness.

3. *Cost-effectiveness* represents a concern for the usage of public transportation services in relation to resources expended. This addresses the question, "How much public transportation service is used or passenger revenue received per dollar or resource expended?" The transit service usage or consumption is measured by passenger trips or revenues received and, as above, the costs are measured in terms of resources expended to produce the public transportation service. The more passengers carried or passenger revenues received in relation to resources expended, the more cost-effective the service (pp. II-9).

These three performance measures concerns are dependent on information of three categories[5]:

1. *Resource inputs* are resources expended in providing transit service. They include labor, capital, materials, services, and other items which are both quantitative and measurable. Inputs may be classified as both financial and non-financial.

2. *Service outputs* are the non-financial operating results of resource expenditures. They may classified by service quantity statistics and service quality statistics.

3. *Public consumption statistics* are the actual results of service outputs and the pricing or fare structure. Such information can be classified as either financial or non-financial, such as passenger-related results (pp. II-10).

Figure 2-1 presents the performance measures in three statistical categories and reflects a basis for addressing performance concerns and evaluations. A triangular structure can be utilized to address the relationship among three sets of performance measures and three sets of statistical categories as noted in Figure 2-2.

The approach outlined by Fielding[4] provides an effective way to evaluate not only the urban public transit service but the performance of rural transit system as well. Like the previous discussed structure, this structure is also very clear and can be easily adapted to an RTMIS software structure. The most important feature is that this structure can basically satisfy both existing record-keeping and data processing procedures. However, this triangle performance measure structure does not explain the whole structure of a computerized performance information system such as RTMIS. There are several related aspects in the organization of data flow and data structure that need to be discussed before a clear structural frame can be determined for software development.

Management Information System in Rural Transit Service

The application of Management Information Systems (MIS) to the transit field is enhanced by current fiscal constraints, energy shortages, and the resulting emphasis on service efficiency and productivity. However, the implementation of MIS to a rural transit system has special applications since the population served by rural transit is widely dispersed and the cost per trip is high. In recent years, rural transit systems have faced reductions in operating

RESOURCE EFFICIENCY PERFORMANCE MEASURE	= Output/Input =	Service Performance Statistics Output / Service Resource Statistics Input
SERVICE EFFECTIVENESS PERFORMANCE MEASURE	= Output/Input =	Service Consumption Statistics Output / Service Performance Statistics Input
COST EFFECTIVENESS PERFORMANCE MEASURE	= Output/Input =	Service Consumption Statistics Output / Service Resource Statistics Input

Figure 2-1 Performance Measure Formulations[5]

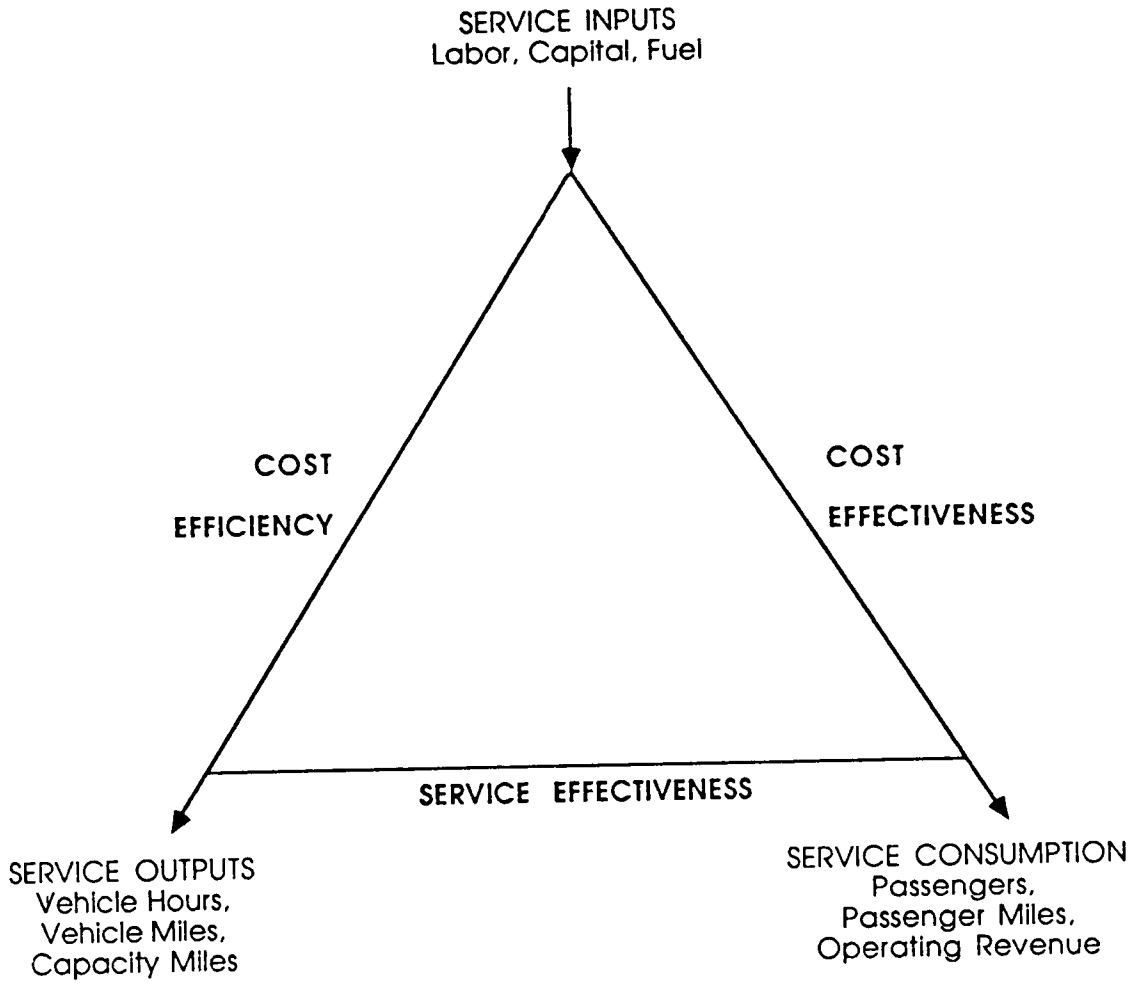

Figure 2-2 Transit Performance Measure Structure[4]

subsidies (e.g. section 18) as well as other cutbacks in local and state funds by pursuing a more efficiency delivery of service.

As discussed by Collura, there were four applications of a MIS in a rural transit system[6]:

1. Billing and accounting;
2. Monitoring and evaluating;
3. Reporting requirement; and
4. Routing, Scheduling, and dispatching (pp. 4)

Further, Professor Collura concluded that the development of a low cost, adaptable MIS could assist rural transit operators in managing an efficient, coordinated rural transit system. Although the basic emphasis of the MIS is to serve the continuous, short-term program management needs of its users, the needs of transportation planners and decision-makers, who are involved in long-range forecasting and policy analysis, must be also taken into consideration.

In 1982, nine transit systems were surveyed with regard to their MIS software application as well as the hardware facilities[7]. All systems used customized programs written on advanced programming languages, and most of them (seven systems) used BASIC. The hardware used by the systems also varied. Two of the systems used a main frame computer, and the rest of them used a mini or micro computer with Random Access Memory(RAM)'s from 64K to 2.5M. The survey results are outlined in Table 2-3. Because of the adoption of advanced language, all these software were developed as a comprehensive specialized transit database which included all four applications of MIS mentioned above.

Table 2-3 Hardwares and Softwares Adopted in MIS For Nine Transit Systems[7]

Project Name/Location	Hardware	Software
Cape Cod Regional Transit	Data Gen. NOVA(mini), RAM 64 K	BASIC
Community Response Transit of Great Cleveland	BASIC 4-730 (mini), RAM192K	BASIC
Delaware Specialized Transit Authority	NCR (micro), RAM 64K	BASIC
Kansas City Transit Authority	IBM 34 (mini), RAM 128K	RPG 2
OATS, Inc., Missouri	Kard J-100 (mainframe), RAM 14Mb	BASIC
Orange County	2, Frame 750's (mini) RAM 2.5Mb	COBOL, FORTRAN
Ozark Transit, Arkansas	Main Frame	BASIC
Santee Wateree Regional Transit Authority, SC	Wang 2200 (mini),	BASIC
SPAN, Denton County, TX	North Star Horizon (micro), RAM 64K	BASIC

Along with the rapid development of computer technology, more sophisticated MIS data base softwares have been developed in recent years[1]. Among them are "SST-3" by Texas A&M University, "PARIS" by Comsis Corporation., "PARMIS" by Ketron, Inc., and "PTMS" by Automated Business Solutions. These softwares are also extensive specialized for applications by transit agencies. The current software system in Tennessee accepts the summary statistics through different means, decentralized manual calculation or customized database program and it is not practical to change these procedures. Rather, the development of a simple RTMIS using existed monthly trip/service and financial reports is the objectives of the research. RTMIS would not be customized to one system, but must respond to the data collection and manipulation process of all eleven transit systems. Appropriate performance measures would be devised from the available data reserved to meet the needs of Tennessee's Section 18 programs. The selected performance measures are listed below:

1. Monthly expenditure
2. Administrative cost
3. Operating cost
4. Capital cost
5. Vehicle assigned
6. Fleet size
7. Cost/vehicle
8. Percent of administrative cost
9. Depreciation cost

10. Vehicle-hours
11. Vehicle-miles
12. Vehicle-mile/veh-hour
13. Vehicle-miles/vehicle assigned
14. Cost/vehicle-mile
15. Cost/vehicle-hour
16. Maintenance Cost/vehicle-mile
17. Labor cost/Vehicle-hour
18. Fuel cost/vehicle-mile
19. Passenger Trips/vehicle-hour
20. Passenger Trips/vehicle-mile
21. Passenger trips/vehicle assigned
22. Wheel chair trips/vehicle assigned
23. Cost/passenger trip

The focus of this research is to develop a software to support a management information system for Tennessee's rural transit services. The effort focused on developing a transit performance information system.

The following guidelines used for the new performance information system software, RTMIS, are listed below[1]:

1. Compatible with existing record keeping functions;
2. Easy to apply;
3. Flexible to grow with changing needs;
4. Adequately represent the board spectrum and diverse nature of rural transit service in Tennessee;

5. Provide information at the county, regional and state level for program monitoring;
6. Present timely reports to the related departments and officials

Before establishing a RTMIS structure, a discussion on the relationship between performance measures and RTMIS must be conducted.

CHAPTER 3
THE DEVELOPMENT OF RTMIS

Overview of RTMIS

Overview

A management information system to meet the need of Tennessee's eleven Section 18 rural transportation systems was developed initially on a Lotus 123 spreadsheet. Development of the template considered the following criteria:

1. Simplicity: the management information software must be compatible with available resources and existing record-keeping procedures.
2. Flexibility: the management information software must be capable of being modified to meet local needs. The software should be consistent with computer expertise found in rural areas as a means of encouraging modifications for local applications.
3. Modular design: rather than provide one integrated "closed" system, the software should be developed in modular units to permit application by operators with different needs.
4. Implementation: the software must be viewed as a tool to assist managers in making decisions and enhancing

communications and not as another requirement imposed by funding agencies.

The software will accommodate approximately 100 vehicles in 20 counties. Year-to-date summaries are provided along with comparisons to monthly summaries.

The management information template requires the following data as part of input files:

1. Monthly ridership by county. The data can be entered based on monthly totals for a county, a vehicle, or a route. Ridership data include: non-contract passenger trips, contract passenger trips, and wheelchair passenger trips.
2. Monthly clients by county include: contract clients, general public clients, and wheelchair clients.
3. Monthly total vehicle-miles traveled by each vehicle summed to a county.
4. Monthly vehicle-hours by each vehicle summed by a county.
5. Vehicle fleet data include: total fleet, average number of vehicles in service.
6. Total system revenue include fare revenue by van, contract revenue, and contributions.
7. Yearly budget.
8. Total system monthly expenditure.
9. Incidental use of vehicles data include passenger trips, revenue, vehicle-miles, and vehicle-hours.

The initial RTMIS program was developed on an IBMPC/XT computer with 640K RAM and 10M hard disk drive by using Lotus 123 Release 2.2 software.

Program Operations

The overall structure of the spreadsheet is outlined in Figure 3-1.

RTMIS allows the user to input:

1. Monthly vehicle trip data. This provides an option to input data for a new month, to continue inputting data, or edit or review previous data. At the end of the month the data can be saved and summarized for review. Also, current data can be printed in system-wide summaries.
2. Monthly expenditure data. Monthly expenditures are entered by category within the administrative, operational, and capital categories. Year-to-date expenditures can be summed and compared to the budget.
3. Fleet characteristics data. Fleet characteristics, such as vehicle number, are entered and can be used to print a listing of vehicles operation in the system.
4. Monthly revenue data. Monthly revenue data from contracts, grants, fares, and in-kind services can be entered and summed for the month with year-to-date totals.

The output of the RTMIS are:

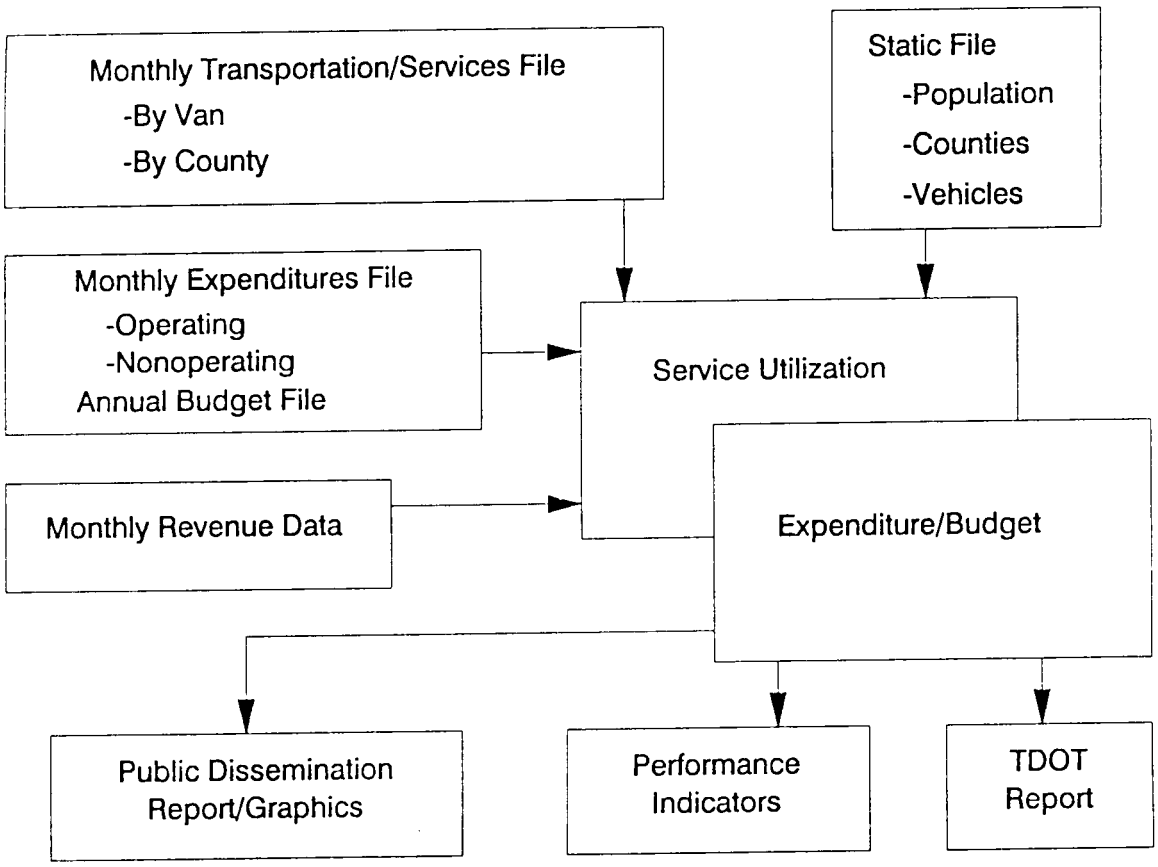

Figure 3-1 Overall Structure of Spreadsheet

1. System-wide summaries. This provides a summary of vehicle-hours, vehicle-miles, etc., for each year of the month with year-to-date totals.
2. County summaries. These provide a summary of vehicle-hours, vehicle-miles, etc., for the current month by county. System totals also are provided.
3. Expenditure versus budget. This provides a summary of expenditures for the month and the year-to-date and compares the results to the budget.
4. Graph options. This provides convenient graphs summarizing many of the aggregate input parameters by month and by county.

Performance Measures and RTMIS

As discussed in previous chapter, the State of Virginia applied an overall structure to the evaluation of rural transit performance. This triangle expressed the conceptional relationship between inputs and outputs of a transit system. The input side is called resource input, and two output sides are called service output and public consumption. For this triangle, there are three pairs of relationships:

1. Resource efficiency: Service outputs Vs Resource inputs;
2. Service effectiveness: Service outputs Vs Public consumption;
3. Cost effectiveness: Public consumptions Vs Resource inputs.

The above performance measures are not sufficient to construct a complete software system. As a computerized information system, it

must provide some functions which could help people analyze and compare these measures on a time dimension basis, such as a month, a year, and/or space dimension basis, such as a county, a transit system. Therefore, RTMIS should have outputs related to the performance measures distributed along both a time and space axes. Based on this consideration, the output of the RTMIS becomes a vector described by a three-dimensional space as noted in Figure 3-2.

In Figure 3-2, the first axis Ox represents the transit system for different location, e.g. different counties; the second axis Oy represents different time periods, it could be a month, fiscal year or year to date; and the third axis Oz represents certain performance measure of efficiency and effectiveness as presented in Figure 2-2. In this Oxyz three-dimensional space, any performance measure defined by the triangle can be located in one particular location. In fact, a performance measure in this three-dimensional space is a vector. Since it is a vector, the methods in comparing vectors can be applied

Thus, a performance measure vector **N** (x, y, z) consists of three components:

1. The time value on the Ox axis;
2. The location value on the Oy axis; and
3. The value of performance measure on the Oz axis.

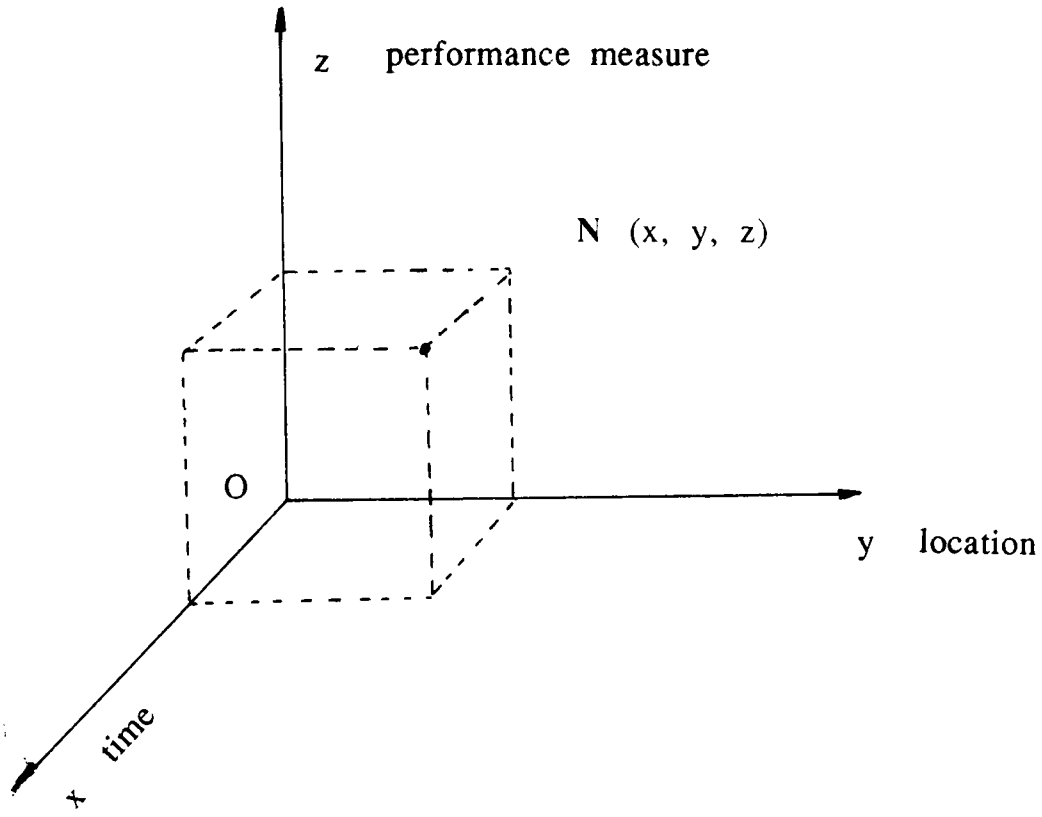

Figure 3-2 RTMIS Output

The combination of these parts forms a performance measure vector **N**.

The output from RTMIS represent a set of performance measures reflecting the effectiveness and efficiency of a transit system such as operating cost per vehicle-mile, passenger-miles, etc. In other words, the numerical value expressed on the z axis is not a single performance measure but a set of numerical values which represent all the performance measures identified as output from the software system. The forth axis, Ow axis, is introduced to describe this set of data. Therefore, any one of the performance measure outputs from the RTMIS can be summarized as a vector **N** (w, x, y, z).

After the definition of the performance measure vector **N** (w, x, y, z), a three variable function z = f (w, x, y) existing in the four-dimensional space Owxyz is defined. In this z function, Function z = f (w, x, y) can be explained as following:

1. w is a independent variable represents different performance measures;
2. x is a time independent variable represents different statistical time periods in the RTMIS output;
3. y is also an independent variable represents different locations of the transit service;
4. z is the dependent variable, its value depends on variables w, x, and y.

The whole output of the RTMIS can be expressed as a function z = f (w, x, y) existing in a four-dimensional space. Here are two examples of this z function:

z = f (w, x, y)

f (vehicle-miles, July 1989, Washington County) = 1,500

f (operating cost/passenger trip, April 1988, Loudon County) = $5.23

After the RTMIS output mode has been established, the relationship between performance measures and RTMIS is also settled (see Table 3-1). In fact, the outputs of the RTMIS software have two basic categories:

1. A set of summarized reports related to the transit system's resource input, service output, and public consumption.
2. A set of performance evaluation reports dealing with transit system's efficiency and effectiveness.

In the first category, RTMIS uses resource inputs, service outputs and public consumption as a input to the software. The output is a summary of the input data. Therefore, the measurements of the output use the same performance measure set as presented by input data. The difference between the input and output is that the RTMIS output summarizes the input data by time and/or location.

In the second category, RTMIS uses resource input, service output and public consumption as input, and provides efficiency and effectiveness measures to assist managers in evaluating the transit system.

Table 3-1 Input and Output Relationship in Performance Measure and RTMIS

RTMIS Output Function	RTMIS Input Measures	RTMIS Output Measures
Summary	Resource inputs Service outputs Public consumption	Resource inputs Service outputs Public consumption
Evaluation	Resource inputs Service outputs Public consumption	Resource efficiency Service effectiveness Cost effectiveness

Software Selection

Introduction of Softwares

A number of computer languages has been developed to parallel the rapid progress of computer technology over the last two decades. Each language is suited to particular fields such as business, mathematics, science, or education[8].

Programming languages can be categorized into three general levels: machine language, assemble language, and advanced language. Depending on the execution mode, the advanced language can be divided by two basic types: interpreted execution and complied execution. For example, BASIC is normally considered as a interpreted executed language, while FORTRAN and PASCAL are considered complied languages.

The advantage of BASIC is that the computer interprets the program statement by statement while the program is running. The program can be run immediately after any changes are made in the program. The disadvantage is that the operation speed is slower when compare to the execution speed of complied language. FORTRAN or PASCAL type languages has a higher execution speed, but the problem is that a so called "compiler" program is needed to translate a source code to an objective code before running the program. The result will not obtained until the objective file has been executed. Any change in a program will cause the compiler to run in order to obtain an objective file.

In recent years, there are several different types of computer software have been developed. Two of them relate to the data processing. One is *Integrated Software*, and another is called *Database Management System* (DMS). Integrated software and DMS are different from advanced languages. Usually they are written in another advanced language, such as "C".

The integrated software combines popular and common application areas, such as spreadsheets, graphics, database management, and data communications into one single program. With several program applications built into one program, users benefit from its convenience, consistency, common commands and data-sharing capabilities. There are two methods of data manipulation. One is an interactive method. It provides a set of commands for accessing, manipulating and displaying the spreadsheet. This allows the user to operate the software through a keyboard, and run the commands one by one, step by step. Another technique is to use a programming language which is called a "macro". Similar to the advanced language, it allows users to write their own applied program. Lotus 123 is an example of integrated softwares.

DMS provides convenient and powerful ways to process data. There are three types of DMS, hierarchical database, network database and relational database. Each one has its own technique to organize data logically and establish relationships among the data files. In microcomputer applications, the most common database structure is the relational database which expresses data in tables

of rows and columns. Data within a relational database are not accessed through predetermined node paths as in hierarchical and network database. Therefore, data are more accessible and independent in relational database. dBase III or IV is one of the most commonly used database software in microcomputer applications. Like Lotus 123, Operation of dBase III and IV also have two modes: screen menu mode and dBase language mode.

Software Selection

The first step of developing a RTMIS was to select an appropriate software/language. There were several aspects must be taken into consideration during the process:

1. Speed;
2. Memory;
3. Data file size;
4. Data processing function;
5. Graphic function;
6. Report function;
7. Program security;
8. Interface with other languages.

There were five softwares/languages considered in the first round selection: FORTRAN, PASCAL, BASIC, dBase III, and Lotus 123.

FORTRAN was rejected. The reason was that it has a weak data processing function and scientific calculation capabilities are normally considered as its advantages. PASCAL is very good in both

scientific calculation and data processing. However, less people are familiar with its language structure, especially its data file structure. Once a software program is written, it is not easy to change or modify. PASCAL was then rejected. In addition, neither FORTRAN or PASCAL has a graphic function, which was considered very important to RTMIS.

After the initial comparison, only BASIC, dBase III & Lotus 123 were considered. A more detailed thorough comparison was carried out among these softwares. In the process, following eight factors were considered:

1. Speed: BASIC is operated under an interactive mode which means that the computer translates each statement one by one to machine code and executes each statement one by one. Compared to the FORTRAN execution mode, it is slow, but it is faster than both dBase III and Lotus123. The execution logic of the different softwares being compared are presented in Figure 3-3. The Lotus macro execution mode is the slowest in all, because it has a strongest interactive function which does not only occupy more memory but takes more time to complete a simple operation.
2. Memory: The more advanced Lotus 123 version requires more memory. Lotus 123 version 2.2 occupies about 320k memory which is about 50% of conventional memory of an IBMPC computer. By comparison BASIC uses about 25-30K

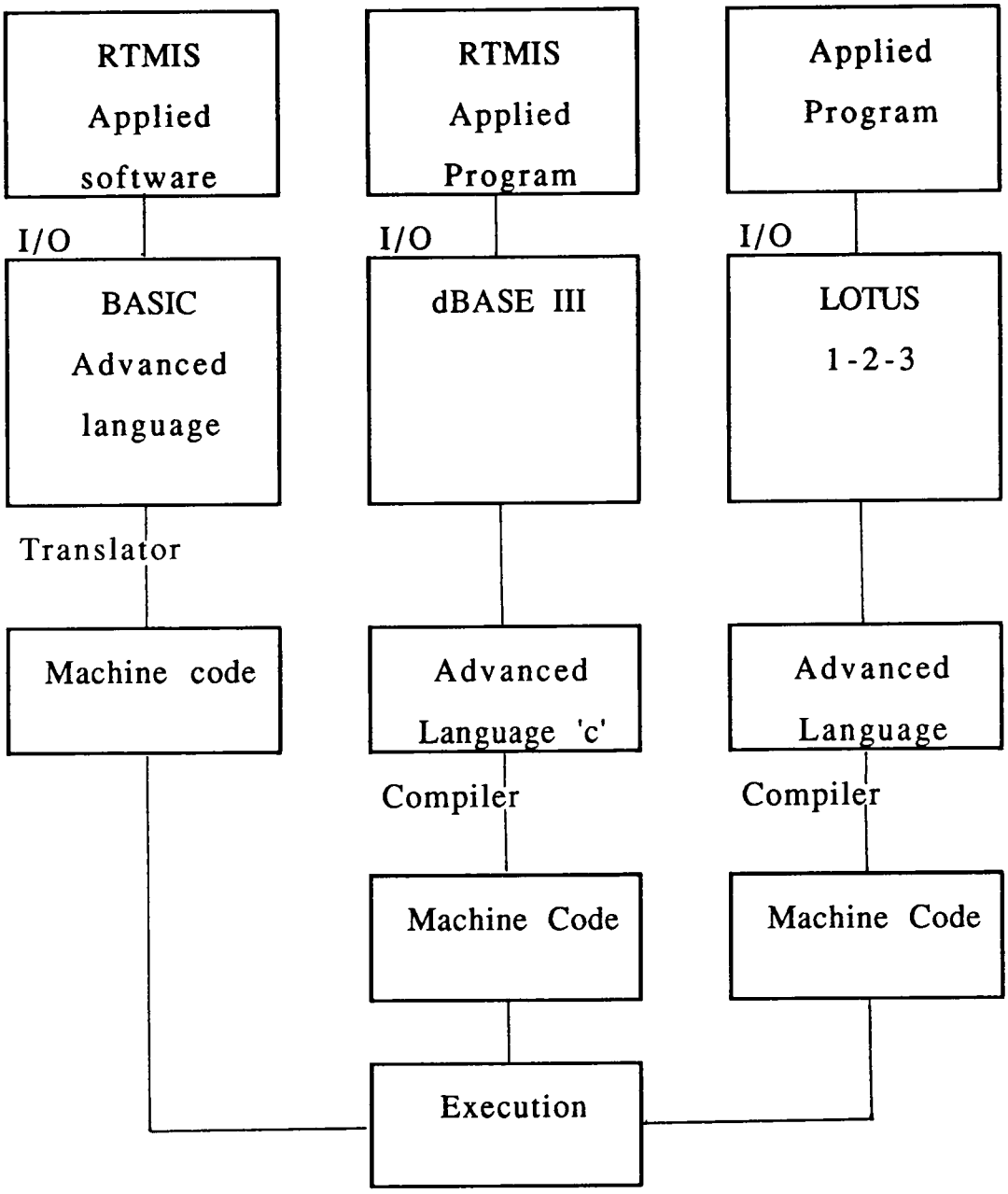

Figure 3-3 Execution Process in Softwares

memory space. The memory for dBase is in the middle which is about 150 k..

3. Data file size: The maximum applicable data file size for BASIC is large, it is about 550K (.txt file). For dBase III, is about 350-400K (.dbf file), and 100-120K (.wk1 file) for Lotus 123. Considering that the .txt file and .dbf file both can handle more information than .wk1 file for the same memory, the actual equivalent data density in .wk1 file will be even lower than its marked size.
4. Data processing function: BASIC itself does not provide any data processing function. All the data process functions, like searching, sorting, etc., are written by a programmer by creating several procedures or subroutines. BASIC language provides a capability to develop this function. dBase III, as a specialized DMS software, provides a set of commands to realize different data processing functions. It is easy for programmer to access the data files and manipulate them. Lotus 123 also has a set of pre-set menu, to assist the user with database operations. With the help of its screen display, and electronic spreadsheet, the database operations become more convenient.
5. Lotus 123 has an excellent graphic function. In BASIC, the graphic function can be completed by a set of programs. Similar to its data processing function, each graph display needs many statements to form a set of subroutines, and it

is complicated for programmer to modify or change the program once it is written.

6. BASIC, dBase, and Lotus 123 all have a good report printing function which allows user to develop their own reports. Lotus 123 has the advantage of a convenient screen display, and the report printing is easier to use than the others.
7. Program security: In BASIC and dBase III, the data file is separated from the program file. It is not easy to destroy both the data file and program file simultaneously. Meanwhile, the program file itself is not easy to access unless the user wants to make a modification. The program needs a word processor or an edit software to make the change. Lotus 123 is a spreadsheet and once the program is retrieved, everything is displayed on the screen. Sometimes, a wrong keyboard operation can erase the program files even if the program has been hidden or blocked by the commands.
8. Interface with other language: Lotus has a very strong interactive capability. It can translate data between any two of following files: dBase II; dBase III; Lotus 123 version 1.0, 2.0, 2.2, 3.0; VISICALC; Symphony; and text file. dBase III can transfer data between .txt file and .dbf file, while BASIC has a relatively weak function.

A summary of evaluation considering the capabilities of these softwares of RTMIS is presented in Table 3-2.

Table 3-2 A Comparison of Different Softwares

	BASIC	dBase III	Lotus 123
Execution Speed	High	middle	Low
Memory requirement	20-30 k	150 k	300 k
Data file size (depends on available memory size)	Large	Middle	Small
Data processing functions	Weak	Strong	Middle
Graphic function	Weak	No	Strong
Report function	Middle	Middle	Strong
Interface from other language	.txt file	.txt file	.dbf file; .txt file; .wq1 file; etc.
Program security	High	High	Low

According to above analysis, Lotus 123 was selected. The reason was that it met all the RTMIS requirements, especially its graphic functions. dBase III might have been selected if it had a graphic function. The second reason was that Lotus 123 uses macro which is easier than BASIC to conduct database operations, such as sorting, searching, etc. Lotus 123, like dBase III, has a very good capability of changing the program structure which is important in dealing with potential program expansions. Additionally, the Tennessee Department of Transportation has designated Lotus 123 as an official software. In fact, several counties and transit agencies have already purchased this software.

Therefore, Lotus 123 was selected to develop a generic RTMIS for Tennessee Section 18 operators.

Application of Lotus 123 to RTMIS

Speed Requirement

The Integrated software Lotus 123 was first developed in 1982 by Lotus Development Crop.. "1" means spreadsheet, "2" means data base management, "3' means business statistics graph. Starting from release 1.0, the latest version is release 3.1. It has several advantages comparing to other spreadsheet software[12]:

1. It is easy to learn and operate;
2. The processing speed is faster than normal electronic spreadsheets;

3. It is easier to operate by using macro to input data and operate the software;
4. The theoretical capacity of spreadsheet is 2048 x 256 cells;
5. A strong help function and interactive tutor system are available.

RTMIS is an applied program built on Lotus 123. Lotus 123 is designed to deal with small data base for normal business purposes, as well as its macro command set. When using Lotus 123 to develop an applied software under the DOS(Disk Operation System), it does not have some of the above advantages. The main problem with Lotus 123 is its slow speed and relatively small useable memory.

The calculation speed of a computer is determined by its CPU (Central Process Unit) structure, system bus and clock frequency. Table 3-3 lists the speed related parameters for major IBM personal computers. As noted for IBM PC/XT computers, the time to run the same program could become quite extensive.

CPU works step by step controlled by a uniformed clock pulse. For the same calculation task, the higher clock frequency, the higher calculation speed. Meanwhile, IBM PC/XT CPU has 2 bytes (16 bits) word length, but it only has one byte (8 bits) data bus lines to exchange processed data between CPU and RAM, I/O facilities and this also limits the speed of computer. PS/2 70, a 32 bits computer, has 4 bytes word length in both CPU and data bus system. This means the computer can process more information simultaneously under the same clock frequency.

Table 3-3 Speed Related Parameters in PCs

Computer Type	CPU	CPU Word Length	Data Bus	Clock Frequency
IBM PC/XT	Intel 8088	16 bits (2 bytes)	8 bits (1 byte)	4.77MHz
IBM PC/AT	Intel 80286	16 bits (2 bytes)	16 bits (2 bytes)	8-12MHz
IBM 386sx	Intel 80386sx	32 bits (4 bytes)	16 bits (2 bytes)	12-20MHz
IBM PS/2-70	Intel 80386	32 bits (4 bytes)	32 bits (4 bytes)	25-33MHz

Memory Requirements

Memory is another problem in developing RTMIS. Lotus 123 needs about 320K RAM to load the program under a normal situation. Unfortunately, the DOS, which is used by most of the IBM PC and its compatibles, could only handle 640K RAM.

In addition to the temporal file, calculation functions also require memories during an execution of the program. The number of memory units used depends on the size of a spreadsheet, and complications of a calculation task. The actual useable memory for a user file is about 150K which should be adequate for conventional business applications, but for RTMIS, this is not sufficient. According to a rough estimation, the macro program itself would have about 2,000 statements which is approximately 150-200K. When adding working files, data base files, output files, etc., 150K useable memory is far less than the minimum requirement. A typical memory assignment in a IBM PC/AT computer is shown in Table 3-4.

Speed and Memory Contradiction

Under the normal situation, the speed of the computer is not closely related to the amount of RAM occupied. In Lotus 123, it has a very close relationship. This is another disadvantage for developing RTMIS on Lotus 123. The problem is when the data file reaches a certain size, the calculation speed goes down very quickly.

Table 3-4 Memory Assignment in IBM PC/AT[7]

Address	Memory Assignment	Function
000000H	512K RAM (System Board)	640K RAM
080000H	128K Expandable RAM (Optional)	
0A0000H	128K Display Buffer	Display Memory
0C0000H	128K Expandable ROM	ROM
0E0000H	64K System Reserved ROM (System Board)	
0F0000H	64K Basic ROM (System Board)	
100000H	15M Expandable RAM (Optional)	Expandable Space for XENIX
FE0000H	64K System Reserved ROM	
FF0000H	64K Basic ROM	

To understand how useable memory impacts computer execution speed, a test was designed. In the test, spreadsheets of different size were used to simulate the data files utilized in RTMIS. The actual memory used by Lotus 123 under the static condition was 260K. The test method was quite simple: let the computer do 100 calculations with a loaded spreadsheet by a pre-written macro program, and recorded the time used to complete the calculations. Table 3-5 indicates the result from this simulated speed test on Lotus 123 release 2.2 when using an IBM PC/XT. It is clear that the speed is effected by the amount of occupied memory. When the percentage of occupied memory increases to 75 percent capacity, the program could only do some very simple one step calculation with a long reaction time. It was also detected that Lotus 123 needed about 100 minutes to complete a sorting function with two primary key columns in a file having 1,000 records with a memory that was 75 percent occupied.

A major effort in developing RTMIS with Lotus 123 became to increase memory while retaining a high calculation speed. In computer technology, there are two common techniques to solve this problem. One is to use an engineering approach which deals with hardware improvement, another is to use programming approach which deals with software improvement. Under some situation, both approaches are adopted simultaneously.

Table 3-5 A Speed Test on Lotus 123

Memory Remains (k byte)	% of Memory Occupied (100%=380 k)	Speed (seconds)
384.9	1	127
300.9	22	206
223.5	58	522
125.8	67	875

With a hardware approach, memory can be expanded to 1 Mb or 2 Mb by adding a RAM chip. This changes DOS to a XENIX operating system which can effectively control up to 15 Mb RAM, or, to purchase another software to expand the addressable range of DOS. In this way, the useable memory could be expanded to an accepted level. Unfortunately, it was not possible to adopt this choice in developing RTMIS. First, it is impossible to change the operation system in all the computers used by Tennessee Section 18 rural transit operators. The greatest concern is that applied softwares on the existing IBM personal computers may not be compatible to the new operational system. Second, the IBM PC/XT and its compatibles do not have RAM expansion capability. Since there are still a considerably amount of PC/XT in use, it may not be an economic way to retire these machines .

A software approach was adopted by reducing the memory occupied by using a smaller size program and smaller size of data files. The disadvantage of this approach is that it requires a longer execution time for some situations. But this approach could solve the space-time contradiction effectively. Another requirement is that this approach requires higher programming skill and a well designed program structure.

Since the hardware approach is not possible, the software approach was adopted in developing RTMIS.

CHAPTER 4
RTMIS STRUCTURE

Structural Programming Technique

Historically, there were no formal rules or guidelines for programers to develop their systems. This created a serious disadvantage that there were no standards for this system process. The structure or the organization of a program largely depended on the person who originally developed it. Once developed a program could be very difficult to read, modify, transfer, or even to learn by another programer. In order to avoid the difficulties of users, a set of rules which are called structured programming methodology, has been developed[11] It brings some uniformity to the system process and helps programmer develop a system with the following advantages.

1. Better system design with fewer errors;
2. Systems with lower cost;
3. More understandable and friendlier programs;
4. More flexible systems able to match future change or expansion;
5. Shorter programming development period.

Four major requirements of the structural programming technique are: 1) *top-down approach*; 2) *the rules of module*; 3)

data-flow VTOC (Visual Table Of Contents) *Diagram* ; and 4) *IPO* (Input Process Output) *Chart*. The development of RTMIS will follow these requirements in order to create a practical and applicable software.

The top-down approach reduces complex processes to their simplest levels, and works from the big picture down to the details. A process is divided and subdivided until it is reduced to a series single functions or tasks, called modules. A properly constructed module should follow two rules:

1. Each module describes only a single task;
2. A module should have one single entry point and one single exit point in the program.

The VTOC data flow diagram explains the flow of the data between module conversion process, but it does not explain how input data are converted to output data. At the top of the VTOC is a higher level module. On the next level are lower level modules of the system. The IPO chart explains the function of each module. In other words, it describes what each module represents and what it is supposed to accomplish. VTOC and IPO are two useful tools to help programmer to utilize the top-down approach.

RTMIS Structure and General Control Module

As mentioned before, the main function of RTMIS was to assist local transit operators to manage the quality of the rural public transportation service. A clear system description and design would assist in achieving this important objective. The major

problem in developing a RTMIS is the contradiction between speed and memory. Since a structural programming technique is adopted in RTMIS, the whole program can be divided into four independent modules. It then becomes possible to separate the RTMIS into four smaller programs corresponding to four modules. Each of these modules can be operated separately. Meanwhile, there is a general control module (numbered 0.0 in VTOC) which determines when one of the four sub-programs should be executed. In this way, the number of occupied RAM could be reduced greatly. The relationship among the major modules is outlined in Figure 4-1, RTMIS Main Module 0.0 VTOC Diagram.

There are three functions in the general control module:

1. Sets time and date. This is important to RTMIS, because the final reports and graphs need to show report date, the internal files need to record the date when files were last modified. This module also helps the transit operators set an appropriate fiscal year range because the fiscal year for 8 of the 11.systems start on July and ends on June, and for the other three systems the fiscal year is September through August.
2. Controls the path to four sub-programs (numbered 1.0 to 4.0 in VTOC) through a menu.
3. Sends all the settings and results to the Information Exchange Block (IEB) which starts at address A400.

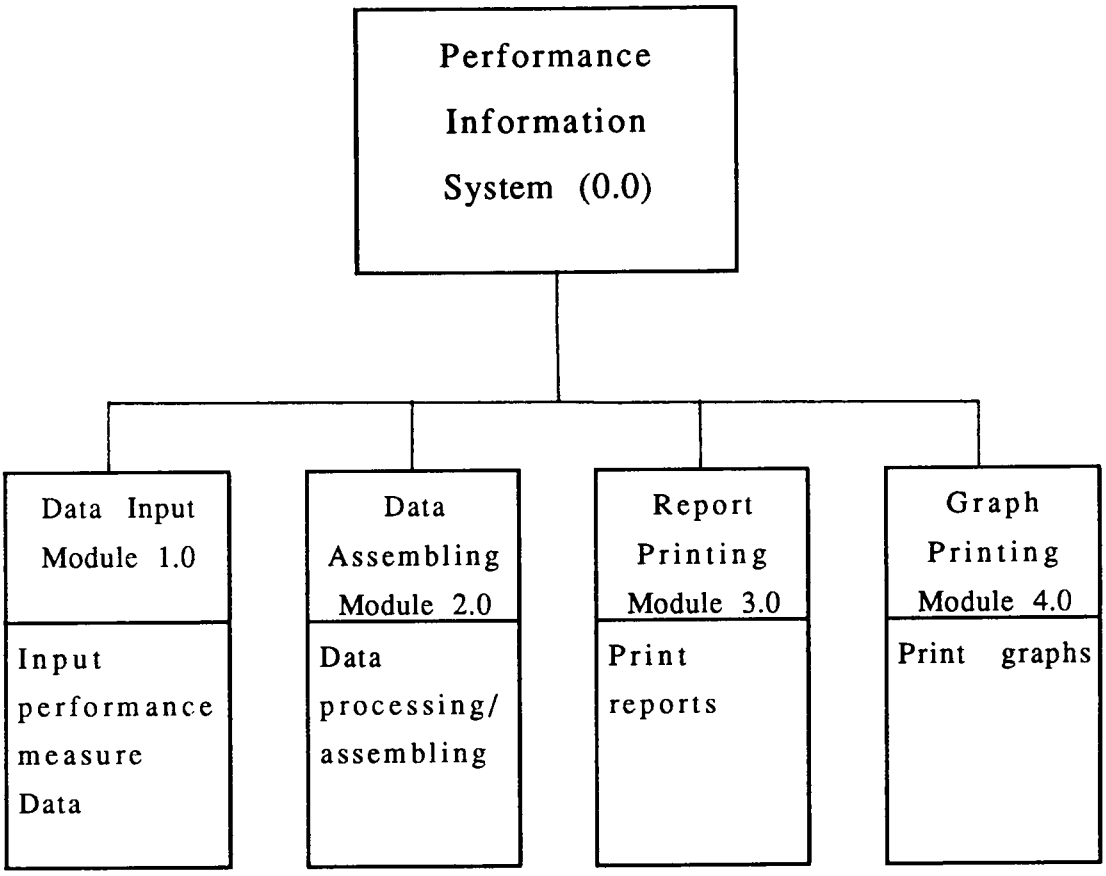

Figure 4-1 Main RTMIS Structure (Module 0.0)

VTOC Diagram

In RTMIS, START.WK1 file and the beginning part of INPUT.WK1 file contains the general control module (0.0). The IPO chart of Module 0.0 are shown in Table 4-1 which explains the data processing procedure of General Control Module.

Associated with each performance category as discussed in Figure 3-3, there is a match with a performance measure defined for application by the Tennessee rural transportation operators. The relationship is highlighted in Table 4-2.

Besides VTOC diagram and the selected performance measures, it is also important to set a series of fixed working zones on a spreadsheet. When RTMIS is running, the program, data files, middle files and Information Exchange Block (IEB) will be opened on a same spreadsheet. It is necessary to give each of these files a fixed area with an appropriate address. The computer program will search the file and process the data according to this pre-assigned address of the working zones. In RTMIS, there are five blocks of cells that are addressed. as noted in Table 4-3.

Discussed in the next Chapter will be the Input Modules of the RTMIS.

Table 4-1 RTMIS General Control Module (0.0)

IPO Chart

Input	Process	Output
1. Current date 2. Select the module to be operated	1. Verify date 2. Determine fiscal year range 3. Record date & fiscal year on IEB	1. Correct date 2. Current fiscal year range 3. Retrieve selected module

Table 4-2 Selected Performance Measures

Performance Category	Performance Measures
Resource Inputs	Monthly expenditure Administrative cost Operating cost Capital cost Vehicle assigned Fleet size Cost/vehicle Percent of administrative cost Depreciation cost
Service Outputs	Vehicle-hours Vehicle-miles

Table 4-2 (Continued)

Performance Category	Performance Measures
Public Consumption	Number of passenger trips General public passenger trips (over and less than 60 years old) Contract passenger trips (over and less than 60 years old) Wheel chair passenger trips (over and less than 60 years old) Fare revenue Percent of elderly trips Percent of wheel chair trips
Resource efficiency	Vehicle-mile/veh-hour Vehicle-miles/vehicle assigned Cost/vehicle-mile Cost/vehicle-hour Maintenance Cost/vehicle-mile Labour cost/Vehicle-hour Fuel cost/vehicle-mile
Service effectiveness	Passenger Trips/vehicle-hour Passenger Trips/vehicle-mile
Cost effectiveness	Passenger trips/vehicle assigned Wheel chair trips/vehicle assigned Cost/passenger trip

Table 4-3 Working Zone Assignment

Zone Name	Function	Address on Spreadsheet
Program	Stores Lotus 123 macro	A450 to H2000
Display	Stores on screen display	A1 to H399
Exchange	Stores system indicator table shared by different modules	A400 to H449
Input	Stores different input data files	I1 to Z200
Temp	Stores middle files and temporal data during the processing	Address starts from I201

CHAPTER 5
INPUT MODULE

Introduction of Input Module

The first module under the General Control Module 0.0 level is Input Module 1.0. The main functions of this 1.0 module is to input the performance measure data and create a sets of data file. Module 1.0 can also be divided into to four sub-modules, which deal with the input tasks of four input data tables. The sub-modules are numbered from 1.1 to 1.4.

Data Table 1 (see Figure 5-1) in Module 1.1 is called the Vehicle Report Monthly Summary. It is a table with 13 columns. Each column represents different vehicle trip information, such as number of passenger trips, vehicle-miles, etc. from each vehicle. Since Table 1 provides vehicle trip information on a monthly basis, there could be a maximum of twelve Data Table 1 in a given year. The file name of Data Table 1 is defined as yyyymmm.WK1, where yyyy represents the two last two digits of a fiscal year and mmm represents the first three letter of a month name. e.g. for Table 1 in the May of fiscal year 1988 to 1989, the file name is 8889MAY.WK1. Module 1.1 can be divided into five sub-modules: append, modify, delete, print, check & save.

DATA TABLE 1 VEHICLE TRIP MONTHLY SUMMARY YEAR: 1988
MONTH: OCT

The last time you changed data was: 09/06/90

				<<<<<<<< NUMBER OF TRIPS >>>>>>>>>								
				GENERAL PUBLIC		CONTRACT		WHEEL CHAIR		VEHICLE	VEHICLE	
RECORD #	VEH. ID	VAN/RT#	COUNTY	< 60	>= 60	< 60	>= 60	< 60	>= 60	-MILES	-HOURS	FARES
1	8706	8	HAWKINS	2	458	0		2		1,892	770	134.73
2	9999	9	HAWKINS	20	406	26		2		2264	770	156.23
3	8822	7	HAWKINS	66	20	91		0		179	440	48.02
4	8823	10	HAWKINS	38	105	360		2		2140	880	144.06
5	8824	16	HAWKINS	0	821	0		0		1503	880	411.23
6	7644	PT109	HAWKINS	0	1	0		0		1167	440	22.21
7	113	37	HAWKINS	15	426	15		0		1588	770	225.34
8	8825	18	HAWKINS	3	116	535		0		2199	880	156.95
9	114	36	HAWKINS	3	126	361		0		2705	770	210.68
10	5846	73	HAWKINS	1	50	20		0		540	440	30.1
11	4223	17	HAWKINS	9	94	9		0		349	440	51.76
12	1035	11	HAWKINS	0	83	421		0		2710	880	162.66
13	1037	12	HAWKINS	2	3	2		0		235	440	15.77
14	4306	14	HAWKINS	2	125	421		0		2493	880	163.4
15	4308	15	HAWKINS	0	0	0		0		250	440	27.33
16	109	20	CARTER	0	291	115		0		1724	770	156.34
17	8708	21	CARTER	0	426	0		0		2134	770	174.82
18	8818	22	CARTER	0	668	75		0		2432	880	281.37
19	5845	23	CARTER	0	30	0		0		278	440	12.73
20	5844	24	CARTER	0	12	0		0		231	440	4.91
21	8821	25	GREENE	13	538	63		0		2132	880	262.78
22	8705	26	GREENE	0	255	57		0		1293	660	127.23
23	8819	27	GREENE	17	480	72		0		1927	880	214.54
24	7037	28	GREENE	9	112	299		0		1562	770	197.34
25	110	29	GREENE	7	126	317		0		1727	770	209.48
26	111	30	GREENE	19	217	80		2		1283	660	127.49
27	112	31	GREENE	2	119	206		19		1372	660	135.35
28	8707	32	GREENE	25	120	89		0		934	440	110.27
29	8820	33	GREENE	41	83	324		2		1,727	770	211.23
30	7645	34	GREENE	0	11	0		0		57	440	5.34
31	9864	35	GREENE	2	49	12		0		395	440	21.54
32	4224	36	GREENE	43	234	195		2		1,926	770	211.15
33	1040	37	GREENE	0	64	32		3		572	440	39.48
34	4305	38	GREENE	0	6	8		0		283	440	5.39
35	4225	40	JOHNSON	0	195	0		0		876	440	80.69
36	8826	41	JOHNSON	0	331	0		0		1,247	660	148.32
37	115	42	JOHNSON	0	35	2		18		469	440	15.47
38	116	43	UNICOI	2	951	2		1		2,849	880	426.48
39	8827	44	UNICOI	47	417	59		0		1,862	880	215.37
40	4226	45	UNICOI	15	429	15		0		1,587	770	208.39
41	8829	46	WASHINGTO	40	621	60		8		2,010	880	308.23
42	8704	47	WASHINGTO	4	99	368		95		1,628	770	215.64
43	7643	48	WASHINGTO	30	55	394		85		1,598	770	210.68
44	8830	49	WASHINGTO	9	54	236		61		1,265	440	145.36
45	8828	50	WASHINGTO	6	693	10		2		2,136	880	347.26
46	117	51	WASHINGTO	24	13	337		37		1,247	660	321.68
47	963	52	WASHINGTO	2	39	135		0		581	440	68.36

Figure 5-1 Input Data Table 1

Vehicle Report Monthly Summary

Data Table 2 (Figure 5-2) in Module 1.2 is monthly expenditure input. It contains planned yearly budget (one column), and monthly expenditure (maximum of 12 months) in a fiscal year. Each month has one column. There are also 27 rows in the table which represent different categories of the budget or expenditure. Expenditures in Data Table 2 are subdivided into three categories: administration expenditure, operation expenditure, and capital cost. The size of this data table is 13 x 27. There is one expenditure file once a fiscal year. The file name is yyyyTAB2.WK1. According to the input functions, Module 1.2 has three sub-modules: input & change, print, save & exit.

Data Table 3 (Figure 5-3) in Module 1.3 which includes supplemental data required by Tennessee Department of Transportation. In the table, each county has a column to report number of clients gained or lost in a month. The file name of the table is yyyyTAB3.WK1. Similar to Module 1.2, Module 1.3 has three sub-modules: input & change, print, save & exit.

The last table is Fleet Information Data Table 5 (Figure 5-4) of Module 1.4. Two columns are in the table: van number, and retired van. This table provides resource input information of a transit service. The file name of the table is yyyyTAB5.WK1. This module has the same sub-modules as Module 1.2 and Module 1.3.

All the VTOC diagrams and IPO charts of Data Input Module 1.0 and its sub-module 1.1 to 1.4 are presented in Appendix A.

DATA TABLE 2 TENNESSEE STATE RURAL TRANSIT YEAR: 8889
MONTHLY EXPENDITURE
10/08/90 was the last time you changed data

	BUDGET	JUL	AUG	SEP	OCT	NOV
ADMINISTRATION						
1. SALARY & WAGE	40,000	2,742	2,061	4,525	4,765	
2. BENEFITS	15,033	415	822	837	872	
3. TRAVEL	6,000	311	132	435	458	
4. RENT/UT.	2,647	115	81	62	94	
5. COMMUNICATION	2,174	288	271	220	215	
6. SUPPLIES	4,700	162	37	275	302	
7. INSURANCE	53,498	0	0	0	0	
8. TRAINING	2,000	165	126	504	545	
9. OVERHEAD.	62,746	3,389	3,576	3,898	4,013	
10. OTHER	4,389	1,044	1,076	1,306	1,486	
11. SUBTOTAL	193,187	8,632	8,181	12,061	12,751	0
OPERATING EXPEND.						
1. DRIVER S & W	220,000	19,813	21,874	19,861	22,156	
2. OTHER SALARY	57,000	4,341	4,824	4,342	4,564	
3. BENEFITS	82,319	6,338	6,965	5,921	6,585	
4. FUEL & OIL	38,644	6,320	5,211	6,300	6,719	
5. LISC./INSURANCE		0	0	0	0	
6. RENT/UT.		0	0	0		
7. OTHER DIRECT	31,371	3,785	1,649	2,463		
8. MAINTAINANCE		0	0	0		
9. INKIND	92,252	8,218	6,026	7,591		
10. TRAINING						
11. DEPRECIATION						
12. OVERHEAD						
13. SUBTOTAL	521,586	48,815	46,550	46,477	40,024	0
CAPITAL						
1. VEHICLES						
2. OTHER						
3. SUBTOTAL	0	0	0	0	0	0
** TOTAL **	714,773	57,446	54,732	58,538	52,775	0
	BUDGET	JUL	AUG	SEP	OCT	NOV

Figure 5-2 Input Data Table 2

Monthly Expenditure.

DATA TABLE 3 SUPPLEMENTAL DATA YEAR: 8889

The last time you changed data was 10/08/90

	1. CR Carter	2. GR Greene	3. HW Hawkins	4. JO Johnson	5. UN Unicoi	6. WA Washingto
JUL						
Contract: New	3	0	3	3	2	1
Contract: Lost						
Gen. Public: New	2	2	4	3	3	2
Gen. Public: Lost						
W-Chair Client	7	17	2	7	12	15
Vehicle Assigned	5	12	14	4	3	12
AUG						
Contract: New	2	3	3	2	0	3
Contract: Lost						
Gen. Public: New	1	1	5	3	4	3
Gen. Public: Lost						
W-Chair Client	7	5	7	9	16	10
Vehicle Assigned	5	12	14	4	3	12
SEP						
Contract: New	2	3	3	4	3	1
Contract: Lost						
Gen. Public: New	4	2	4	3	1	5
Gen. Public: Lost						
W-Chair Client	16	12	2	10	1	14
Vehicle Assigned	5	12	14	4	3	12
OCT						
Contract: New	3	4	4	2	4	1
Contract: Lost						
Gen. Public: New	2	4	4	5	4	4
Gen. Public: Lost						
W-Chair Client	1	17	11	17	9	17
Vehicle Assigned	5	12	14	4	3	12

Figure 5-3 Input Data Table 3

Supplemental Data

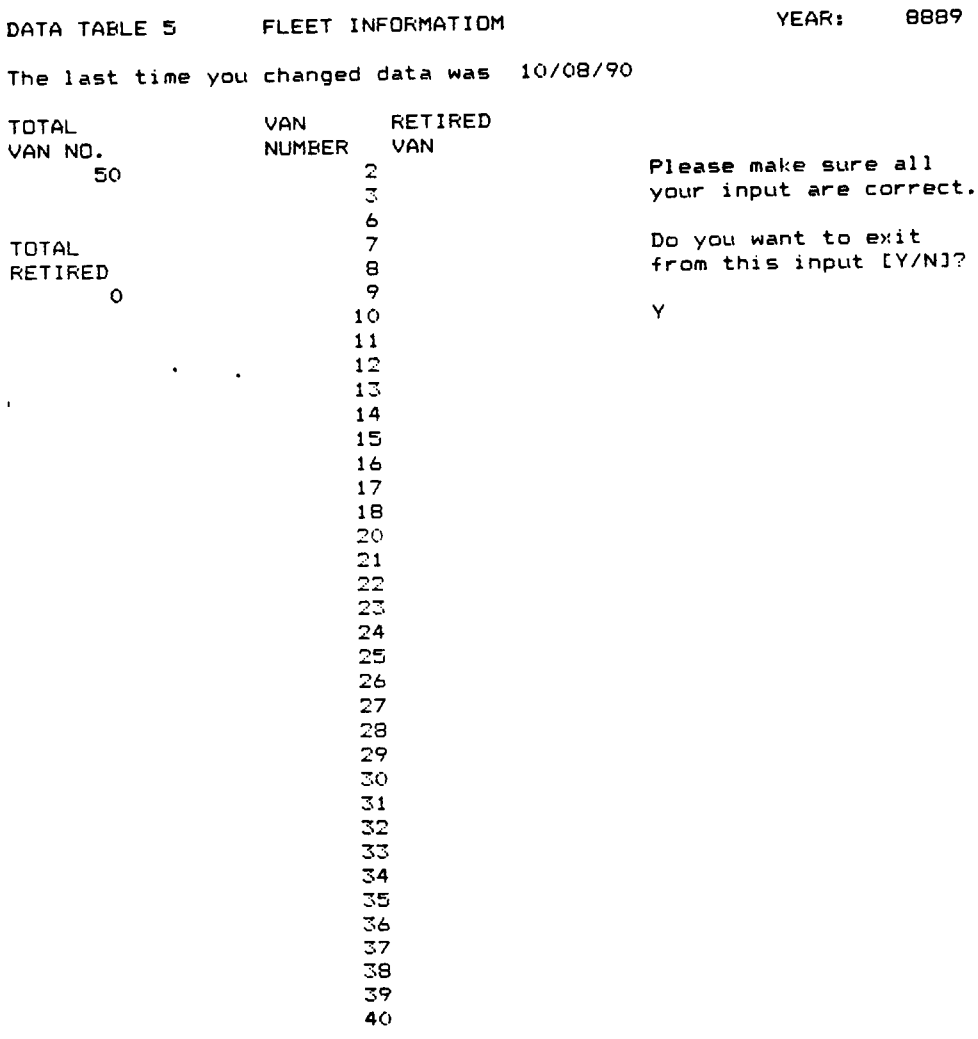

Figure 5-4 Input Data Table 5

Fleet Information

Design Considerations

Input & Output Technique

The final purpose of programming is to let the user apply the program. The information exchange between user and computer is through the input/output module of the program, so the quality of the input/output module is very important in an applied software. In computer programming, *availability* is one of the most important aspects in evaluating the quality of an input/output program of a software.

Availability considerations include[12]:

1. Give user instruction when program needs an input;
2. Provide default value whenever it is possible;
3. Use simple, and natural way to input data in order to give user high degree of convenience;
4. Display error information when wrong input occurs;
5. Provide help functions;
6. Provide a clear and easy to understand input screen format.

Input Screen Format

Input Data Table 1 is the largest data file set in RTMIS. A great effort has been made in the Module 1.1 programming process in order to provide Tennessee Section 18 rural transit operators a friendly and convenient interactive function. There are two input screen formats that can be adopted in Lotus 123. One is "Full Screen Format" where the user input each record directly in a formatted

data table on the screen by moving the cursor. This is the most common way to input data in Lotus 123. Users can then access any cell on that input table. The risk is that the data table could be erased by an enormous operation, like /RE command or /WE command in Lotus 123. Meanwhile, the user has to move cursor every time after one field of a record has been inputted. When the input data table has more than 8 columns, it is not easy to prevent mistakes. In Lotus 123, each screen has 8 columns (A to H) which represent eight fields in a normal situation, and if a record has more than 8 fields, the user has to move to another screen. This could pose a difficulty even for a trained operator to enter data. Since there were 13 fields and maximum of 199 records in Data Table 1, it was not appropriate to develop a input format based on a "Full Screen Format".

Another approach is "Separate Screen Format" by using a very common format used in other advanced programming languages. Actually, this is an extension of the "Menu" technique. In this format, the user inputs each record on a pre-set screen. When one record is completed, the program copies the record to the formal data table file, and display the pre-set screen for next record input. The user does not have to worry about the location of the field, the record number, the program takes care of all input related functions. All an operator needs to do is to use the keyboard to input data according to the instruction shown on screen. This provides the user a easy, understandable input format and a simple way to input data. On the other hand, much more programming is

required to develop the Separate Screen Format. One of the reasons is that Lotus 123 macros are not designed as a standard language, but rather as an assistance tool for spreadsheet operations. In RTMIS, more than 300 statements are needed for "Separate Screen Format", while less than 50 statements would be required had the "Full Screen Format" been utilized. The input format and its screen displays used in RTMIS are shown in Appendix B: Users' Guide for Tennessee Rural Transit Management Information System.

Input Data Check

RTMIS Input Data Table 1 Module 1.1 also provides a basic error check function on the County Name input. In RTMIS, the county name is a primary key word in data processing, as many of statistical reports are based on it and any error in the county name would seriously effect the accuracy of the reports.

Under normal condition, this check should be executed immediately after the record input similar to that done in the most advanced language. In Lotus 123, It takes a few seconds for the program to process the check. When comparing this checking speed to keyboard input speed, the slower response makes this immediate check impossible. A separated check function has to be designed for RTMIS.

The principal of the check function is quite simple. The program obtains a county name Data Table 1 file(yyyymmm.wk1), and compare it to the county name list on a previously set file, yyyytab4.wk1, which contains all county names for a particular

transit system. If this county name can be found on the list, then next county name on yyyymmm.wk1 file will be picked. If a county name can not be found on the county name list, the program will send out an error massage and display the error record. The user than will be asked to quit from the check module and go back to the modify module or delete module to correct the mistake. After the error is corrected, the program will start to check again from very beginning until no error is detected. The program could save Data Table 1 only after all the errors on county name are corrected. There are several other "compare" methods that could be used in data structure technique. The one used in RTMIS is not the most efficient, but it is very simple and easy to program by using Lotus 123. If the number of records are limited, the processing time should be acceptable. In this case, the comparing process takes about 5 minutes on an IBMPC/XT machine. which is one of the slowest computers on the current computer market.

The next chapter will discuss the data assembling module.

CHAPTER 6
DATA ASSEMBLING MODULE

Introduction of Assembling Module

Following the Data Input Module 1.0 is Module 2.0, Data Assembling Module. There are four major tasks in this module:

1. Summarize Data Table 1 by county name and month;
2. Create middle files;
3. Create final report file;
4. Create graph file for printing.

According to above tasks, Module 2.0 can be also divided into 4 sub-modules which are numbered from 2.1 to 2.4.

The input to Module 2.0 contains three parts. One is the output of Module 1.0, as previously mentioned. The input files of Module 2.0 are Data Table1, Data Table2, Data Table3, and Data Table 5. Data Table 4, a predetermined internal file which includes the names and population of counties in the system, is also considered one of the input files. In addition, a set of predefined data forms provide a frame for creating print out reports. Corresponding to the report format, there are eight blanked report files: T1.WK1, T2.WK1,..., T7.WK1, T9.WK1. Since the final reports of RTMIS need information concerning previous fiscal year's transit

operations for comparison to the current year, the previous fiscal year's summary files are used as the third part of Module 2.0 input.

The output of the Assembling Module 2.0 has two sets of files: Report Set and Graph Set. The report set has 8 files which represent 8 output report tables of RTMIS, and the graph set has 12 files which represent 12 output graphs of RTMIS. These output files are related to hundreds of performance measures representing the three variable functions z = f(w,x,y). How to organize a process structure largely depends on the understanding of the relationship between input and output files, and depends on software capabilities. Basically, all the files can be divided into two categories: time period related and location related. In the data process, the strategy is to simplify the whole process by dividing and sub-dividing a big multi-task procedure into several small single task procedures, combine them into different categories and then process them by category. In RTMIS, two basic categories are time period category (by month, year) and location category (by county name). After examining the structure and contents of the final reports, the assembling procedure of Module 2.0 is determined.

The procedure of executing an assembling module is linear. There is no menu to be selected by user. The program runs the sub-modules through a certain sequence. Module 2.1 is run first, module 2.2 is second, ..., until all the sub-modules are executed. The VTOC diagram and the IPO chart of Assembling Module 2.0 are shown on Appendix D.

Design Consideration

Middle File

The middle files and middle areas work as bridges connecting the input and output. This helps the programer to organize the structure of the data processing. It also makes the program easy to write, modify, and expand.

In RTMIS, there are four middle areas (W1, W2, W3, W4) on the spreadsheet, and two middle files (mmmW1.WK1, yyyyW3.WK1). The middle area is a defined area on a spreadsheet. It has a fixed address and serves as a temporary file. In fact, it is a matrix with several columns and rows. Each element in this matrix represents a certain performance measure value. The difference is this middle area only exists during the execution of a module or a program. It will be erased when the program ends. When the data in a middle area need to be stored on the disk, it becomes a middle file.

The data processing in RTMIS has two stages. The first step is "primary processing" which summarized all the input information in the middle area W1 to W4 which include sorting and summarizing existing data by time period (month or year) or location (county). The second step is to select appropriate performance measures and copy them to the final report files which form the report tables or graphs. In other words, the final reports are a combination of the elements on Middle area W1 through W4. Only W1 and W2 would

be stored on the disk, they become middle files mmmW1.WK1 and yyyyW3.WK1.

The main function of the middle areas in RTMIS can be addressed as following:

1. W1 area: It stores currently processed monthly performance measures. Since the program processes data month by month, W1 always keeps the current processed results. When the program saves the contents of W1 on a disk, it becomes a W1 file. The maximum number of W1 files is twelve. They start from July in current year and end to June next year. The actual number of W1 files in RTMIS depends on the current processing month. e.g. if the current processed month is August, the number of files would be two, because August is the second month of a fiscal year. In RTMIS, the Information Exchange Block (IEB) helps user to determine the number of W1 files.
2. W2 area: It has the same structure as W1 area and stores year to date performance measures information. This data process in RTMIS is quite simple. In the W2 area, each element is the sum of corresponding elements in W1 files which start from beginning of a fiscal year to the current processing month. The contents in W2 area can be used for two purposes. One is to be used in the present data processing report, another is to be used as the previous year data when RTMIS works in the next year. Because of

this second reason, W2 area is stored under the yyyyW3.WK1 file name.

3. W3 area: It is a area reserved for loading yyyyW3.WK1 file of previous fiscal year. Its structure is the same as W2.

Information Exchange Block (IEB)

RTMIS is a complete program but it has to be separated into four smaller programs (major modules) because of a limited usable memory and program security consideration. This generates a question: how to share some necessary information like filename, the processing date, etc. among four programs in order to continue the data processing procedure. An IEB was designed for this purpose.

IEB is an area with fixed address in a program. In fact, the program is displayed as a spreadsheet in Lotus 123. Each program records the file management information, such as filename, address, time, etc. on the IEB. This information will be changed along with the execution of a program. When another program needs to use the common information, IEB is retrieved. Since IEB has a fixed address, it is easy to be retrieved. In RTMIS, the retrieving procedure was placed at the beginning of each major module.

Address A400 to H449 were reserved for IEB. It has 400 cells which are sufficient for RTMIS. The physical cell assignment is shown on Figure 6-7. IEB contains the following massages:

1. Current date: used for recording when user last changed the files, or created new file name.

```
                                                                    READY
A399:

        A         B         C         D         E         F         G         H
399
400 IMONTH    DATA_1    DATA_2    DATA_3   MON_IND  TAB1NAME
401 JUL              1         1         1         1 88AUG     8889TAB2
402 AUG              1         1         1         2 88AUG     8889TAB3
403 SEP              1         1         1         3 88AUG     8889TAB4
404 OCT              1         1         1         4 88AUG     8889TAB5
405 NOV              0         0         0         5 88AUG             1
406 DEC              0         0         0         6 88AUG
407 JAN              0         0         0         7 89AUG     TAB2
408 FEB              0         0         0         8 89AUG     TAB3
409 MAR              0         0         0         9 89AUG     TAB4
410 APR              0         0         0        10 89AUG     TAB5
411 MAY              0         0         0        11 89AUG
412 JUN              0         0         0        12 89AUG
413     -999
414 AUG              4         4         4
415     1988      1989 88        89             1988 8889      8788
416 06/19/91 09:12 AM DATE_3    DATE_4            1
417 N_COUNTY
418           AN_MON    AWONE     WTWO_1    WTWO_2
19-Jun-91  09:17 AM                                              CAPS
```

```
A419: (FO)                                                          READY

        A         B         C         D         E         F         G         H
419
420 AMONTH    N_MON     AS_IND    WONE
421 JUL              1         3 JULW1     W3
422 AUG              2         3 AUGW1     8788W3
423 SEP              3         3 SEPW1     8889W3
424 OCT              4         3 OCTW1
425 NOV              5         3 NOVW1
426 DEC              6         3 DECW1
427 JAN              7         3 JANW1
428 FEB              8         3 FEBW1
429 MAR              9         3 MARW1
430 APR             10         3 APRW1
431 MAY             11         3 MAYW1
432 JUN             12         3 JUNW1
433     -999
434 A_MONTH
435
436
437
438
19-Jun-91  09:20 AM                                              CAPS
```

Figure 6-1 IEB Cell Address Assignment

2. All the file names: files on different month or year have different name.
3. Current month file names: used for other programs to process the same files in one execution procedure of RTMIS.
4. Fiscal year massage: used for recording number of months that have been processed, used to create new file name.
5. File existing massage: used for searching if a certain file has been created or not.

After all the data are processed, the final results of the RTMIS will be presented through Report and Print Graph Modules which will be discussed in the next chapter.

CHAPTER 7
REPORT AND GRAPH PRINT MODULE

Introduction of Output Modules

Two modules will be discussed in this chapter: Report Print Module 3.0 and Graph Print Module 4.0. The main functions of these two modules are to:

1. Retrieve report or graph files already created by assembling Module 2.0.
2. Format the printer to appropriate mode.
3. Put titles on reports or graphs.
4. Print out reports or graphs.

Function 1 is the input of the modules, Functions 2 and 3 are the process procedures, and Function 4 is the output of the modules.

The Report Print Module can print out up to eight reports. A menu allows user to select which report is printed. The name of the reports are listed on Figure 7-1, though a menu screen. In Graph Print Module, a special program called "ALLWAYS" is used to print out graphs. Two sets with a total number of 16 graphs can be generated. Figure 7-2 presents the Menus.

```
A1: '(1)                                                          READY

      A       B       C       D       E       F       G       H
1   (1)
2                   TENNESSEE STATE RURAL TRANSIT
3                   MANAGEMENT INFORMATION SYSTEM
4
5                   ******************************
6                     P R I N T   R E P O R T S
7
8           Please select [1-10]:            10
9
10          1. Monthly Report: Trips/Service by County
11          2. Year to Date Report: Trips/Service by County
12          3. Monthly Report: Performance Measures
13          4. Year to Date Report: Performance Measures
14          5. System Total: Performance Measures
15          6. Monthly Financial Performance Measures
16          7. Monthly Expenditure Vs Budget
17          9. Section 18 Monthly Report
18          10. Exit from REPORT PRINT Modul
19
20
08-Oct-90  11:10 AM                                              CAPS
```

```
A1: [W9] '(1)                                                     READY

      A       B       C       D       E       F       G       H
1   (1)
2                   TENNESSEE STATE RURAL TRANSIT
3
4                   MANAGEMENT INFORMATION SYSTEM
5
6                   ******************************
7                     P R I N T   G R A P H S
8
9                   Please select [1-4]:             4
10
11                  1. Print Graph SET ONE: Current Month
12
13                  2. Print Graph SET TWO: Year to Date
14
15                  3. Print Graph SET THREE: Other
16
17                  4. Quit from GRAPH PRINT Modul
18
19
20
08-Oct-90  12:46 PM                                              CAPS
```

Figure 7-1 Report Print Module 3.0 Menu

```
      A       B       C       D       E       F       G       H
41  (3)
42                    TENNESSEE STATE RURAL TRANSIT
43
44                    MANAGEMENT INFORMATION SYSTEM
45
46                    ******************************
47                      P R I N T   G R A P H S
48
49                    SET TWO contains following graphs:
50
51                    1. Total Passenger Trips by Month
52                    2. % of Elderly Trips by Month
53                    3. Vehicle Miles per vehicle by Month
54                    4. Trips per Vehicle Mile by Month
55                    5. Trips per vehicle by Month
56                    6. Cost per Trips by Month
57                    7. Cost per Vehicle Mile by Month
58
59                    Press [ENTER] to proceed
60
08-Oct-90  12:50 PM                                          CAPS
```

```
A21: [W9] '(2)                                                READY

      A       B       C       D       E       F       G       H
21  (2)
22                    TENNESSEE STATE RURAL TRANSIT
23
24                    MANAGEMENT INFORMATION SYSTEM
25
26                    ******************************
27                      P R I N T   G R A P H S
28
29                    SET ONE contains following graphs:
30
31                    1. Total Passenger Trips by County
32                    2. % of Elderly Trips by County
33                    3. Vehicle Miles per vehicle by County
34                    4. Trips per Vehicle Mile by County
35                    5. Trips per vehicle by County
36
37                    Press [ENTER] to proceed
38
39
40
08-Oct-90  12:48 PM                                          CAPS
```

Figure 7-2 Graph Print Module 4.0 Menu

The Report Print Module contains eight sub-modules which represent eight reports. The process procedure of each module is the same: retrieve report file, format printer, and send report file to printer for printing. Graph Print Module contains two sub-modules which represent two sets of graph print procedures. Two procedures have the same structures: load "ALLWAYS", retrieve graph files, format printer, and print out graphs. The VTOC diagrams and IPO charts of Report Print Module 3.0 and Graph Print Module 4.0 are shown in Appendix A

Design Consideration

"Allways" Function

Lotus 123 is an integrated software. It contains three basic functions: spreadsheet, database, graphics, and data communications. A user can select one of the three functions through a menu provided by Lotus 123 program. Before Release 2.2, the graphic print function was a separated program. The user had to quit from Lotus123 spreadsheet, and utilize another program "Pgraph" to print graphs. This caused a major problem in using Lotus macros, because macro could not control the Pgraph program and the graphs could not be printed through RTMIS. Lotus 123 Release 2.2 has added an extra program called "ALLWAYS" to solve the problem. "ALLWAYS" is an attached program comes with Lotus 123 Release 2.2 software. It has three major advantages:

1. Graph printing function can be controlled by Lotus 123 macro;
2. Worksheets and graphs can be printed on a single printed page; and
3. Spreadsheet can be printed in different styles and sizes.

Because of the new functions in Lotus 123, a graphic function of RTMIS becomes practical. In other words, macro can be used in RTMIS to control all the modules including graphics. The Lotus 123 Release 2.2 with "ALLWAYS" needs additional memory and, of course, has a lower speed. To save time and increase the execution speed, the "ALLWAYS" program will be only loaded when a Graph Print Module 4.0 is operated. Even though the usable memory in an IBMPC/XT is about 150K when "ALLWAYS" is loaded, memory capacity will no longer be a problem in Module 4.0, because only one graph file retrieved each time.

Fixed Graph Set Function

In Module 4.0, another consideration is printer speed. Compare to the execution speed of a program in CPU, the printer speed is very slow because of its mechanical components. In a printer, there are two print modes: letter mode and graphic mode. Within each mode, there are two modes: low density mode and high density mode. The printing speed of the letter mode is higher than the graphic mode, the low density mode is higher than the high density mode. In RTMIS, the graph print uses the high density mode which has the slowest printing speed. For an Epson LX-80

printer, the average printing time for one graph is about six minutes. It requires about 100 minutes to print out all 16 graphs for RTMIS. Meanwhile, the user has to make a selection through the menu every six minutes in order to get the desired graphs printed. A fixed graph set function is adopted in the design as a convenience to the user. Sixteen graphs are divided into two fixed sets. Each set contains eight of the most commonly used graphs. The user can select either one of these two sets to be printed. Once the selection is made, the eight graphs will all be printed out continuously Each set needs about 50 minutes and the user does not have to attend the computer during this period. The third set is designed for the graphs which are not commonly needed. In the third set, the user can specify the desired graphs to be printed.

CHAPTER 8
CONCLUSIONS AND RECOMMENDATION FOR FUTURE RESEARCH

Program Test

After a program is developed, system test is a critical requirement The purpose of testing is to prove that there are no errors in the program. However, it is impossible to verify that a software that is completely free of errors. Testing is a process of executing a program with the explicit intention of finding errors. It is expected that the system error can be reduced to a minimum level through appropriate test.

Two tests were performed for RTMIS: unit testing and system testing. The unit testing examines the programs comprising the system. For RTMIS, "units" implies the various modules and subroutines. Unit testing first checks the modules one by one to locate errors. Through this procedure, the errors in logic and coding which are included in the tested module would be detected. A bottom-up testing approach was adopted in the testing. In the bottom-up testing, the lowest level modules were first tested. A set of sample data was used for detecting coding and logic errors. After the bottom level modules (Module 1.1.1 to 1.4.3) were tested, the next level module (Module 1.1 to 1.4) were tested by a set of

sample data. Finally, a set of simulated data was used to test the upper level module, Module 1.0. The same procedure were repeated for Module 2.0-Data Assembling Module, Module 3.0-Report Print Module, and Module 4.0-Graph Print Module.

System testing was performed by using a set of actual data obtained from First Tennessee Human Resource Agency (FTHRA) which provided rural transportation services in six counties of northeast Tennessee. The major concern of this test was to see the compatibility of individual modules, in other words, the interfaces and switches among modules. The output of the software were also checked by comparing results to manual calculations .

It has been proved that the structure, the design and the practice of a RTMIS are successful through the test. The performance of RTMIS has also been reviewed by the TDOT officials. Although the RTMIS was developed under the Tennessee environment, it has a high potential to be used by other Section 18 small rural transit operations because of its simple structure.

Conclusions

1. RTMIS is an example of a practical and small size MIS developed through the use of Lotus 123. Based on the test results, it is concluded that it can be used for any of Tennessee's eleven Section 18 operations.
2. RTMIS is approaching the upper limit of Lotus 123 Release 2.2 memory. To develop a more complicated, more

advanced RTMIS, another advanced language would be required.

3. Similar to applying an advanced language, the structural programming technique was an important aspect of using Lotus 123 to develop RTMIS.
4. The application of the structural programming technique allowed RTMIS to be developed with a data structure that fits the existing record-keeping requirements of eleven Section 18 operations in Tennessee.
5. In order to provide a convenient program for the user to understand and maintain, Lotus 123 was selected in comparison on other softwares or languages.
6. Lotus 123 has a relative slow speed for large scale data processing. It is recommended that an advanced database language, like dBase, be used to expand RTMIS functions and capabilities. Lotus 123 has an excellent graphic function, however, this capability can be achieved through a DOS batch file ever if the data were processed by another database language.

Further Improvements

1. RTMIS provides a very simple and practical data processing program to assist Section 18 rural transit operators to analyze performance measures in their daily operations. In fact, it is a simplified version of a standard MIS, therefore, some of the MIS functions have not been considered in the

RTMIS design process. Among these functions, "Information Search" is one of them. The capability of Lotus 123 macro's and the limited usable memory under the DOS made this search function impossible to complete. Macros are easy to understand and to build simple functions. The macro is designed as an useful tool to assist user in speeding up the manual keyboard operations. The information search needs macro to handle very complicated logical judgements and large amount of calculations. This is beyond the capability of macro. Even in an advanced language, like BASIC and PASCAL, it will require a complex program to build a search function. Meanwhile, the search function in RTMIS will require about 2000 records plus about 1000 macro statements to be loaded on a single spreadsheet. It is impossible for the existing facility to accommodate such a search function, thus,

2. The latest version of Lotus 123, Release 3.1 makes the expansion of memory possible without any additional software. When Release 3.1 is loaded on a personal computer with expanded memory, it can use the extra memory. After some minor changes, RTMIS can be directly applied to a PC with extended memory.
3. dBase III or higher version of dBase provides an excellent function in data processing. It can be used in all database related occasions which include information search function. Compared to other advanced language, dBase is

easy to use and maintenance. The execution speed of a complied dBase program can compete with BASIC or PASCAL. The graphic function can still be developed under Lotus 123. The communication and link between to programs can be achieved through a DOS batch program. It would be desirable to combine the advantages of the two softwares to develop a complete RTMIS. The new RTMIS would have:

1) No memory limitation;
2) All MIS functions includes information search;
3) Immediately input data check;
4) Graphic functions.
5) Flexibility for further expansion.

LIST OF REFERENCES

LIST OF REFERENCES

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APPENDIXES

Appendix A: VTOC Diagrams and IPO Charts of RTMIS

Appendix B: Users' Guide for Tennessee Rural Transit Management Information System

APPENDIX A

VTOC DIAGRAMS AND IPO CHARTS

OF RTMIS

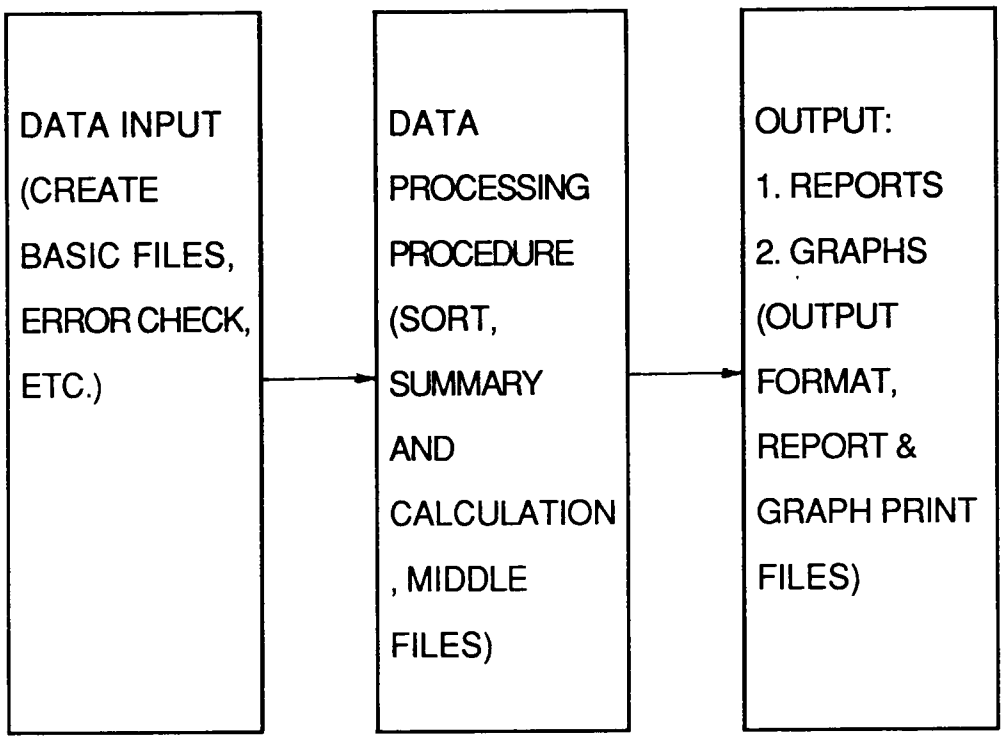


Figure A-1 RTMIS Basic Data Flow Structure

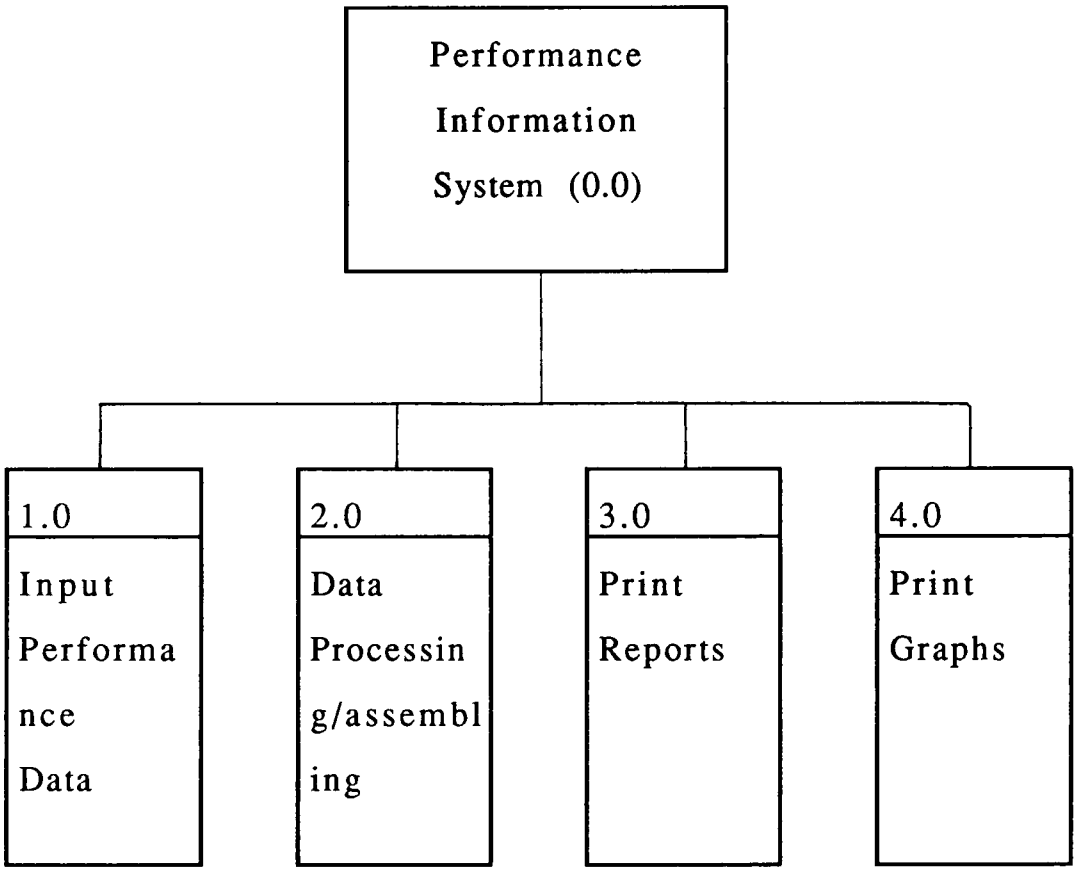


Figure A-2 Main RTMIS Structure (Module 0.0)

VTOC Diagram

Table A-1 RTMIS General Control Module 0.0

IPO Chart

Input	Process	Output
1. Current date 2. Select the module to be operated	1. Verify date 2. Determine fiscal year range 3. Record date & fiscal year on IEB	1. Correct date 2. Current fiscal year range 3. Retrieve selected module

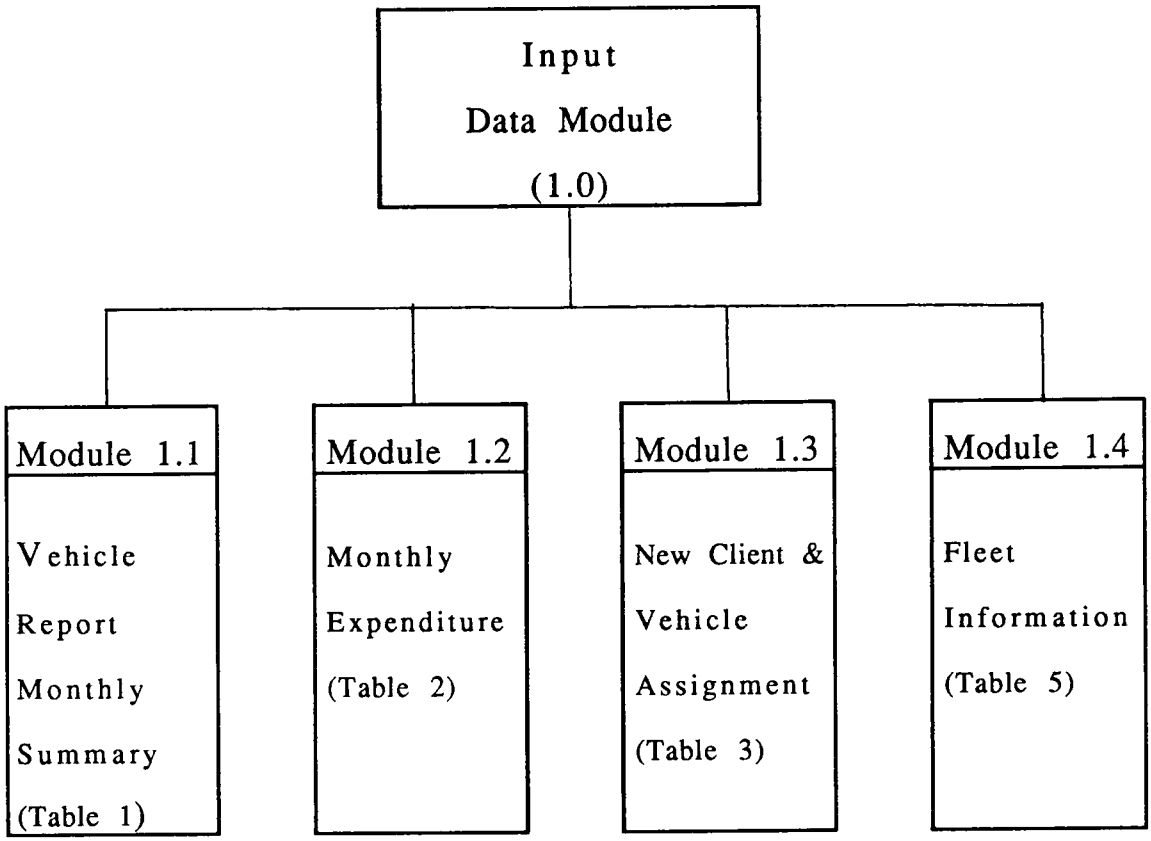


Figure A-3 Input Module (1.0)

VTOC Diagram

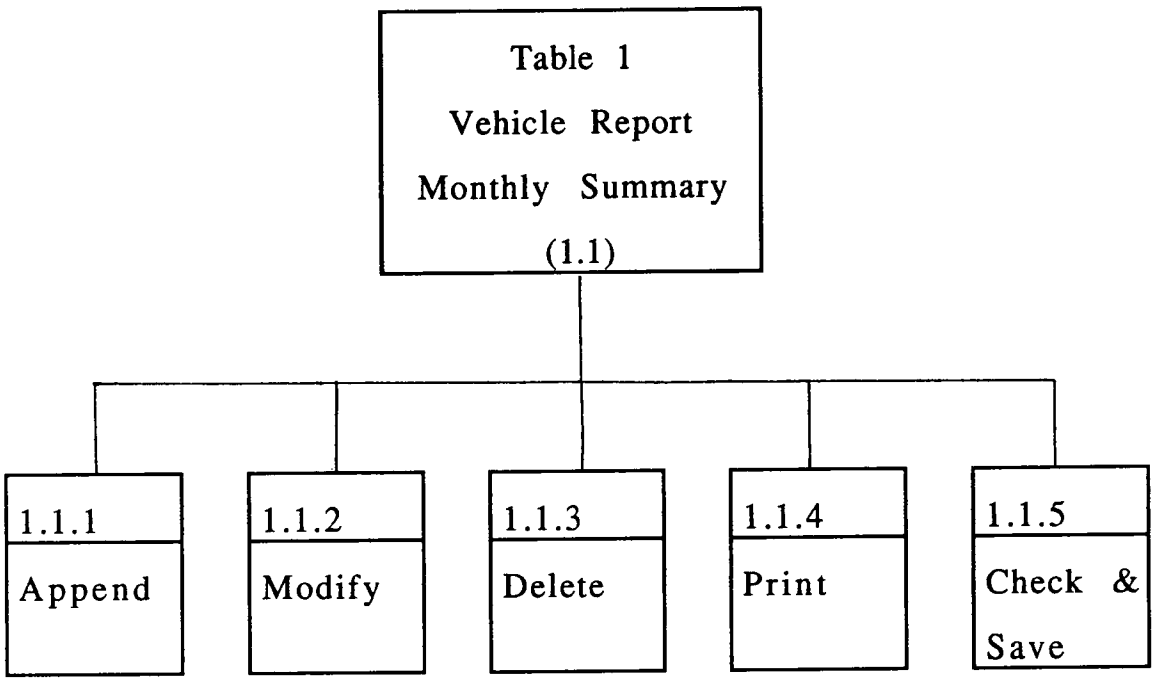


Figure A-4 Data Table 1 Input Module 1.1
VTOC Diagram

Table A-2 Data Table 1 Input Module 1.1

IPO Chart

Modules	Input	Process	Output
1.1.1 Append	1. Input Table 1 performance indicator: Veh.ID; Van Route; County Name; Number of Trips; Veh-miles; Veh-hours; Fares 2. Next record massage 3. Exit from Append massage	1. Copy input on the screen to Data Table 1 zone. 2. Assign record number to input data. 3. Proceed next record or exit	Data Table 1: yyyynnn. wk1 file
1.1.2 Modify	1. Record number 2. Correct performance indicator data 3.Modify next record massage	1. verify record number or display error massage 2. Display the record to be checked. 3. Copy corrected record from screen to Data Table 1 4. Proceed next record	Corrected Data Table 1 file: yyyynnn. wk1

Table A-2 (Continued)

Modules	Input	Process	Output
1.1.3 Delete	1. Record number 2. Confirmed record number	1.Verify record number 2. Display error massage 3. Display the record to be deleted 4. Delete confirmed record from Data Table 1	Data Table 1 file: yyyynnn. wk1
1.1.4 Print	Data Table 1	Set printer	Data Table 1
1.1.5 Check & Save	1. Data Table 1	1. Sort Data Table 1 2. Eliminate blank records and pack the file 3. Check county name in the records 4. Output error massage and record number if unknown county name appears 5. Save checked Data Table 1	Checked Data Table 1

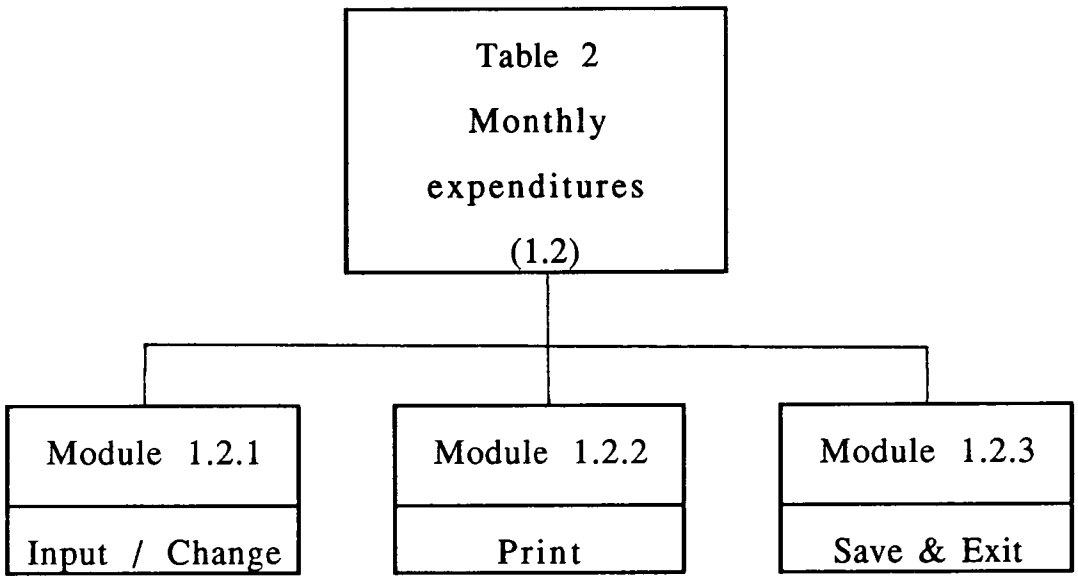


Figure A-5 Data Table 2 Input Module 1.2

VTOC Diagram

Table A-3 Data Table 2 Input Module 1.2

IPO Chart

Modules	Input	Process	Output
1.2.1 Input or Change	1. Current month expenditure 2. Complete input/change massage	1. Retrieve Input Table 2 (screen display) and Data Table 2 2. Copy completed record from screen to Data Table 2 3. Exit	Data Table 2 file yyyyTAB2.WK1
1.2.2 Print	Data Table 2	1.Set Printer 2. Execute print command 3. Exit	Data Table 2
1.2.3 Save & Exit	Data Table 2	1. Get file name from Indicator exchange block 2. Save file 3. Clean Screen and delete named cells	Data Table 2 file yyyyTAB2.WK1

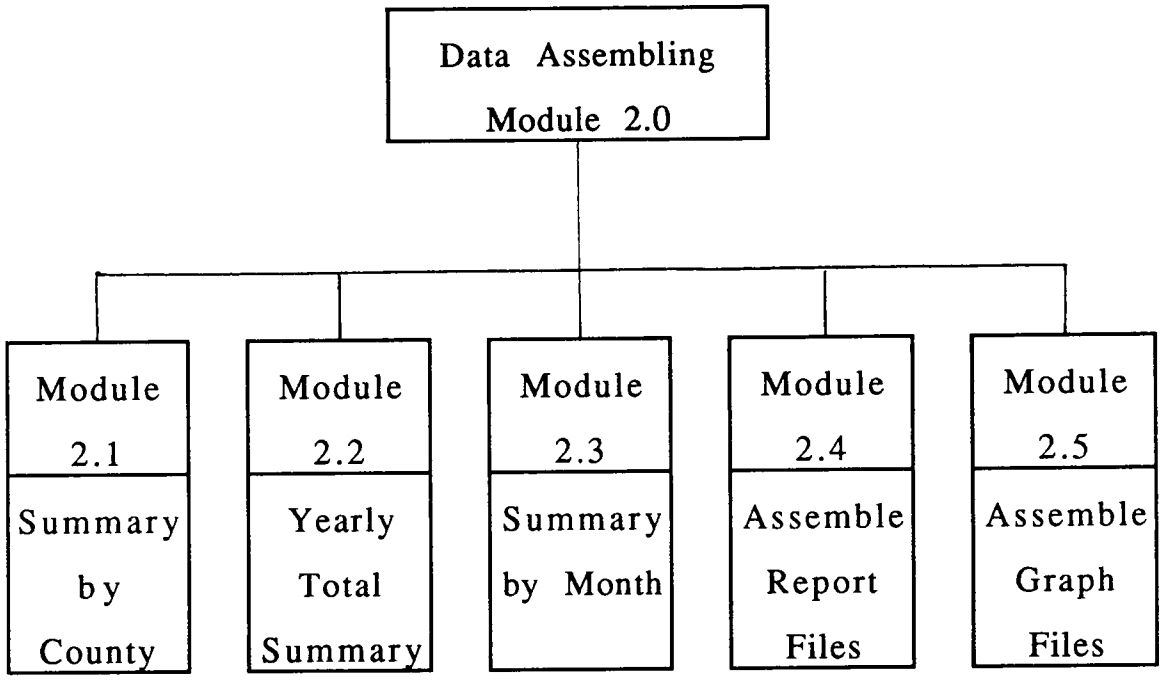


Figure A-6 Data Assembling Module 2.0

VTOC Diagram

Table A-4 County Summary Module 2.1

IPO Chart

Input	Process	Output
Data Table 1, Data Table 3	1. Set W1 area 2. Summarize Data Table 1 by County 3. Copy summarized results to W1 area 4. Copy selected performance indicators in Data Table 3 to W1 area 5. Save W1 area to W1 file	1. W1 area on the spreadsheet 2. W1 file: mmmW1.WK1

Table A-5 Yearly Summary Module 2.2

IPO Chart

Input	Process	Output
mmmW1.WK1 files which contain monthly trip reports summarized by county	1. Set W2 area in order to accommodate year to date summary by county 2. Add each W1 file to W2 area in order to get current year total values by county 3. Save completed W2 area information to current year total file yyyyW3.WK1 4. Retrieve previous year total file, yyyyW3.WK1, on W3 area	1. Current Month W1 area 2. Current year to date total area W2 3. Previous year total area W3 4. Current year to date total file: yyyyW3. WK1

Table A-6 Monthly Summary Module 2.3

IPO Chart

Input	Process	Output
Current year to date mmmW1.Wk1 files	1. Retrieve Wi file to W1 area 2. Set W4 area 3. Summarize individual W1 area and copy the summary to W4 area	W4 area starts from address J100

Table A-7 Report Assembling Module 2.4

IPO Chart

Input	Process	Output
1. W1, W2, W3, W4 area 2. T1.WK1, ... , T7.WK1, W9.WK1 report structure files	1. Calculate Current year monthly average (W2 area) 2. Calculate Previous year monthly average (W3 area) 3. Copy appropriate performance measures from area W1,...,W4 to report structure files: T1, ..., T7, T9 4. Save Filled T1,...,T7, T9 under file name RPT_1.WK1, ..., RPT_7.WK1, RPT_9.WK1	RPT_1.WK1, ..., RPT_7.WK1, RPT_9.WK1 files

Table A-8 Graph Assembling Module 2.5

IPO Chart

Input	Process	Output
W1, W2, W3, W4 areas	1. Pick up appropriate performance measures and set them on graph files 2. Save graph files	Two graph file sets: 1. G1_1.PIC ~ G1_6.PIC files for monthly reports; 2. G2_1.PIC ~ G2_6.PIC files for county reports 3. G3_1.PIC, ..., files reserved for uncommonly used graphs.

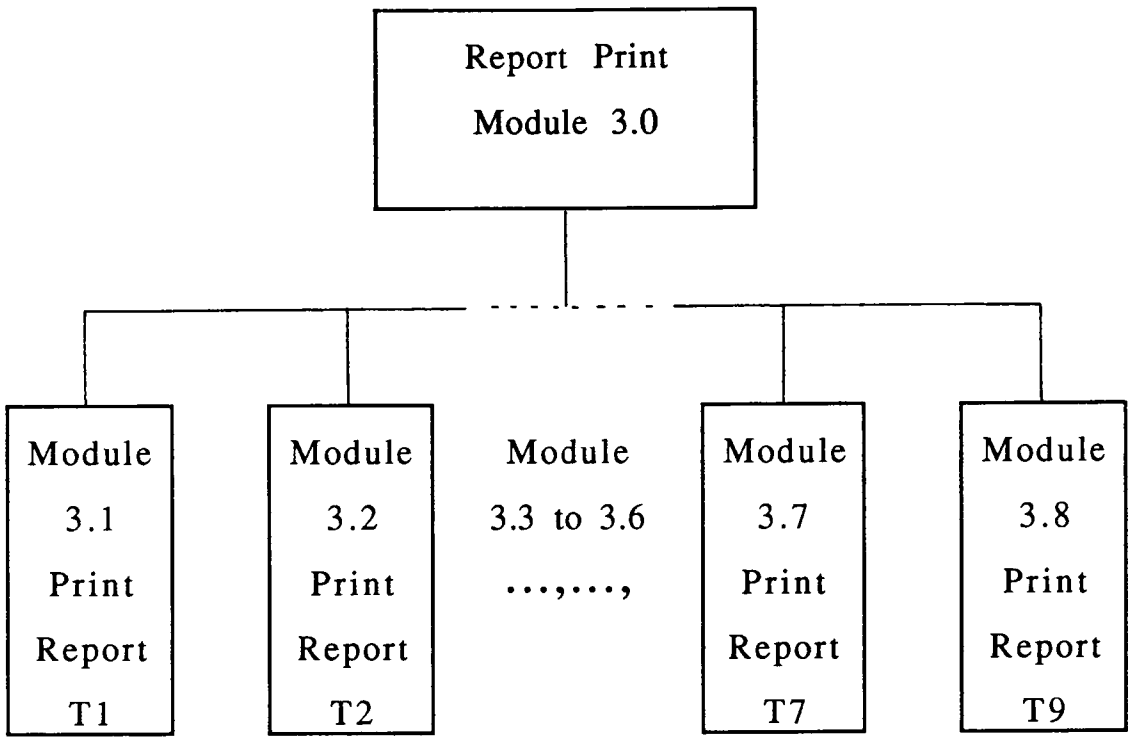


Figure A-7 Report Print Module 3.0
VTOC Diagram

Table A-9 Report Print Module 3.0

IPO Chart

Input	Process	Output
RPT_1.WK1, ..., RPT_7.WK1, RPT_9.WK1 files	1. Clear working area; 2. Retrieve IEB; 3. Format printer; 4. Execute printing tasks.	Report tables 1 to 7, and 9

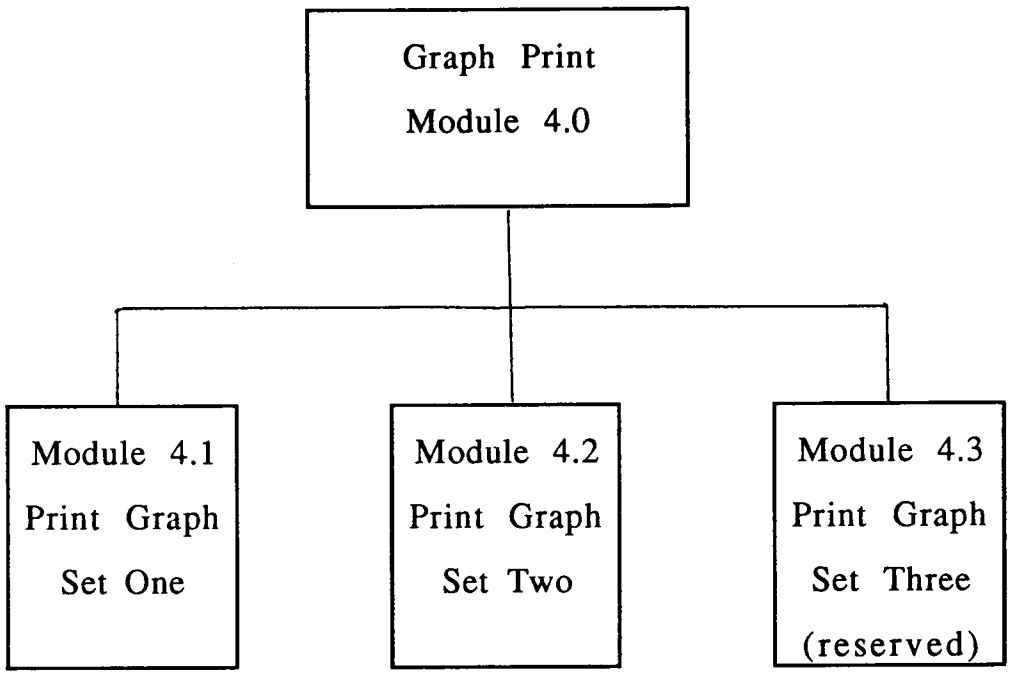


Figure A-8 Graph Print Module 4.0
VTOC Diagram

Table A-10 Graph Print Module 4.0

IPO Chart

Input	Process	Output
Two graph file sets: 1. G1_1.PIC ~ G1_6.PIC files for monthly reports; 2. G2_1.PIC ~ G2_6.PIC files for county reports 3. G3_1.PIC, ..., files reserved for uncommonly used graphs.	1. Clear working area; 2. Retrieve IEB; 3. Format printer; 4. Assign graph titles; 5. Execute printing tasks.	Graphs G1_1 to G1_6; G2_1 to G2_6;

APPENDIX B

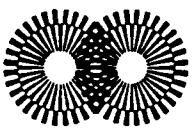
USERS' GUIDE FOR TENNESSEE RURAL TRANSIT

MANAGEMENT INFORMATION SYSTEM

DRAFT

USERS' GUIDE
FOR
TENNESSEE RURAL TRANSIT
MANAGEMENT INFORMATION SYSTEM
(RTMIS)

Transportation Center



The University of Tennessee

DRAFT

USERS' GUIDE FOR TENNESSEE RURAL TRANSIT MANAGEMENT INFORMATION SYSTEM (RTMIS)

Liyang Fang
Graduate Research Assistant
Transportation Center

Transportation Center
The University of Tennessee

October 8, 1990

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APPENDIX C: SAMPLE GRAPHS

1. INTRODUCTION

The purpose of developing this Rural Transit Management Information System (RTMIS) templet is to assist Tennessee rural transit system managers and operators in providing the most efficient and effective service. The specific performance measures utilized in this program are discussed in the final report, "Development of a Generic Management Information System for Tennessee Section 18 Operators." Similar to a standard database system, the RTMIS program includes the following three functions:

1. Data input and change (input)
2. Data processing (processing)
3. Report printing (output)

1.1. Input Function

Based on the specific needs of Tennessee's rural transit system managers and operators, the input module of RTMIS includes five tables which consist of: (1) vehicle operation; (2) monthly expenditures and budget; (3) new clients; (4) vehicle assignment; and (5) county population data. All the input tables are shown in Appendix A. Among these tables, the County Name and Population (input Table 4) is pre-set in the program; the user does not need to change this table in most normal situations.

Table 1, Vehicle Report Monthly Summary, is the basic input table which will be updated each month for each vehicle operating in the system. Since it is the most comprehensive input table, Table 1 provides functions options to Append, Modify, Delete, Print, and Check to make sure that all the data are correct before data processing procedure commences. The other input module

provides two functions -- Change and Print. The user can check his/her input through the Print function.

1.2. Data Processing

The Data Processing module consists of two main steps: (1) create a series of middle files; and (2) use middle file to create a final graph report and table report. The processing time is about 50 minutes on the computer with Intel 8088 cpu, 20 minutes with a Intel 80286 cpu, and 10 minutes with Intel 80386 cpu.

1.3. Report Printing

Eight reports can be printed. Basically, the monthly reports are statified by counties. Most of them present the data for year to date, yearly average, and current month. Appendix B shows all eight reports printed for sample data.

1.4. Graph Printing

Two sets of graphs are currently provided by RTMIS. One is concerned with current month information statified by county. The other is concerned with year-to-date information and presents the data from the start of the fiscal year to the current month. The first graph set one has five graphs and the second graph set two has seven graphs. A third graph set is not available currently, as it provides a space for further development. Appendix C provides sample graphs.

1.5. Other

All the data input are designed by the fiscal year defined as July 1 to June 30 of the next year.

2. HARDWARE ENVIRONMENT

RTMIS was developed on an IBM PC-XT computer with an Intel 8088 cpu (4.77 MHz clock frequency). The print functions were designed for an Epson LX-80 printer.

RTMIS is written in Lotus 1-2-3 Release 2.2 macro. The graph printing utilizes ALLWAYS, an attached software coming with Lotus 1-2-3 Release 2.2. The advantage of ALLWAYS is that it provides the user with access to graph printing procedure directly through a macro. In earlier Lotus 1-2-3 versions, the graph printing was done by PGRAPH, and this operation cannot be accessed without quitting the 1-2-3 program.

To run a complete Lotus 1-2-3 2.2 release software, it is necessary to have at least 4Mb hard disk capacity. In addition, the RTMIS needs about 1Mb hard disk memory. The total disk space requirement is thus around 5Mb.

RTMIS can be executed on an IBM PC-XT, or an AT computer (or a compatible) as well as a computer with a Intel 80386 cpu chip. In order to save processing time, it is recommended that a computer with a 80286/80386 cpu chip be used.

All the print commands are set for an Epson LX-80 series printer.

3. INSTALLATION

RTMIS contains two 5 1/4" diskettes. Disk 1 contains the program while Disk 2 contains the data structure.

3.1. Install Lotus-1-2-3

Referring to the Lotus-1-2-3 user manual, install the Lotus 1-2-3 program under subdirector LOTUS or 123. Next install the ALLWAYS program.

3.2. Install RTMIS

Under subdirector LOTUS or 123, create a RTMIS subdirector by typing:

md TT [enter]

TT is the name of this subdirectory. It is possible to use another name to substitute for TT. Enter subdirector TT by typing:

cd TT [enter]

Insert the program diskette (Disk 1) in the A drive, then type:

copy A: *.* [enter]

Insert the data structure diskette (Disk 2) in the A drive, then type:

Copy A: *.* [enter]

Copy both diskettes under subdirectory TT. Go back to Lotus program subdirectory by typing:

cd .. [enter]

4. USE RTMIS

4.1. Beginning

Before using RTMIS, do the following steps:

1. Turn on the computer and turn on the printer.
2. Check the current date and time in DOS commands. Type:

   date [enter]

   - If date is correct, press [enter] again.
   - If the date is not correct, type in the current date, then [enter].

   Type:

   time [enter]

   - If time is correct, press [enter] again.
   - If the time is not correct, type in the current time, then [enter].
3. Get into Lotus 1-2-3 by typing:

   cd LOTUS [enter]

   or:

   cd 123 [enter]

   Then type:

   123 [enter]

4. Shut down UNDO functions. Lotus provides an UNDO function which lets the user restore the previous spreadsheet screen. This function prevents against incorrect operations and protects the data in worksheet. Use:/WGDOUDQ to shut down this UNDO function when more memory is required. For example, the spreadsheet in RTMIS needs a large memory capacity and the UNDO function occupies 150 kb memory.

It is impossible to process the data with UNDO functions not shut down. Alternatively, shutting down the UNDO function can speed up the calculation. This is very important for 8088/8086 cpu based computers.

5. Change the file directory:

   /FDC:\LOTUS\TT[enter]

   or:

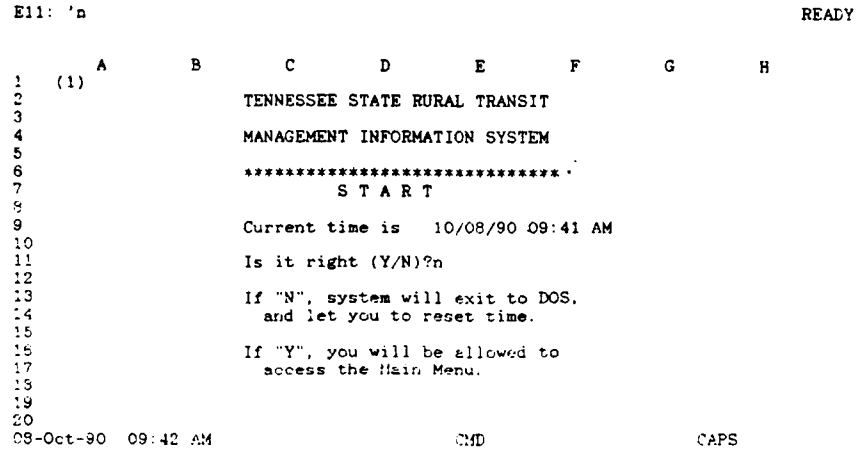
   /FDC:\123\TT[enter]

6. Start RTMIS program:

   /FRSTART[enter]

4.2. Using RTMIS

After starting RTMIS, the user will be asked to verify the current date and time:



When answer is "Y", RTMIS goes into Main Menu. The user may select different modules by pressing the 1-6 numerical values and [enter].

```
A41: '(3)                                                          READY

       A        B        C        D        E        F        G        H
41  (3)
42                    TENNESSEE STATE RURAL TRANSIT
43
44                    MANAGEMENT INFORMATION SYSTEM
45
46                    ******************************
47                        M A I N   M E N U
48
49                    Your selection is [1-6]:
50
51                    1. Input Data
52                    2. Assemble Data
53                    3. Print Reports
54                    4. Print Graphs
55                    5. Information Searching
56                    6. Quit
57
58
59
60                                                              CAPS
08-Oct-90  09:47 AM
```

If 1 is selected, the program goes into a Data Input module. The screen shows some information and asks for the month of input data.

```
A61: '(4)                                                          READY

       A        B        C        D        E        F        G        H
61  (4)
62                    TENNESSEE STATE RURAL TRANSIT
63
64                    MANAGEMENT INFORMATION SYSTEM
65
66                    ******************************
67                      D A T A   I N P U T
68
69            You are working on    1988     1989 Fiscal Year data.
70
71            The last month you worked on is:    SEP
72
73            Which month do you want input data? SEP
74            (First three charactors only)
75
76
77
78
79
80
08-Oct-90  09:49 AM                                            CAPS
```

After a while, another screen display lets the user select four aspects of input data such as: (1) Vehicle Report Monthly Summary; (2) Monthly Expenditures; (3) New Client & Veh. Assignment; and (4) Fleet Information. The user can key in 1-5 numerical value and [enter] to select the item desired.

```
A81: '(5)                                                          READY

        A       B       C       D       E       F       G       H
81  (5)
82                  TENNESSEE STATE RURAL TRANSIT
83
84                  MANAGEMENT INFORMATION SYSTEM
85
86                  ******************************
87                    D A T A   I N P U T
88
89                  Please select [1-5]:              5
90
91                  1. Vehicle Report Monthly Summary
92                  2. Monthly Expenditures
93                  3. New Client & Veh. Assignment
94                  4. Fleet Information
95                  5. Quit from INPUT Modul
96
97
98
99
100
08-Oct-90  09:50 AM                                              CAPS
```

If (1) Vehicle Report Monthly Summary is selected, there are six choices available to the user by entering number 1-6 and [enter). For first-time input always select Append.

```
A101: '(6)                                                         READY

        A       B       C       D       E       F       G       H
101 (6)
102                 TENNESSEE STATE RURAL TRANSIT
103
104                 MANAGEMENT INFORMATION SYSTEM
105
106                 ******************************
107                   D A T A   I N P U T
108
109                 Please select [1-6]:              6
110
111                 1. Append
112                 2. Modify
113                 3. Delete
114                 4. Print
115                 5. Check & Save
116                 6. Exit
117
118
119
120
08-Oct-90  09:51 AM                                              CAPS
```

If Append is selected, the following screen displays are available. The cursor is inditially located under the record number. When information is entered, the cursor will drop to the next input cell automatically. To process the next record, just move the cursor to "N" location and press "Y." The next record screen will then be ready. To leave Append, move the cursor to the second "N" location and press "Y." The program will go back to the Table 1 input menu.

```
M204:                                                                READY

      I        J        K        L        M        N        O        P
201 INPUT TABLE 1      VEHICLE TRIP MONTHLY SUMMARY          YEAR:     1988
202                                                          MONTH: AUG
203          RECORD #                          38
204          VEH. ID
205          VAN/RT#
206          COUNTY NAME
207        # GEN.PUBLIC <60
208        T GEN.PUBLIC >=60
209        R CONTRACT <60
210        I CONTRACT >=60
211        P HANDICAPPED <60
212        S HANDICAPPED >=60
213          VEH-MILES
214          VEH-HOURS
215          FARES
216
217          Input next record [Y/N]?   N
218          Exit from append [Y/N]?    N
219
220
28-Aug-90  02:30 PM                    CMD


M217:                                                                READY
```

If Modify is selected, there are two consecutive screens shown below. One asks for the input record number, another asks if the modification has been completed. Move the cursor to the appropriate location and answer the question the program will modify the file. If the record number selected is out of range of the available data, the computer will go back to Table 1 input menu.

```
M217:                                                              READY

      I       J       K       L       M       N       O       P
201 INPUT TABLE 1     VEHICLE TRIP MONTHLY SUMMARY          YEAR:     1988
202                                                         MONTH: AUG
203          RECORD #
204          VEH. ID
205          VAN/RT#
206          COUNTY NAME
207        # GEN.PUBLIC <60
208        T GEN.PUBLIC >=60
209        R CONTRACT <60
210        I CONTRACT >=60
211        P HANDICAPPED <60
212        S HANDICAPPED >=60
213          VEH-MILES
214          VEH-HOURS
215          FARES
216
217          Please input record number:
218
219
220
28-Aug-90  02:33 PM                    CMD


M204: 8114                                                         READY

      I       J       K       L       M       N       O       P
201 INPUT TABLE 1     VEHICLE TRIP MONTHLY SUMMARY          YEAR:     1988
202                                                         MONTH: AUG
203          RECORD #                        30
204          VEH. ID                       8114
205          VAN/RT#                         39
206          COUNTY NAME                  UNICOI
207        # GEN.PUBLIC <60                   0
208        T GEN.PUBLIC >=60                 45
209        R CONTRACT <60                     0
210        I CONTRACT >=60
211        P HANDICAPPED <60                  0
212        S HANDICAPPED >=60
213          VEH-MILES                     428
214          VEH-HOURS                     440
215          FARES                       20.01
216
217          Modification completed [Y/NN
218
219
220
28-Aug-90  02:43 PM                    CMD
```

The Delete option is similar to Modify. There are two consecutive display screens. To prevent mistakes, the user needs to verify the record he/she wants to delete.

```
M217:                                                              READY

       I        J        K        L        M        N        O        P
201 INPUT TABLE 1     VEHICLE TRIP MONTHLY SUMMARY           YEAR:     1988
202                                                          MONTH: OCT
203           RECORD #
204           VEH. ID
205           VAN/RT#
206           COUNTY NAME
207         # GEN.PUBLIC <60
208         T GEN.PUBLIC >=60
209         R CONTRACT <60
210         I CONTRACT >=60
211         P HANDICAPPED <60
212         S HANDICAPPED >=60
213           VEH-MILES
214           VEH-HOURS
215           FARES
216
217           Please input record number:
218
219
220
06-Sep-90  10:12 AM                       CMD
```

```
M218: 'N                                                           READY

       I        J        K        L        M        N        O        P
201 INPUT TABLE 1     VEHICLE TRIP MONTHLY SUMMARY           YEAR:     1988
202                                                          MONTH: OCT
203           RECORD #                          31
204           VEH. ID                         9864
205           VAN/RT#                           35
206           COUNTY NAME                   GREENE
207         # GEN.PUBLIC <60                     2
208         T GEN.PUBLIC >=60                   49
209         R CONTRACT <60                      12
210         I CONTRACT >=60
211         P HANDICAPPED <60                    0
212         S HANDICAPPED >=60
213           VEH-MILES                       395
214           VEH-HOURS                       440
215           FARES                         21.54
216
217           Delete this record [Y/N]?  y
218           Are you sure [Y/N]?        N
219
220
06-Sep-90  10:13 AM                       CMD
```

Before saving the data, RTMIS will check all the county names as they appear in input Table 1. If a county name is not correct, RTMIS will indicate the record number and exit to the Table 1 input menu. This allows the user to correct county name. If no error is found, RTMIS will save Table 1 file. Note this check is time consuming and needs to be selected with discretion. A subsequent check will recheck all names again.

Input Tables 2, 3, 5 have the same input menu, which is shown below. There are three options: (1) Input or Change; (2) Print; and (3) Save & exit.

```
A121: '(7)                                                          READY

       A        B        C        D        E        F        G        H
121 (7)
122                  TENNESSEE STATE RURAL TRANSIT
123
124                  MANAGEMENT INFORMATION SYSTEM
125
126                  ******************************
127                     D A T A   I N P U T
128
129                  Please select [1-3]:              3
130
131                  1. Input or Change
132                  2. Print
133                  3. Save & exit
134
135
136
137
138
139
140
08-Oct-90  09:53 AM                                          CAPS
```

For the input data screen display, the three tables are a little bit different. Leaving the input screen again involves entering "Y" at the appropriate locations. Following are the three screens for Tables 2, 3 and 5.

```
N204: 'N                                                              READY

       I          J          K          L          M          N          O          P
201 INPUT TABLE 2       TENNESSEE STATE RURAL TRANSIT                  YEAR: 8889
202                     MONTHLY EXPENDITURE                            MONTH:      OCT
203           Please check your input data.
204           Do you want to EXIT from input(Y/N)?N
205
206 ADMINISTRATION      1. SALARY & WAGE                    4,765
207 '      .            2. BENEFITS                           872
208                     3. TRAVEL                             458
209                     4. RENT/UT.                            94
210                     5. COMMUNICATION                      215
211                     6. SUPPLIES                           302
212                     7. INSURANCE                            0
213                     8. TRAINING                           545
214                     9. OVERHEAD                         4,013
215                     10. OTHER                           1,486
216 OPERATING EXPEND.   1. DRIVER S & W                    22,156
217                     2. OTHER SALARY                     4,564
218                     3. BENEFITS                         6,585
219                     4. FUEL & OIL                       6,719
220                     5. LISC./INSURANCE                      0
08-Oct-90  02:29 PM                        CMD                        CAPS
```

```
K205: 3                                                               READY

       I          J          K          L          M          N          O          P
201 INPUT TABLE 3       SUPPLEMENTAL DATA      YEAR:      1988    MONTH: OCT
202
203            COUNTY     CONTRACT CLIENT     GENERAL PUBLIC  W-CHAIR    VEHICLE
204                         NEW      LOST       NEW      LOST  CLIENT    ASSIGNED
205 1 CA Carter                3                  2                 1           5
206 2 GR Greene                4                  4                17          12
207 3 HA Hawkins               4                  4                11          14
208 4 JO Johnson               2                  5                17           4
209 5 UN Unicoi                4                  4                 9           3
210 6 WA Washington            1                  4                17          12
211
212
213
214
215
216
217
218           Do you want to EXIT from input(Y/N)?N
219           Please check your input data before EXIT.
220
08-Oct-90  02:34 PM                        CMD                        CAPS
```

```
K7: 2                                                              READY

.      I         J         K         L         M         N         O         P
1   DATA TABLE 5        FLEET INFORMATION                      YEAR:     8889
2
3   The last time you changed data was  10/08/90
4
5   TOTAL               VAN       RETIRED
6   VAN NO.             NUMBER    VAN
7         50                  2                    Please make sure all
8                             3                    your input are correct.
9                             6
10  TOTAL                     7                    Do you want to exit
11  RETIRED                   8                    from this input [Y/N]?
12        0                   9
13                           10                    N
14                           11
15                           12
16                           13
17                           14
18                           15
19                           16
20                           17
08-Oct-90  03:01 PM                    CMD                    CAPS
```

After leaving Input Data module, the Main Menu will appear again. Before printing any reports or graphs, the Assemble Data module must be processed. There are four screens shown below. The first one asks for what month the user wants to assemble the data. RTMIS will check if this month has data available for assembly or not. The third screen makes sure the user is ready to process the data. When the processing is completed, the fourth screen appears. A user can exit from Assemble Data by pressing [enter].

```
A1: '(1)                                                          READY

      A        B        C        D        E        F        G        H
1   (1)
2                    TENNESSEE STATE RURAL TRANSIT
3
4                    MANAGEMENT INFORMATION SYSTEM
5
6                    ******************************
7                    D A T A    A S S E M B L I N G
8
9           Current fiscal year is:        1988     1989
10
11          The last month you input data was:  SEP
12
13          The last month you assembled was:          0
14
15          The month you want to assemble is:
16          (First three charactors only)
17
18
19
20
08-Oct-90  09:55 AM                                          CAPS
```

```
A21: '(2)                                                         READY

      A        B        C        D        E        F        G        H
21  (2)
22                   TENNESSEE STATE RURAL TRANSIT
23
24                   MANAGEMENT INFORMATION SYSTEM
25
26                   ******************************
27                   D A T A    A S S E M B L I N G
28
29
30          The month you want to assemble does not exist
31
32            or has not completed yet, please press [ENTER]
33
34            to exit from this module and check your input.
35
36
37
38
39
40
08-Oct-90  09:56 AM                                          CAPS
```

```
A41: '(3)                                                          READY

      A        B        C        D        E        F        G        H
41  (3)
42                    TENNESSEE STATE RURAL TRANSIT
43
44                    MANAGEMENT INFORMATION SYSTEM
45
46                    ******************************
47                    D A T A    A S S E M B L I N G
48
49
50                    Do you want to start now [Y/N]?     y
51
52                    "Y" to proceed,
53                    "N" to exit to main menu.
54
55
56
57
58
59
60
08-Oct-90  09:58 AM                                          CAPS
```

```
A61: '(4)                                                          READY

      A        B        C        D        E        F        G        H
61  (4)
62                    TENNESSEE STATE RURAL TRANSIT
63
64                    MANAGEMENT INFORMATION SYSTEM
65
66                    ******************************
67                    D A T A    A S S E M B L I N G
68
69
70
71                    Assembling has been completed.
72
73                    Press [ENTER] to exit.
74
75
76
77
78
79
80
08-Oct-90  11:09 AM                                          CAPS
```

The third module part of the RTMIS program is Print Reports. Only one screen display is included. The user may select the exact report desired by entering 1-9 and [enter]. Once a report is printed, RTMIS will go back to Print Reports menu and await further instruction.

```
A1: '(1)                                                          READY

        A       B       C       D       E       F       G       H
1   (1)
2                       TENNESSEE STATE RURAL TRANSIT
3                       MANAGEMENT INFORMATION SYSTEM
4   .   .
5     .                 ******************************
6                         P R I N T   R E P O R T S
7
8             Please select [1-10]:          10
9
10            1. Monthly Report: Trips/Service by County
11            2. Year to Date Report: Trips/Service by County
12            3. Monthly Report: Performance Measures
13            4. Year to Date Report: Performance Measures
14            5. System Total: Performance Measures
15            6. Monthly Financial Performance Measures
16            7. Monthly Expenditure Vs Budget
17            9. Section 18 Monthly Report
18            10. Exit from REPORT PRINT Modul
19
20
08-Oct-90  11:10 AM                                              CAPS
```

The fourth module of the RTMIS program is Print Graphs. There are two sets of graphs available, and can be accessed by entering 1 or 2 and [enter].

```
A1: [W9] '(1)                                                     READY

        A       B       C       D       E       F       G       H
1   (1)
2                       TENNESSEE STATE RURAL TRANSIT
3
4                       MANAGEMENT INFORMATION SYSTEM
5
6                       ******************************
7                         P R I N T   G R A P H S
8
9                       Please select [1-4]:          4
10
11                      1. Print Graph SET ONE: Current Month
12
13                      2. Print Graph SET TWO: Year to Date
14
15                      3. Print Graph SET THREE: Other
16
17                      4. Quit from GRAPH PRINT Modul
18
19
20
08-Oct-90  12:46 PM                                               CAPS
```

The following two screens identifying the contents of two graph groups will next appear.

```
                                                                    READY

      A       B       C       D       E       F       G       H
41  (3)
42                  TENNESSEE STATE RURAL TRANSIT
43
44                  MANAGEMENT INFORMATION SYSTEM
45
46                  ******************************
47                    P R I N T   G R A P H S
48
49                  SET TWO contains following graphs:
50
51                  1. Total Passenger Trips by Month
52                  2. % of Elderly Trips by Month
53                  3. Vehicle Miles per vehicle by Month
54                  4. Trips per Vehicle Mile by Month
55                  5. Trips per vehicle by Month
56                  6. Cost per Trips by Month
57                  7. Cost per Vehicle Mile by Month
58
59                  Press [ENTER] to proceed
60
08-Oct-90  12:50 PM                                          CAPS
```

```
A21: [W9] '(2)                                                      READY

      A       B       C       D       E       F       G       H
21  (2)
22                  TENNESSEE STATE RURAL TRANSIT
23
24                  MANAGEMENT INFORMATION SYSTEM
25
26                  ******************************
27                    P R I N T   G R A P H S
28
29                  SET ONE contains following graphs:
30
31                  1. Total Passenger Trips by County
32                  2. % of Elderly Trips by County
33                  3. Vehicle Miles per vehicle by County
34                  4. Trips per Vehicle Mile by County
35                  5. Trips per vehicle by County
36
37                  Press [ENTER] to proceed
38
39
40
08-Oct-90  12:48 PM                                          CAPS
```

After selecting the graph set and pressing enter all the graphs will print and the program returns to the Print Graphs menu.

APPENDIX A

INPUT TABLES

DATA TABLE 1 VEHICLE TRIP MONTHLY SUMMARY YEAR: 1988
MONTH: OCT

The last time you changed data was: 09/06/90

				<<<<<<<< NUMBER OF TRIPS >>>>>>>>>								
				GENERAL PUBLIC		CONTRACT		WHEEL CHAIR		VEHICLE	VEHICLE	
RECORD #	VEH. ID	VAN/RT#	COUNTY	< 60	>= 60	< 60	>= 60	< 60	>= 60	-MILES	-HOURS	FARES
1	8706	8	HAWKINS	2	458	0		2		1,892	770	134.73
2	9999	9	HAWKINS	20	406	26		2		2264	770	156.23
3	8822	7	HAWKINS	66	20	91		0		179	440	48.02
4	8823	10	HAWKINS	38	105	360		2		2140	880	144.06
5	8824	16	HAWKINS	0	821	0		0		1503	880	411.23
6	7644	PT109	HAWKINS	0	1	0		0		1167	440	22.21
7	113	37	HAWKINS	15	426	15		0		1588	770	225.34
8	8825	18	HAWKINS	3	116	535		0		2199	880	156.95
9	114	36	HAWKINS	3	126	361		0		2705	770	210.68
10	5846	73	HAWKINS	1	50	20		0		540	440	30.1
11	4223	17	HAWKINS	9	94	9		0		349	440	51.76
12	1035	11	HAWKINS	0	83	421		0		2710	880	162.66
13	1037	12	HAWKINS	2	3	2		0		235	440	15.77
14	4306	14	HAWKINS	2	125	421		0		2493	880	163.4
15	4308	15	HAWKINS	0	0	0		0		250	440	27.33
16	109	20	CARTER	0	291	115		0		1724	770	156.34
17	8708	21	CARTER	0	426	0		0		2134	770	174.82
18	8818	22	CARTER	0	668	75		0		2432	880	281.37
19	5845	23	CARTER	0	30	0		0		278	440	12.73
20	5844	24	CARTER	0	12	0		0		231	440	4.91
21	8821	25	GREENE	13	538	63		0		2132	880	262.78
22	8705	26	GREENE	0	255	57		0		1293	660	127.23
23	8819	27	GREENE	17	480	72		0		1927	880	214.54
24	7037	28	GREENE	9	112	299		0		1562	770	197.34
25	110	29	GREENE	7	126	317		0		1727	770	209.48
26	111	30	GREENE	19	217	80		2		1283	660	127.49
27	112	31	GREENE	2	119	206		19		1372	660	135.35
28	8707	32	GREENE	25	120	89		0		934	440	110.27
29	8820	33	GREENE	41	83	324		2		1,727	770	211.23
30	7645	34	GREENE	0	11	0		0		57	440	5.34
31	9864	35	GREENE	2	49	12		0		395	440	21.54
32	4224	36	GREENE	43	234	195		2		1,926	770	211.15
33	1040	37	GREENE	0	64	32		3		572	440	39.48
34	4305	38	GREENE	0	6	8		0		283	440	5.39
35	4225	40	JOHNSON	0	195	0		0		876	440	80.69
36	8826	41	JOHNSON	0	331	0		0		1,247	660	148.32
37	115	42	JOHNSON	0	35	2		18		469	440	15.47
38	116	43	UNICOI	2	951	2		1		2,849	880	426.48
39	8827	44	UNICOI	47	417	59		0		1,862	880	215.37
40	4226	45	UNICOI	15	429	15		0		1,587	770	208.39
41	8829	46	WASHINGTO	40	621	60		8		2,010	880	308.23
42	8704	47	WASHINGTO	4	99	368		95		1,628	770	215.64
43	7643	48	WASHINGTO	30	55	394		85		1,598	770	210.68
44	8830	49	WASHINGTO	9	54	236		61		1,265	440	145.36
45	8828	50	WASHINGTO	6	693	10		2		2,136	880	347.26
46	117	51	WASHINGTO	24	13	337		37		1,247	660	321.68
47	963	52	WASHINGTO	2	39	135		0		581	440	68.36

DATA TABLE 2 TENNESSEE STATE RURAL TRANSIT YEAR: 8889
MONTHLY EXPENDITURE
10/08/90 was the last time you changed data

	BUDGET	JUL	AUG	SEP	OCT	NOV
ADMINISTRATION						
1. SALARY & WAGE	40,000	2,742	2,061	4,525	4,765	
2. BENEFITS	15,033	415	822	837	872	
3. TRAVEL	6,000	311	132	435	458	
4. RENT/UT.	2,647	115	81	62	94	
5. COMMUNICATION	2,174	288	271	220	215	
6. SUPPLIES	4,700	162	37	275	302	
7. INSURANCE	53,498	0	0	0	0	
8. TRAINING	2,000	165	126	504	545	
9. OVERHEAD.	62,746	3,389	3,576	3,898	4,013	
10. OTHER	4,389	1,044	1,076	1,306	1,486	
11. SUBTOTAL	193,187	8,632	8,181	12,061	12,751	0
OPERATING EXPEND.						
1. DRIVER S & W	220,000	19,813	21,874	19,861	22,156	
2. OTHER SALARY	57,000	4,341	4,824	4,342	4,564	
3. BENEFITS	82,319	6,338	6,965	5,921	6,585	
4. FUEL & OIL	38,644	6,320	5,211	6,300	6,719	
5. LISC./INSURANCE		0	0	0	0	
6. RENT/UT.		0	0	0		
7. OTHER DIRECT	31,371	3,785	1,649	2,463		
8. MAINTAINANCE		0	0	0		
9. INKIND	92,252	8,218	6,026	7,591		
10. TRAINING						
11. DEPRECIATION						
12. OVERHEAD						
13. SUBTOTAL	521,586	48,815	46,550	46,477	40,024	0
CAPITAL						
1. VEHICLES						
2. OTHER						
3. SUBTOTAL	0	0	0	0	0	0
** TOTAL **	714,773	57,446	54,732	58,538	52,775	0
	BUDGET	JUL	AUG	SEP	OCT	NOV

DATA TABLE 3 SUPPLEMENTAL DATA YEAR: 8889

The last time you changed data was 10/08/90

	1. CR Carter	2. GR Greene	3. HW Hawkins	4. JO Johnson	5. UN Unicoi	6. WA Washingto
JUL						
Contract: New	3	0	3	3	2	1
Contract: Lost						
Gen. Public: New	2	2	4	3	3	2
Gen. Public: Lost						
W-Chair Client	7	17	2	7	12	15
Vehicle Assigned	5	12	14	4	3	12
AUG						
Contract: New	2	3	3	2	0	3
Contract: Lost						
Gen. Public: New	1	1	5	3	4	3
Gen. Public: Lost						
W-Chair Client	7	5	7	9	16	10
Vehicle Assigned	5	12	14	4	3	12
SEP						
Contract: New	2	3	3	4	3	1
Contract: Lost						
Gen. Public: New	4	2	4	3	1	5
Gen. Public: Lost						
W-Chair Client	16	12	2	10	1	14
Vehicle Assigned	5	12	14	4	3	12
OCT						
Contract: New	3	4	4	2	4	1
Contract: Lost						
Gen. Public: New	2	4	4	5	4	4
Gen. Public: Lost						
W-Chair Client	1	17	11	17	9	17
Vehicle Assigned	5	12	14	4	3	12

DATA TABLE 5 FLEET INFORMATION YEAR: 8889

The last time you changed data was 10/08/90

TOTAL VAN NO.	VAN NUMBER	RETIRED VAN
50	2	
	3	
	6	
TOTAL	7	
RETIRED	8	
0	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	
	17	
	18	
	20	
	21	
	22	
	23	
	24	
	25	
	26	
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	28	
	29	
	30	
	31	
	32	
	33	
	34	
	35	
	36	
	37	
	38	
	39	
	40	
	41	
	42	
	43	
	44	
	45	
	46	
	47	
	48	
	49	

Please make sure all
your input are correct.

Do you want to exit
from this input [Y/N]?

Y

APPENDIX B

EXAMPLES OF EIGHT PRINTED REPORTS

TABLE 1 Monthly Report -- Trips/Services By County 10/08/90
YEAR 1988 MONTH JUL Date Reported: 03:42 PM

	<<<<<<<<<<<< NUMBER OF TRIPS >>>>>>>>>>>>									
			General Public		Contract			Vehicle	Vehicle	
County	Total	Elderly	< 60	>= 60	< 60	>= 60	W-Chair	-Miles	-Hours	Fares
Carter	1,233	1,041	0	1,041	192	0	192	4474	1980	570.59
Greene	255,442	253,062	199	2,120	2,181	250,942	282,899	18770	8910	2,058.50
Hawkins	69,825	67,665	93	2,751	2,067	64,914	74,941	19064	9240	1,763.88
Johnson	502,527	502,516	0	632	11	501,884	561,360	3262	1760	278.97
Unicoi	2,215	2,017	89	2,017	109	0	109	7653	2420	1,051.95
Washingto	3,712	1,520	224	1,445	1,968	75	2,378	14565	5910	2,174.85
Medical	0	0	0	0	0	0	0	0	0	0.00
Sub-Total	0	0	605	10,006	6,528	817,815	921,879	67788	30220	7,898.74
Other			0	0	0	0	0	0	0	0.00
Total			605	10,006	6,528	817,815	921,879	67788	30220	7,898.74

TABLE 2 Year to Date Report -- Trips/Services by County 10/08/90
Year 1988 Month OCT Date Reported: 03:47 PM

County	CA Carter	GR Greene	HA Hawkins	JO Johnson	UN Unicoi	WA Washingto	MED Medical	Sub-Total	OTH Other	Total
Trips										
* This Month:	1,617	4,346	5,256	563	1,937	3,229	0	16,948	0	16,948
* Year to Date:	5,386	18,471	19,682	2,434	8,293	13,380	0	67,646	0	67,646
* Monthly Avg.										
This Year:	1,347	4,618	4,921	609	2,073	3,345	0	16,912	0	16,912
Last Year:	1,468	4,378	4,913	578	2,144	3,358	0	16,838	0	16,838
Elderly Trips										
* This Month:	1,427	2,414	2,834	561	1,797	1,574	0	10,607	0	10,607
* Year to Date:	4,533	9,263	11,039	2,396	7,595	6,314	0	41,140	0	41,140
* Monthly Avg.										
This Year:	1,133	2,316	2,760	599	1,899	1,579	0	10,285	0	10,285
Last Year:	1,260	2,335	2,913	569	1,974	1,586	0	10,637	0	10,637
Wheelchair Trips										
* This Month:	0	28	6	18	1	288	0	341	0	341
* Year to Date:	0	201	25	66	1	1,173	0	1,466	0	1,466
* Monthly Avg.										
This Year:	0	50	6	17	0	293	0	367	0	367
Last Year:	0	57	6	16	0	323	0	401	0	401
Vehicle-Miles										
* This Month:	6,799	17,190	22,214	2,592	6,298	10,465	0	65,558	0	65,558
* Year to Date:	19,158	67,950	77,363	11,420	27,268	47,783	0	250,942	0	250,942
* Monthly Avg.										
This Year:	4,790	16,988	19,341	2,855	6,817	11,946	0	62,736	0	62,736
Last Year:	4,381	18,691	16,985	2,743	5,828	11,875	0	60,502	0	60,502
Vehicle-Hours										
* This Month:	3,300	9,020	10,120	1,540	2,530	4,840	0	31,350	0	31,350
* Year to Date:	8,800	33,550	34,807	6,490	9,350	20,680	0	113,677	0	113,677
* Monthly Avg.										
This Year:	2,200	8,388	8,702	1,623	2,338	5,170	0	28,419	0	28,419
Last Year:	1,926	7,275	9,448	1,451	2,663	5,807	0	28,569	0	28,569
Fares										
* This Month:	630.17	1,878.61	1,960.47	244.48	850.24	1,617.21	0.00	7,181.18	0	7,181
* Year to Date:	2,379.97	8,409.91	7,199.98	1,087.38	3,862.37	6,783.95	0.00	29,723.56	0	29,724
* Monthly Avg.										
This Year:	594.99	2,102.48	1,800.00	271.85	965.59	1,695.99	0.00	7,430.89	0	7,431
Last Year:	555.17	1,977.83	1,784.25	279.25	877.75	1,835.33	0.00	7,309.58	0	7,310
New Clients										
* This Month:	5	8	8	7	8	5		41		41
* Year to Date:	19	19	30	25	21	20		134		134
* Monthly Avg.										
This Year:	5	5	8	6	5	5	0	34	0	34
Last Year:	5	5	8	7	5	5	0	35	0	35

TABLE 3 System Total -- Trips/Services
Year 1988 Month OCT Date Reported: 10/08/90 03:48 PM

	This Month	Year to Date	Monthly Average This Year	Last Year
Trips	16,948	67,646	16,912	16,838
Elderly Trips	10,607	41,140	10,285	10,637
Wheelchair Trips	341	1,466	367	401
Vehicle-Miles	65,558	250,942	62,736	60,502
Vehicle-Hours	31,350	113,677	28,419	28,569
Fares	7,181.18	29,723.56	7,430.89	7,309.58
New Client	41	134	34	35

TABLE 4 Year to Date Report--Time Profile Performance Measures 10/08/90
Year 1988 Month OCT Date Reported: 03:49 PM

County	CA Carter	GR Greene	HA Hawkins	JO Johnson	UN Unicoi	WA WashingtonMED Medical		Sub-Total	OTH Other	Total
Trips/Population										
* This Month:	0.07	0.11	0.18	0.04	0.22	0.10	ERR	0.11	ERR	0.11
* Year to Date:	0.22	0.46	0.68	0.18	0.95	0.42	ERR	0.46	ERR	0.46
* Last Year	0.72	1.30	2.04	0.50	2.95	1.28	ERR	1.37	ERR	1.37
% of Elderly Trips										
* This Month:	88.25%	55.55%	53.92%	99.64%	92.77%	48.75%	ERR	62.59%	ERR	62.59%
* Year to Date:	84.16%	50.15%	56.09%	98.44%	91.58%	47.19%	ERR	60.82%	ERR	60.82%
* Last Year	85.88%	53.32%	59.30%	98.41%	92.04%	47.25%	ERR	63.17%	ERR	63.17%
% of W-Chair Trips										
* This Month:	0.00%	0.64%	0.11%	3.20%	0.05%	8.92%	ERR	2.01%	ERR	2.01%
* Year to Date:	0.00%	1.09%	0.13%	2.71%	0.01%	8.77%	ERR	2.17%	ERR	2.17%
* Last Year	0.00%	1.29%	0.12%	2.68%	0.01%	9.61%	ERR	2.38%	ERR	2.38%
W-chair Trips/Van										
* This Month:	0.00	2.33	0.43	4.50	0.33	24.00	ERR	6.82	ERR	6.82
* Year to Date:	0.00	16.75	1.79	16.50	0.33	97.75	ERR	29.32	ERR	29.32
* Last Year	0.00	20.76	1.93	13.78	0.24	116.42	ERR	34.49	ERR	34.49
Miles/Veh-hour										
* This Month:	2.06	1.91	2.20	1.68	2.49	2.16	ERR	2.09	ERR	2.09
* Year to Date:	2.18	2.03	2.22	1.76	2.92	2.31	ERR	2.21	ERR	2.21
* Last Year	2.27	2.57	1.80	1.89	2.19	2.05	ERR	2.12	ERR	2.12
Trips/Veh-hour										
* This Month:	0.49	0.48	0.52	0.37	0.77	0.67	ERR	0.54	ERR	0.54
* Year to Date:	0.61	0.55	0.57	0.38	0.89	0.65	ERR	0.60	ERR	0.60
* Last Year	0.76	0.60	0.52	0.40	0.81	0.58	ERR	0.59	ERR	0.59
Trips/Veh-mile										
* This Month:	0.24	0.25	0.24	0.22	0.31	0.31	ERR	0.26	ERR	0.26
* Year to Date:	0.28	0.27	0.25	0.21	0.30	0.28	ERR	0.27	ERR	0.27
* Last Year	0.34	0.23	0.29	0.21	0.37	0.28	ERR	0.28	ERR	0.28
Miles/Vehicle										
* This Month:	1,359.80	1,432.50	1,586.71	648.00	2,099.33	872.08	ERR	1,311.16	ERR	1,311.16
* Year to Date:	3,831.60	5,662.50	5,525.93	2,855.00	9,089.33	3,981.92	ERR	5,018.84	ERR	5,018.84
* Last Year	3,688.84	6,848.61	5,471.79	2,437.78	8,227.06	4,285.71	ERR	5,204.46	ERR	5,204.46
Trips/Vehicle										
* This Month:	323.40	362.17	375.43	140.75	645.67	269.08	ERR	338.96	ERR	338.96
* Year to Date:	1,077.20	1,539.25	1,405.86	608.50	2,764.33	1,115.00	ERR	1,352.92	ERR	1,352.92
* Last Year	1,235.79	1,604.31	1,582.60	513.63	3,027.18	1,211.82	ERR	1,448.47	ERR	1,448.47

TABLE 5 System Total -- Performance Measures 10/08/90
03:50 PM

Year 1988 Month OCT Date Reported:

	This Month	Year to Date	Last Year
Trips/Population			
* General Public	0.08	0.29	0.90
* Contract	0.04	0.17	0.47
% Trips over 60			
* General Public	62.59%	60.82%	63.17%
* Contract	0.00%	0.00%	0.00%
% W-Chair Trips			
* <=60 Years Old	2.01%	2.17%	2.38%
* > 60 Years Old	0.00%	0.00%	0.00%
W-Chair Trips/User	4.74	6.08	6.73
Miles/Veh-hour	2.09	2.21	2.12
Trips/Veh-mile	0.26	0.27	0.28
Miles/Vehicle	1,311.16	5,018.84	5,204.46
Trips/Vehicle	338.96	1,352.92	1,448.47

TABLE 6 Monthly Financial Performance Measures 10/08/90

Year 1988 Month OCT Date Reported: 03:51 PM

	This Month	Year to Date	Last Year
* Cost/Veh-mile	0.98	0.94	0.10
* Cost/Veh-hour	2.04	2.07	0.21
* Cost/Vehicle	1,281.58	4,695.90	514.27
* Cost/Trip	3.78	3.47	0.36
Maintenance Cost/Veh-mile	0.00%	0.00%	0.00%
% of Administrative Cost	0.20	0.18	0.25
Labor Cost/Veh-hour	1.06	1.12	0.11
Fuel Cost/Veh-mile	0.10	0.10	0.00
Depreciation/Vehicle	0.00	0.00	0.00

* Excludes capital

TABLE 7 Monthly Expenditure Vs Budget 10/08/90
Year 1988 Month OCT Date Reported: 03:51 PM

	This Month	Year to Date	% of Budget	Average This Year	Last Year
ADMINISTRATION					
1. SALARY & WAGE	4,765.32	14,092.27	35.23%	3,523.07	4,576.25
2. BENEFITS	872.31	2,947.05	19.60%	736.76	911.33
3. TRAVEL	458.08	1,335.51	22.26%	333.88	712.58
4. RENT/UT.	94.25	351.91	13.29%	87.98	61.92
5. COMMUNICATION	214.94	993.67	45.71%	248.42	1,067.75
6. SUPPLIES	302.14	775.90	16.51%	193.98	1,704.83
7. INSURANCE	0.00	0.00	0.00%	0.00	4,978.33
8. TRAINING	545.20	1,340.65	67.03%	335.16	185.75
9. OVERHEAD	4,012.71	14,875.48	23.71%	3,718.87	4,692.83
10. OTHER	1,486.34	4,912.81	111.93%	1,228.20	167.67
11. SUBTOTAL	12,751.29	41,625.25	21.55%	10,406.31	19,063.08
OPERATING EXPEND.					
1. DRIVER S & W	22,156.16	83,704.14	38.05%	20,926.04	24,925.17
2. OTHER SALARY	4,563.93	18,071.25	31.70%	4,517.81	7,240.50
3. BENEFITS	6,584.93	25,809.26	31.35%	6,452.32	6,488.25
4. FUEL & OIL	6,719.15	24,549.83	63.53%	6,137.46	3,491.50
5. LISC./INSURANCE	0.00	0.00	ERR	0.00	2,255.83
6. RENT/UT.	0.00	0.00	ERR	0.00	2,287.83
7. OTHER DIRECT	2,957.37	10,854.09	34.60%	2,713.52	255.75
8. MAINTAINANCE	0.00	0.00	ERR	0.00	12.67
9. INKIND	8,346.27	30,181.38	32.72%	7,545.35	3,186.92
10. TRAINING		0.00	ERR	0.00	0.00
11. DEPRECIATION		0.00	ERR	0.00	0.00
12. OVERHEAD		0.00	ERR	0.00	2,528.75
13. SUBTOTAL	51,327.81	193,169.95	37.04%	48,292.49	52,677.67
CAPITAL					
1. VEHICLES		0.00	ERR	0.00	4,269.33
2. OTHER		0.00	ERR	0.00	563.25
3. SUBTOTAL	0.00	0.00	ERR	0.00	4,833.00
** TOTAL **	64,079.10	234,795.20	32.85%	58,698.80	76,574.92

Table 9 SECTION 18 MONTHLY DATA REPORT 10/08/90
YEAR: 1988 MONTH: OCT Date reported: 03:52 PM
AGENCY:

	This Month	Year to Date
I. Noncontract Passenger Trips:		
A. Trips by passengers under 60	518	1,967
B. Trips by passengers over 60	10,607	41,140
II. Contract Passenger Trips:		
A. Trips by passengers under 60	5,823	24,539
B. Trips by passengers over 60	0	0
III. Clients Served:		
A. Contract clients		
1. New client added	18	59
2. Client lost	0	0
B. General public clients		
1. New client added	23	75
2. Client lost	0	0
IV. Wheelchair Clients:		
A. Trips by passenger in wheelchairs		
1. under 60	341	1,466
2. Over 60	0	0
B. Number of clients in wheelchairs	72	241
V. Total Vehicle Miles Traveled:	65,558	250,942
VII. Revenue:		
A. Fare revenue	7,181.18	29,723.56
VIII. Costs:		
A. Administrative	12,751.29	41,625.25
B. Operating	51,327.81	193,169.95
C. Capital	0.00	0.00
D. Total costs	64,079.10	234,795.20
X. Incidential Usage of Vehicles:		
A. Incidential passenger trips	0	0
B. Revenue from Inc. trips	0	0

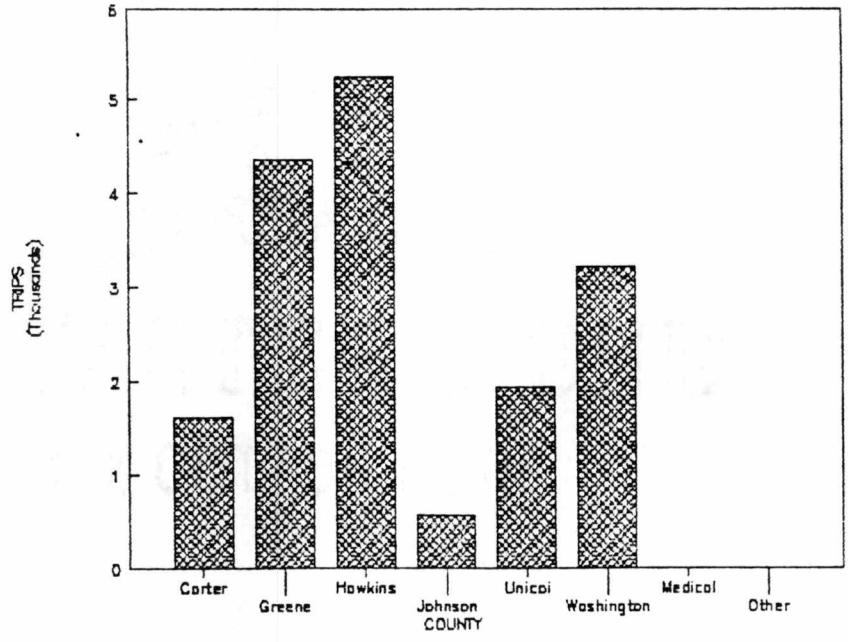
APPENDIX C

SAMPLE GRAPHS

TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

TOTAL PASSENGER TRIPS BY COUNTY 10/08/90

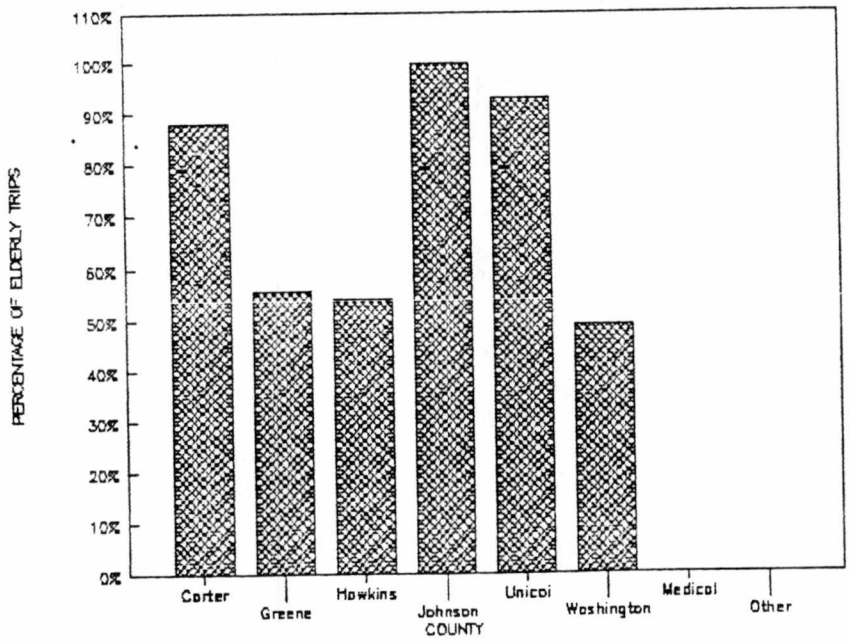
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

% OF ELDERLY TRIPS BY COUNTY 10/08/90

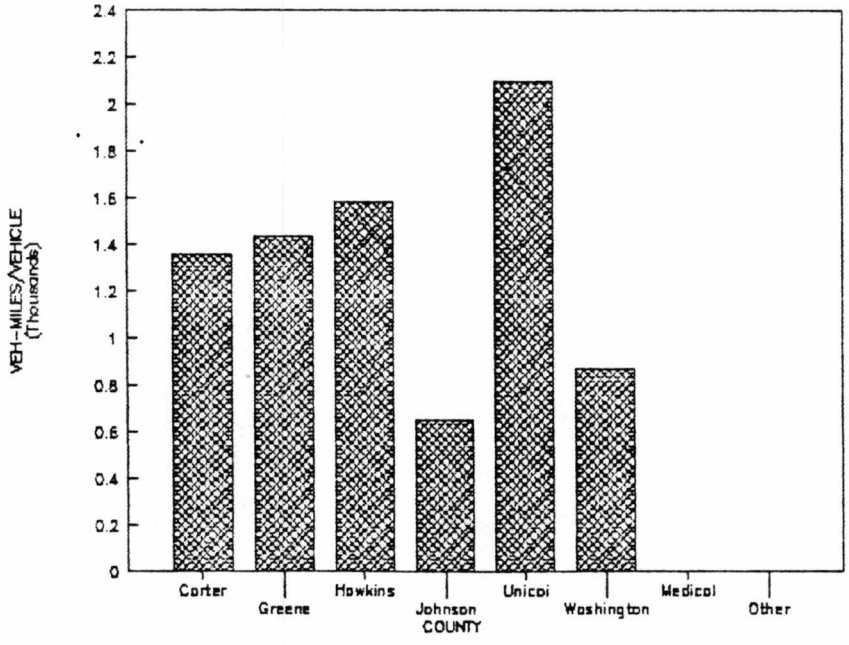
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

VEHICLE MILES/VEHICLE BY COUNTY 10/08/90

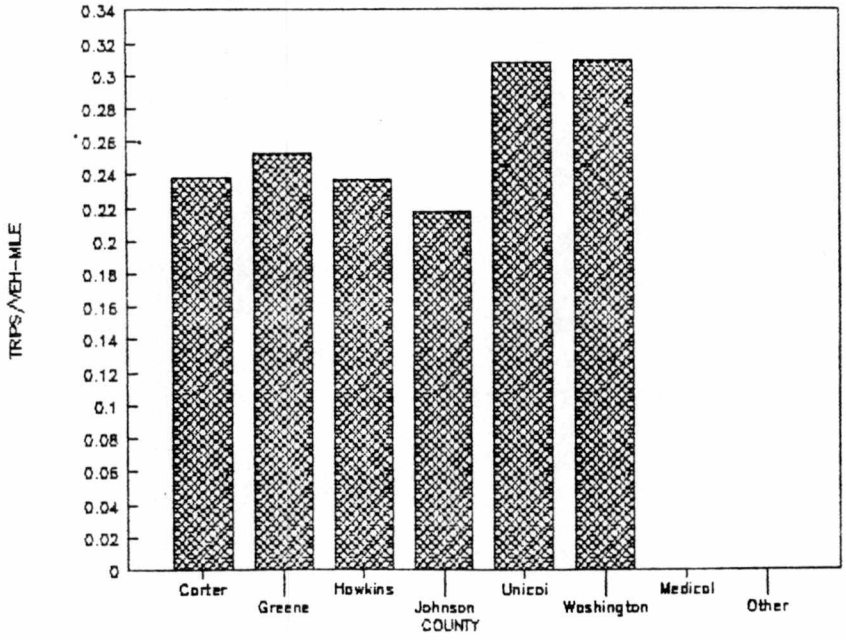
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

PASSENGER TRIPS/VEHICLE MILE BY COUNTY 10/08/90

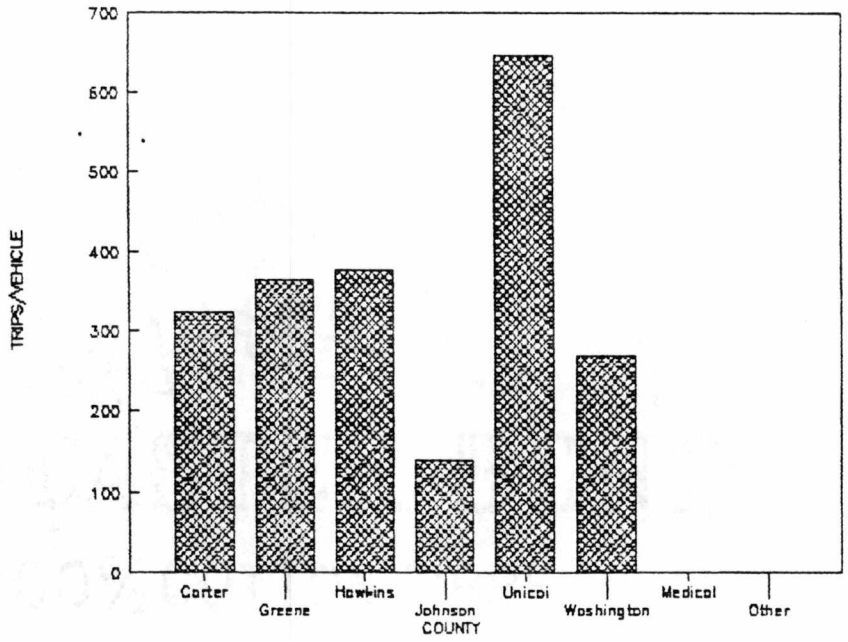
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

PASSENGER TRIPS/VEHICLE BY COUNTY 10/08/90

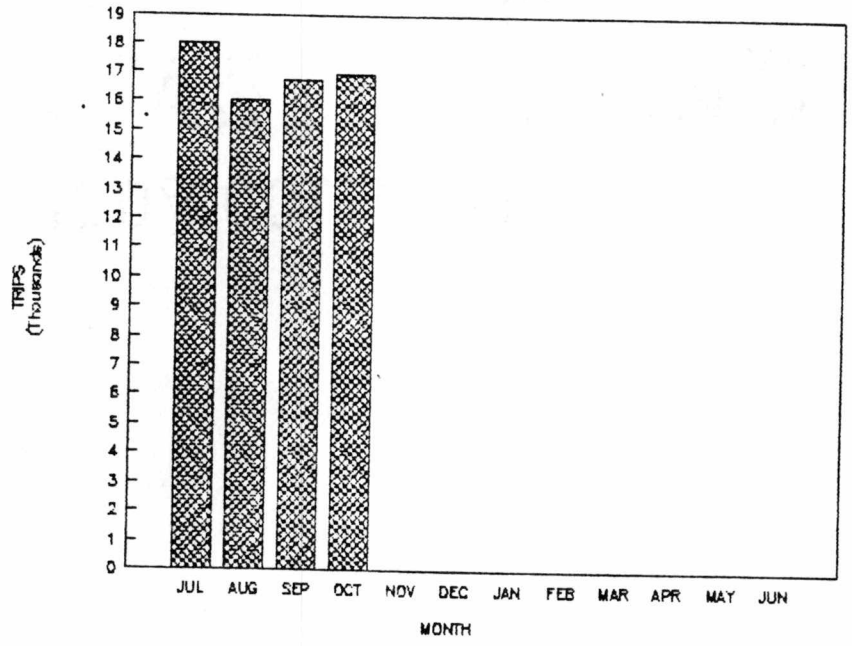
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

PASSENGER TRIPS BY MONTH

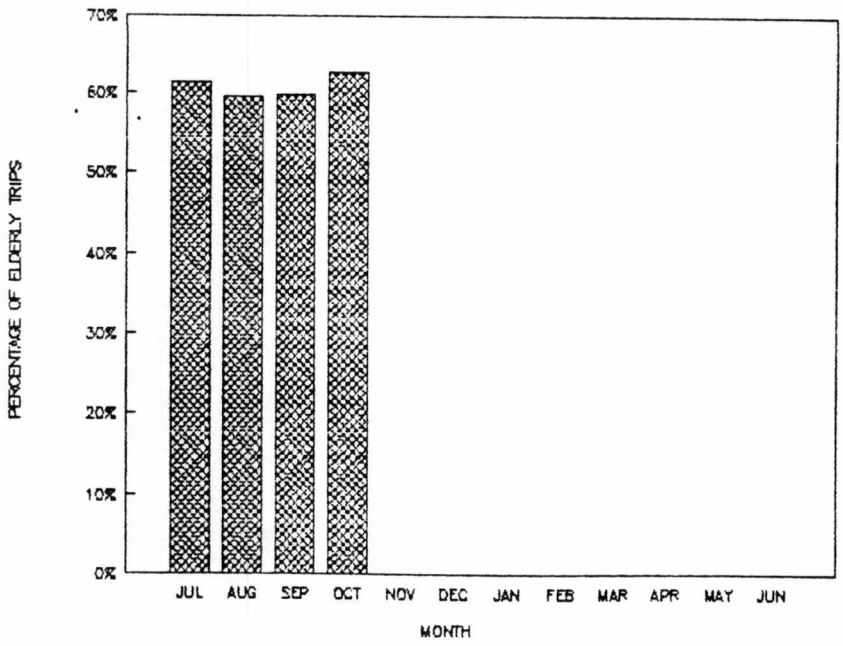
YEAR: 1988 MONTH: OCT Date reported: 10/08/90 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

% OF ELDERLY TRIPS BY MONTH

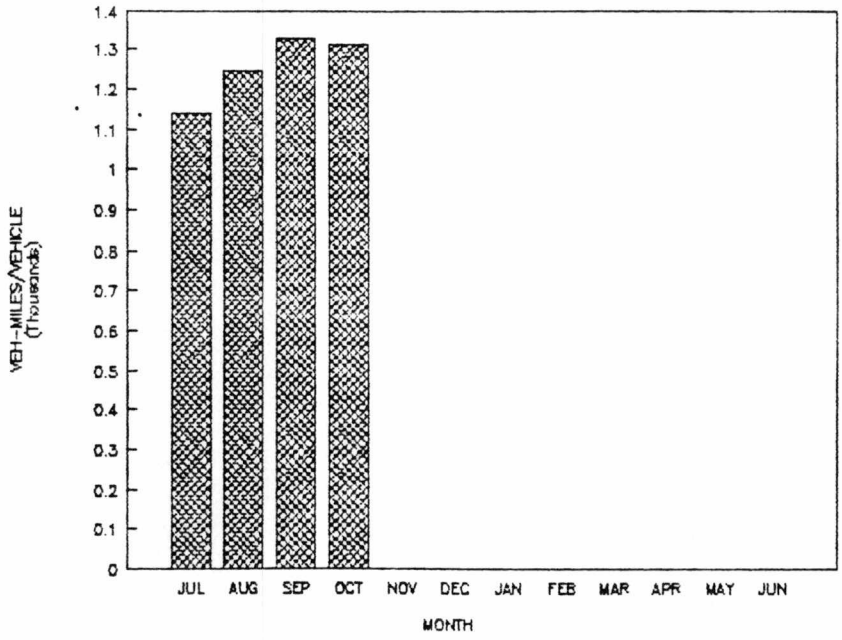
YEAR: 1988 MONTH: OCT Date reported: 10/08/90 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

VEHICLE MILES/VEHICLE BY MONTH 10/08/90

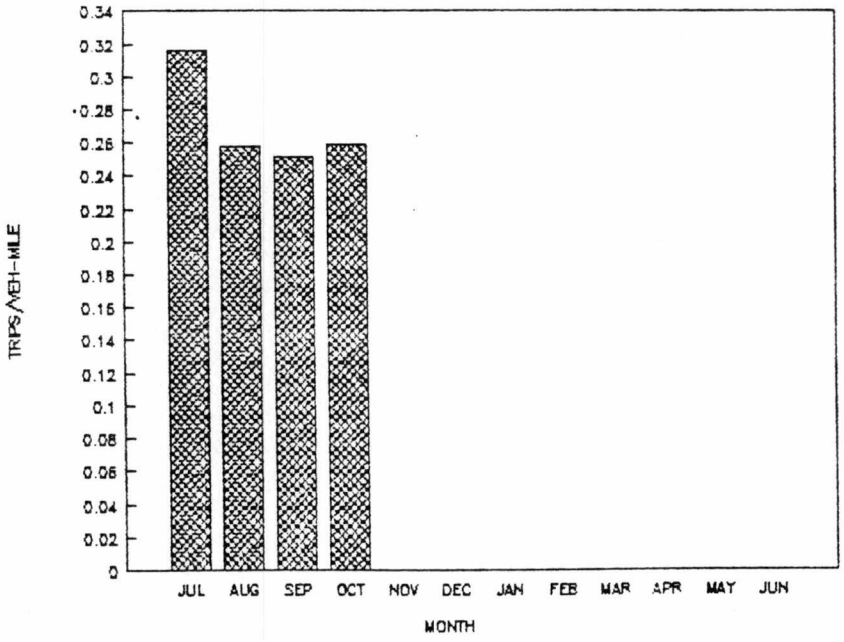
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

PASSENGER TRIPS/VEHICLE MILE BY MONTH 10/08/90

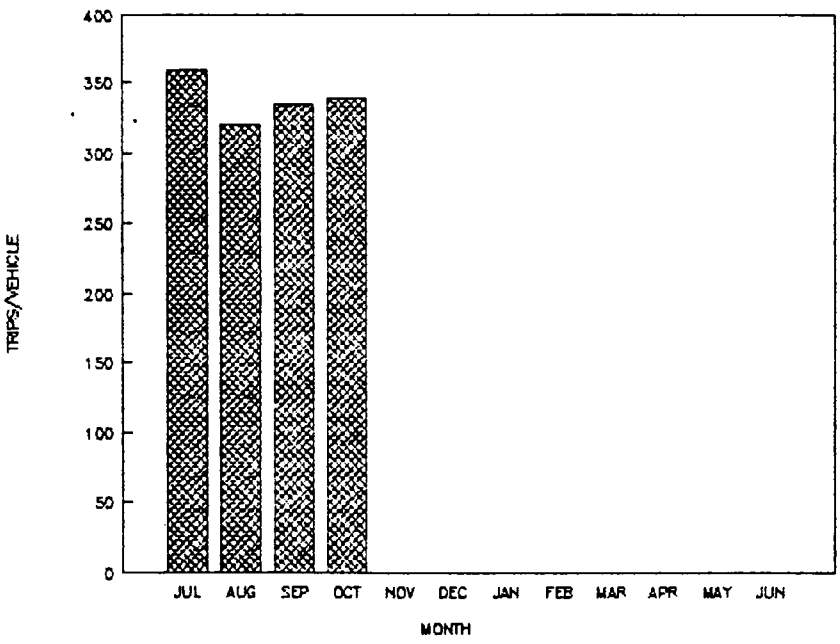
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

PASSENGER TRIPS/VEHICLE BY MONTH 10/08/90

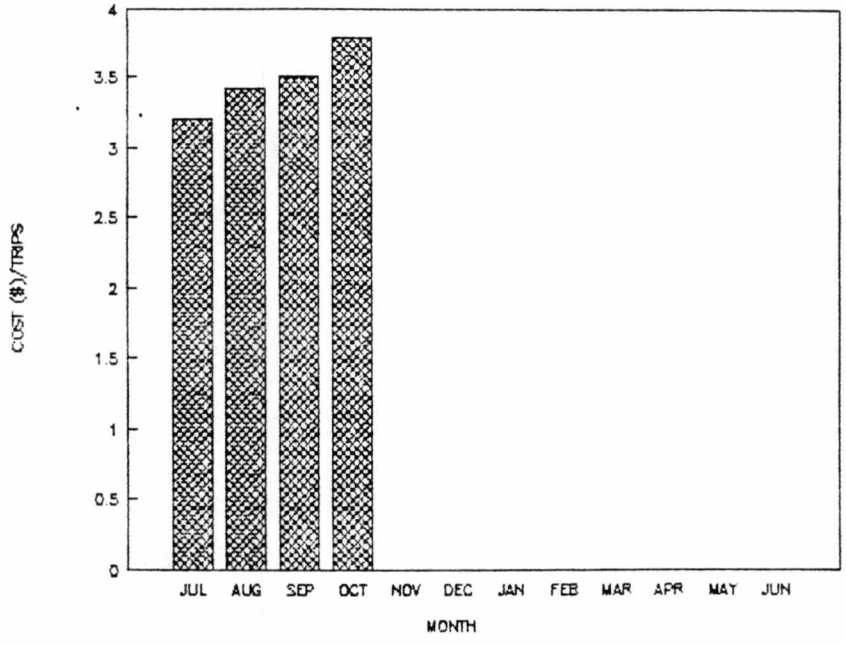
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

COST/TRIP BY MONTH 10/08/90

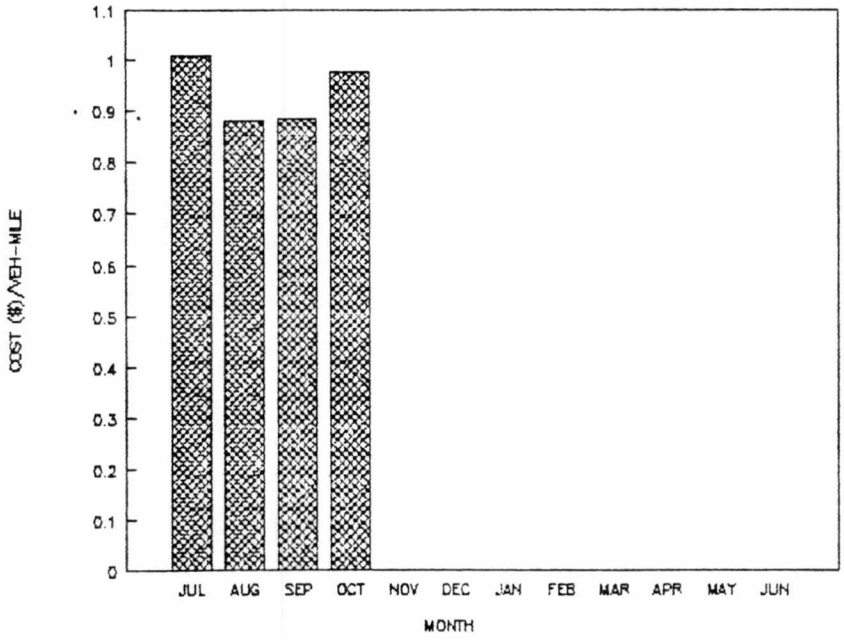
YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



TENNESSEE RURAL TRANSIT PERFORMANCE INFORMATION SYSTEM

COST/VEHICLE MILE BY MONTH 10/08/90

YEAR: 1988 MONTH: OCT Date reported: 03:54 PM



VITA

Liyang Feng was born in Shanghai, China on February 22, 1950. He attended primary school and middle school in Hong Kou District (Shanghai). Like millions of Chinese teenagers, he had to quit from the middle school after three years study, because of the Great Proletarian Cultural Revolution in China.

Ten years later, he passed nationwide entrance exam and was assigned to study in Shanghai Institute of Railway Technology. In January 1982, he received the degree of Bachelor of Engineering in transportation management. As a transportation engineer, he worked for the research division of Shanghai Public Utility Bureau and Shanghai City Planning Bureau from 1982 to 1988. In 1988, he entered the U.S. and worked for Wilbur Smith Associates, Columbia, SC. He was accepted as a graduate student in Civil Engineering Department, University of Tennessee in January 1990.