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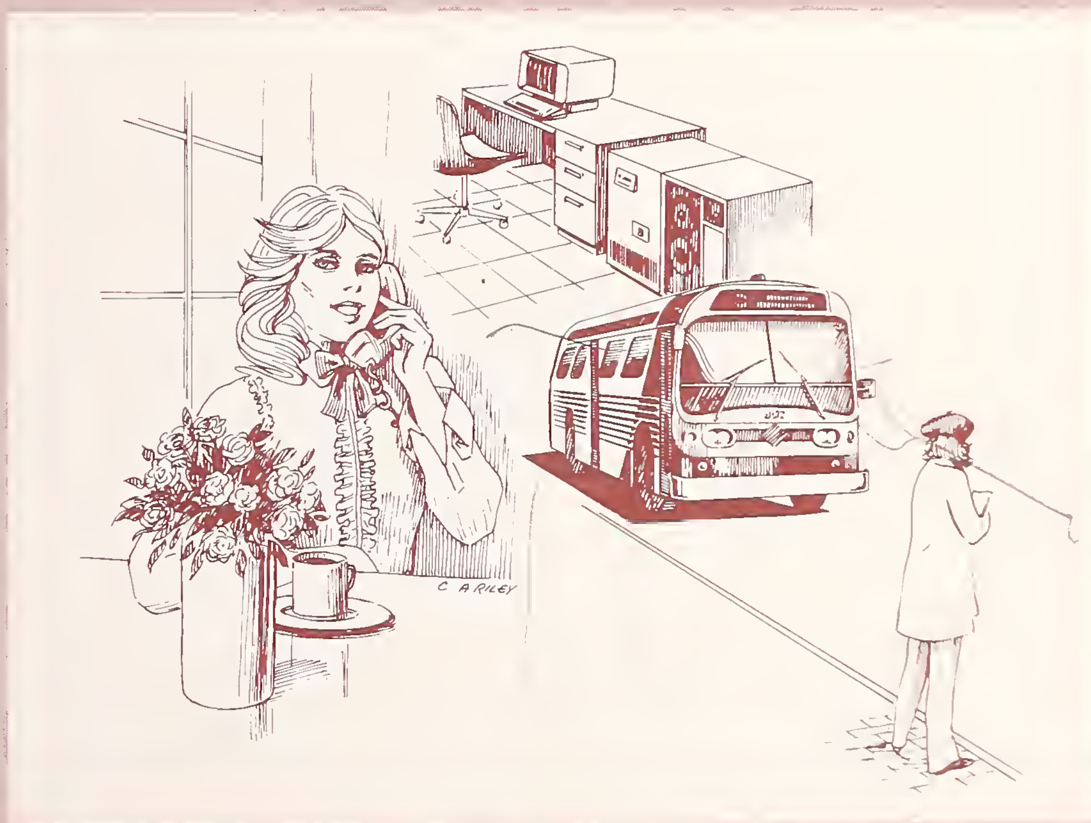
Evaluation of the Salt Lake City Computerized Rider Information System

UMTA/TSC Evaluation Series

Final Report
November 1985



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16. Abstract The Utah Transit Authority (UTA) Computerized Rider Information System (CRIS) project involved the installation of an automated telephone service to quickly provide bus stop-specific schedule and service information to residents throughout the Authority's service region, which includes Salt Lake City and its surrounding suburbs, as well as the city of Ogden, Utah. Potential bus users obtain this information by calling telephone numbers assigned to specific bus stops or groups of stops. UTA's bus dispatchers have access both to the CRIS system and to the existing dispatch/communications system which includes radios on each bus. The dispatchers monitor bus drivers' reports or schedule deviations and in turn enter this information into the CRIS system. In this way the information supplied to potential passengers who call the CRIS numbers reflects actual operating conditions. The primary goal of the system was to increase ridership and passenger revenues by making up-to-date service information available to all potential users of the transit system. UTA implemented this system, initially on six test routes, on February 4, 1983 under the name "Buzz-A-Bus."

This final evaluation report is based on information gathered on CRIS system impacts throughout the sixteen-month Phase I period, which included two system effectiveness tests of six months each separated by four additional months of system operations. The final report includes a history of the system and an analysis of CRIS system usage and awareness, as well as the impacts on bus ridership and the usage of UTA's other information services. The system's cost and benefits are studied, and its lessons for other transit agencies are described.

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Preface

This document was prepared under Task Directive DOT-TSC-1752-23 as part of the Service and Methods Demonstration Program sponsored by the Urban Mass Transportation Administration's Office of Management Research and Transit Services. This report presents an evaluation of the operations and impacts of the first phase of a computerized rider information system (CRIS) implemented by the Utah Transit Authority (UTA) in Salt Lake City. In Phase I of this project, the CRIS system was provided for six test routes. Each bus stop on these routes was assigned a unique telephone number which provides schedule, delay, and detour information when called by a prospective bus user.

This final evaluation report is based on information gathered on CRIS system impacts throughout the sixteen-month Phase I period, which included two system effectiveness tests of six months each separated by four additional months of system operations. The final report includes a history of the system and an analysis of CRIS system usage and awareness, as well as the impacts on bus ridership and the usage of UTA's other information services. The system's costs and benefits are studied, and its lessons for other transit agencies are described.

The authors of this report are Earl R. Ruiter and Richard E. Lung. Cambridge Systematics is grateful to Maureen Kirkeby, Automobile Club of Utah, for providing data on Salt Lake City gasoline costs by month. We would also particularly like to acknowledge the cooperation and assistance of the following UTA staff during the course of the evaluation: Butch Jentzsch and Jon Neilsen, both of whom served as CRIS Project Managers during portions of the evaluation period; Diane Peck, Customer Services Department; and Terry Mallin, Marketing Department.

Valuable suggestions and guidance were provided by the following individuals, each of whom served as evaluation manager at the Transportation Systems Center during a portion of the evaluation: Carla Heaton, Arthur Priver, and Robert Waksman. Helpful comments on this report were also received from Lawrence Bruno of UMTA.

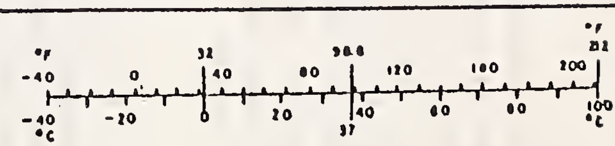
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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Executive Summary

Project Overview

The Utah Transit Authority (UTA) Computerized Rider Information System (CRIS) project involved the installation of an automated telephone service to quickly provide bus stop-specific schedule and service information to residents throughout the Authority's service region, which includes Salt Lake City and its surrounding suburbs, and also the city of Ogden, Utah. Potential bus users obtain this information by calling telephone numbers assigned to specific bus stops or groups of stops. UTA's bus dispatchers have access both to the CRIS system and to the existing dispatch/communications system which includes radios on each bus. The dispatchers monitor bus drivers' reports of schedule deviations and in turn enter this information into the CRIS system. In this way the information supplied to potential passengers who call the CRIS numbers reflects actual operating conditions. The primary goal of the system was to increase ridership and passenger revenues by making up-to-date service information available to all potential users of the transit system. UTA implemented this system, initially on six test routes, on February 4, 1983 under the name of "Buzz-A-Bus." The contractor for hardware and software services was Teleride, a Canadian-based firm.

System Description

UTA's Buzz-A-Bus system consists of telecommunications equipment plus computer hardware and software which has the following functions:

- the general public can quickly obtain bus schedule information for a specific location (one or more bus stops) by directly dialing an ordinary 7-digit telephone number;

- scheduled times of arrival are provided for the next two or three buses (depending on how soon the first bus will arrive) on each route serving the specified location;

- automatically generated computer voice responses provide up-to-date schedule information without the involvement of a telephone operator.

The system also has the following capabilities for updating and evaluation:

- The supplier can adapt the system to obtain schedule information directly from a computerized scheduling data base, if such a data base exists.

- When delays, detours, or service stoppages occur, bus dispatchers can select messages which indicate the amount of delay, the reason for the delay or stoppage, and/or a telephone number to call for additional information.

- The automated voice response vocabulary can be recorded and updated on-site to revise general information, advertising, transfer instruction messages, etc.

- The system can be "queried" to provide displays, reports and system utilization statistics including telephone line usage, call volumes and the system's current operational status.

- The system includes video display screens which show current status updates for all routes and provide the capability for radio dispatchers and customer information center clerks to retrieve schedule data on request.

- The system can be upgraded in the future for usage with an automatic vehicle monitoring system.

Project Objectives

For UTA, the primary objective which led to the decision to implement a CRIS system was a desire to increase transit ridership and, hence, passenger revenues. The CRIS system was expected to accomplish this objective by:

- expanding the availability and visibility of transit information services for potential riders in the community; and

- providing sufficient information to enable users to reduce waiting times at bus stops.

By expanding transit information for potential riders and providing a new means for them to increase their familiarity with bus routes and schedules, UTA hoped to attract new riders. By providing more information on arrival times at specific stops, UTA hoped to assist existing passengers already familiar with the bus routes. They are provided with the information required to improve their level of service, thereby tending to increase the number of transit trips taken.

CRIS systems are designed to aid users in reducing their wait times (and variability of wait times) in two ways. First, CRIS systems provide an alternative source for the bus schedule information available from route maps and route schedule pamphlets. CRIS is most likely to aid potential riders who do not have the printed materials, those who have difficulty in understanding them, or those who cannot estimate arrival times at bus stops not specifically listed in these materials. When the CRIS system is used by these types of riders, their wait times can be reduced, provided the bus service is fairly reliable. Rather than arriving at their bus stops in a random pattern, riders can schedule their arrivals to coincide with the times provided by CRIS, after allowing for a "margin of safety". Second, by providing updated information on major schedule changes or delays, a CRIS system can minimize the extent to which passengers experience unexpected further delays waiting for a bus.

The intended advantages of a CRIS system are likely to be greater for bus routes that have longer headways (which would occur most in the off-peak periods) and for buses experiencing long delays reported by bus drivers to their dispatchers (which would occur most on relatively long routes, on routes passing through congested areas, and/or in times of bad weather).

Thus, it was hoped that the Salt Lake City CRIS system would help to achieve the further impacts of:

- Increasing the economic efficiency of UTA's transit services by attracting new passengers during off-peak periods, when ridership may be below critical load factors and marginal revenues due to new riders may well exceed marginal costs.

- Decreasing the potential for overload on the operators of UTA's non-automated telephone information lines, especially during times of poor weather conditions. Although CRIS systems only provide bus schedule information--a limited subset of the information available from UTA's non-automated Customer Service Department--data on calls to this department indicate that fully 90 percent of them involve requests for schedule information. Even recognizing that a broader range of schedule information is available from Customer Service than from the CRIS system, UTA foresaw a significant potential for reducing calls to Customer Service.

Key Project Features

A key feature of the Salt Lake City CRIS project was its staged implementation strategy. The UTA-Teleride contract provided UTA with a number of evaluation and acceptance points which came into play as the system was expanded to serve all UTA bus routes. These points in time provided divisions of the total system implementation effort into the following phases:

- Implementation; during which a test system was installed for six UTA bus routes.

- Phase I; during which the initial six-route system was operated and its impacts on ridership were determined. During this phase, Teleride conducted a marketing program on both the six test routes and on six similar control routes. Phase I was originally scheduled to continue for a six month "test period", but was subsequently extended by UTA to allow another wave of route-specific marketing to be carried out, followed by a second six-month test period.

- Phase II; up to six months in which Teleride would extend the system to include all Salt Lake County bus routes.

- Phase III; up to three months in which Teleride would extend the system to bus routes in Davis and Weber counties, providing complete coverage for the entire UTA system as it existed when the CRIS project began.

The total period of the agreement was designed to be approximately 21 months, depending on the amount of time taken by Teleride for the various phases. With UTA's decision to extend Phase I, however, the time period could expand to be as long as 36 months. The total cost of the agreement was estimated to be approximately $725,000.

The UTA-Teleride agreement provided UTA with a number of options concerning the continuation of the project, based on how effective the CRIS system was in increasing ridership on the six test routes in Phase I. A number of these options were tied to a contractually-specified measure of effectiveness termed the Increase Factor. The Increase Factor was defined as the difference between the annual percentage increase in ridership on test routes and that on the control routes. Because it did not exceed three percent, UTA had the option to halt the project or go on to Phases II and III at little cost of local funding. If the Increase Factor had been more than three percent, then the local funding costs would have been more than recovered from increased passenger revenues.

Major Project Impacts

This Final Report provides a presentation and analyis of the six-route Phase I Buzz-a-Bus system's impacts on each of the following aspects of transit service in Salt Lake City during the sixteen-month period from February 1983 through May 1984:

- Bus passenger levels on the system as a whole, and specifically on the CRIS test and control routes.
- Usage of CRIS as reflected in telephone calls made to the system.
- Awareness and usage of CRIS as revealed in an on-board survey conducted on the CRIS routes.

- Usage of UTA's Customer Service Department to obtain information on bus routing and scheduling.

- The projected costs and benefits of the complete system as it will exist following Phase III.

The paragraphs which follow summarize the impacts in each of these areas.

Bus Ridership Trends--During the entire analysis period, UTA's total daytime bus patronage grew at an average annual rate of one percent. Ridership levels were down through most of 1983, due mainly to the severe flooding and consequent bus system disruption which occurred in Salt Lake City in the summer of that year. A turn-around occurred in December, 1983: by early 1984 patronage levels had increased quite dramatically over the prior year.

Compared with these system-wide trends, ridership on the CRIS test routes did not do as well. Overall, a decrease of 0.1 percent was observed. On the six control routes, an increase of 3.2 percent occurred. The UTA Board considered these results to be inconclusive. Indeed, the difference between the changes for test and control routes (-3.3 percent) does not significantly differ from the value of zero which would be expected if CRIS had no impact on ridership, or even from the value of +3 percent accepted as a goal by UTA and Teleride.[1]

Relative ridership results on the CRIS test and control routes during both six-month test periods were consistent with the results for the entire analysis period. The percentage ridership decrease during the first test

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[1] Throughout this Executive Summary, measures of CRIS system performance and comparative values (either constants or "before-CRIS" measurements) are termed significantly different if the probability of these differences, estimated statistically, is less than 5 percent.

period was greater for the CRIS test routes than for the control routes. Because the CRIS system did not demonstrate its effectiveness as originally hoped, UTA could exercise a number of options concerning the future of the system, including halting the project completely at essentially no cost to UTA. Rather than stopping the project or going on immediately to Phases II and III, the UTA Board exercised another option by deciding to extend Phase I and conducting another test period, from December 1, 1983 through May 1984. Although both test and control routes gained riders in the second test period, the earlier trends in relative performance continued. Thus after this second test, UTA again could exercise its option to discontinue the project. Citing the inconclusiveness of the ridership results and other perceived system benefits, the UTA Board decided to approve continuation of the project to Phases II and III. The benefits perceived by the Board included the value of the marketing efforts and computer hardware provided to UTA as part of its contract with Teleride. The UTA Board also cited the likelihood that with CRIS in operation for the entire system and with UTA's growth to include Provo transit services in January 1985, the Customer Service Department would not require expansion.

The importance of a number of potential causative factors affecting bus ridership was studied statistically. These factors included the local unemployment rate, temperature, bus fares, gasoline costs, seasonal variables, trends over time, and the existence of the CRIS system. The results indicated that ridership levels on the CRIS test and control routes were not significantly related either to the existence of the CRIS system or to the number of CRIS calls. Conversely, each of the other variables listed above, with the exception of the price of gasoline, were significant determinants of ridership levels. Using various combinations of all the above variables, equations were estimated which explain between 60 and 80 percent of the variation in daily ridership levels.

CRIS System Usage--During February 1983, the first month of operation of the CRIS system, over 6200 calls were made to the automated CRIS system, averaging more than 1000 for each of the six test routes. In the subsequent months, this number rapidly decreased. By April 1983, only 2800 calls were made. Clearly, many of the calls made in February were one time only information or curiosity calls rather than ones likely to be repeated on a regular basis. The continuing decline during the first test period, however, indicated either that not enough people knew about the CRIS system and how to use it, and/or that many of those who tried the system did not find it particularly useful or needed on a continuing basis. Increases in usage during the flooding which occurred in May and June 1983 and during the second test period indicated both the impacts of continued marketing and the increased importance of the system during times of bad weather.

A study of CRIS call rates per passenger at the end of Phase I revealed that for every 1000 passengers, there were 17 calls to the CRIS system. This rate varied in a relatively narrow range for the six test bus routes, with the more lightly travelled routes tending to have the higher call rates. A greater range of variation was observed in call rates by time of day. Early in the project, the off-peak call rates were higher, averaging 23 per 1,000 passengers, double the peak period average of 11.5. At the conclusion of Phase I, daytime call rates for peak and off-peak periods were nearly equal; peak period rates increased by 26 percent and off-peak rates declined by 30 percent. These results suggest that some off-peak riders had gained in their familiarity of the bus schedules through their prior use of the system.

Statistical analyses of daily CRIS call rates and a number of trend, weather and marketing-related potential explanatory variables were performed. The results indicate that the number of calls increased significantly in cold weather months. Increases also occurred following each of the CRIS marketing efforts. The impacts of the marketing activities typically were evident for periods ranging from two to four weeks. Other variables studied--time since the start of the CRIS project and the amount of rain--were not found to be important in explaining CRIS call rates. Taken together, the factors mentioned above accounted for two-thirds of the total amount of variation in the number of CRIS calls per day. The remaining daily variation was caused by random fluctuations and/or unmeasured factors.

Call rates to CRIS can also be compared with the rates of calls to UTA's Customer Service Department, which provides non-computerized information on bus routing and scheduling. At the end of Phase I, calls to the CRIS system accounted for 43 percent of all calls (to CRIS and to Customer Service) made for schedule information on test routes. This value increased from 27 percent at the end of the first test period, indicating an increasing awareness and usage of CRIS by those needing schedule information. Nevertheless, many riders who could obtain the information they needed from the CRIS system continued to use the more established Customer Service system. When the rates for the two types of information calls were added together they revealed that test route riders obtained route information at a slightly greater rate than did the riders on the control routes. Near the end of Phase I (May 1984), the combined rate for the test routes was 55 calls per 1000 passengers; this compared to a corresponding Customer Service rate of 48 for the control routes. The difference, representing less than one percent of test route riders, does not suggest that the CRIS system met a significant need not otherwise addressed by UTA's information services.

Awareness of the CRIS System--An on-board survey conducted on the six test routes in March 1983 revealed that 66 percent of the passengers responding to the survey had heard of the CRIS system, but that only 28 percent of them knew how to use the system and only 21 percent had used the system more than once. Most of those who had heard of the system learned about it from their contacts with the UTA system itself: 25 percent by seeing the decals on the bus stop signs, 28 percent via on-bus advertising, and 7 percent from information received from Customer Service. Another 20 percent learned about the system from more general media advertising or by word of mouth. Only 19 percent first heard of the system from the direct-mail marketing which preceded Phase I. These results for bus users suggested that the first CRIS marketing effort was also probably not as effective as desired in reaching those not currently using the UTA buses. As a result, in May 1983 Teleride and UTA tested a new marketing effort based on door-to-door distribution rather than direct mail distribution. Teleride extended this strategy to all test routes early in the second test period (January 1984).

Tabulations of the percentages of CRIS users by their demographic characteristics revealed that younger bus passengers use the system more frequently than older passengers, and that employed people use the system less frequently than those who are unemployed.

CRIS Impacts on Calls to Customer Service--The number of calls to UTA's Customer Services operators increased between 1982 and 1983, from 1,900 calls per day in 1982 to over 2,300 in 1983. In the first half of 1984, this rate decreased by about 10 percent. There was a net increase of 12 percent in calls to Customer Service from 1982 to 1984.

Using telephone call logs maintained by UTA's Customer Service operators during two-week periods in March 1983 and 1984, the impacts of the CRIS system on these calls could be studied. The information on inquiries by route obtained from these logs indicated that the most important route-specific variables which affected the Customer Service inquiry rates were bus route length, number of bus trips per day, and whether or not express services are offered. This is true both for total inquiries and for schedule-related inquiries (which constitute nearly 96 percent of the total). More Customer Service calls per passenger tend to be made to obtain information on longer bus routes, on routes providing fewer bus trips per day, and on non-express routes--those which serve both non-work and work trips.

Both in 1983 and 1984, the Customer Service inquiry rates for CRIS test routes did not significantly differ from those for other routes having similar characteristics with respect to route length, trips per day, and express services. However, in 1984 the average rate of calls to the Customer Service operators for information on CRIS routes was just two-thirds of the average rate for UTA's control routes. The CRIS system apparently did have an impact on the need for Customer Service operators to serve users of the CRIS test routes, even though the observed data are not sufficient to establish this impact as statistically significant.

<u>System Costs and Benefits</u>--Analysis of the quantifiable costs of the UTA CRIS system revealed that upon contract completion its total costs in current dollars would be $798,320, equal to the contract amount ($725,251)

plus UTA support costs ($238,119) less a loan from Teleride to UTA ($165,050) which will not require repayment because the specified ridership increase of three percent did not materialize. These costs are broken down by phase and category in Table ES-1. Because complete implementation of the full UTA CRIS system extended to the end of 1985, these costs were spread over a three-year period. As reported in Chapter 5, the quantifiable benefits during this implementation period were limited to temporary revenue increases on the test and control routes attributed to the marketing conducted as part of the CRIS project. Due to their short duration, the magnitude of these increases is estimated to be just $15,600. Because relative levels of ridership did not increase on the CRIS test routes, there were no revenue increases due to the CRIS system itself.

To assess the expected value of a completed CRIS system in Salt Lake City, the observed results during Phase I were extended to the complete system. Continuing costs for labor, telephone equipment, and system maintenance of $154,400 per year (in 1983 dollars, as are all others in the remainder of this Summary) are expected in 1986 (the assumed year of system completion) and each year thereafter during which the system remains in operation. Offsetting these costs will be annual benefits in the form of savings in the Customer Service Department as more callers switch to using the CRIS system to obtain schedule information. After allowing five years (until 1990) some time for the usage of CRIS to reach the potential observed for the test routes in Phase I and for the Customer Service Department to reduce its annual costs for staff and equipment, these benefits are expected to be $167,300 per year. The average <u>net</u> annual benefit in 1990 and each subsequent year of the system's life is estimated to be $12,900.

TABLE ES-1: CRIS System Estimated Costs

Cost Category	Phase I	Phases II & III	Total
Contract Costs			
System hardware	$227,598	$ ---	$227,598
Labor and overhead	83,168	4,712	87,880
Travel[1]	45,000	5,000	50,000
Proprietary software	50,000	---	50,000
Stop numbering[1]	10,000	15,000	25,000
System software	6,473	---	6,473
Hardware delivery	4,500	---	4,500
Video display option	20,000	58,000	78,000
Marketing	108,330	87,470	195,800
Contract Cost Subtotals	$555,069	$170,182	$725,251
UTA Support Costs			
Staff costs			$ 88,249
System installation and start-up			101,870
System maintenance			48,000
Support Cost Subtotal			$238,119
Teleride Loan[2]			($165,050)
Total System Costs			$798,320

1 Estimates subject to revision based on actual costs incurred.

2 Repayment not required because ridership goals were not met.

Each of the one-time and continuing costs and benefits discussed above can be combined to estimate the Net Present Value of a complete CRIS system in Salt Lake City. When an interest rate of 10 percent is used to discount expected future-year costs and benefits, a ten-year system life is assumed, and all dollar values are stated in terms of 1983 dollars, the system is found to have a net <u>cost</u> of $891,000 rather than a net value or benefit. Thus, based on the consideration of all quantifiable costs and benefits, the Salt Lake City CRIS system does <u>not</u> represent a cost-effective investment of local and Federal funds.

Sensitivity tests indicate that major changes in the assumptions underlying the economic analysis would be required to change this conclusion. Either of the following changes by itself would be required for the estimated Net Present Value to increase to zero:

- A systemwide ridership increase of 492,000 passengers per year due to the CRIS system, 3.2 percent of the existing ridership level. This increase would be in the opposite direction of the change observed in Phase I; nonetheless, statistically the two changes are not significantly different. The possibility of such a small ridership increase due to the CRIS system cannot be rejected.

- If the benefits of using the CRIS computer to support the Customer Service operators and for non-CRIS data processing were $266,000 per year rather than zero, as predicted. Some benefits of CRIS computer usage are quite likely, but this high level of annual benefits from equipment costing just $232,000 and continually used to support the CRIS system is essentially impossible.

- A further reduction of 53 percent in calls to the Customer Service Department; a total reduction of 86 percent rather than the 33 percent observed in Phase I. Considering the differences in types of information available from Customer Service and the CRIS system, this change would be very unlikely.

Other changes which would reduce the net cost of the system somewhat but could not by themselves cause an overall net benefit include each of the following:

- a longer economic life of the project: even with an infinite system life, the NPV remains negative

- no continuing telephone rental and system maintenance cost
- any feasible level of benefits to UTA of using the CRIS computer for non-CRIS data processing
- major levels of wage inflation at UTA, over and above the general level of inflation.
- a reduction in the time required for full Customer Service Department savings to be realized, from five years to two years

A combination of a number of changes such as those discussed above, all in the indicated direction, will probably be required for the Salt Lake City CRIS system to be a cost-effective investment.

Conclusions: Strengths and Weaknesses of CRIS Systems

Even though the available counts of bus passengers on the CRIS test and control routes during Phase I of UTA's I CRIS system did not show the desired impacts on system ridership, it has provided general evidence of the strengths and weaknesses of automated passenger information systems. The following conclusions are based on all of the information obtained in this system evaluation:

- The ridership results also do not show with statistical significance that ridership targets were not met. The chances are one in four that ridership increased on the CRIS test routes, relative to the control routes. Also, the possibility exists (with an expected chance of less than one in ten) that ridership increased at the desired level of three percent on the CRIS test routes.
- Analyses of the observed levels of ridership on UTA's CRIS test and control routes indicated that ridership levels on these routes were not significantly related either to the existence of the CRIS system or to the number of CRIS calls. Conversely, each of the following variables were found to be significant determinants of ridership levels: the local unemployment rate, temperature and other seasonal variables, bus fare level, and trends over time.
- The ridership results for CRIS test routes versus control routes suggest that the marketing activities carried out in connection with the CRIS project--activities which could have been done with or without a CRIS system--had a greater impact on ridership than the system itself. However, these impacts were of short duration,

pointing out the need for marketing activities to be repeated frequently to provide continuous impacts.

- When all of the data obtained on transit information calls--to both CRIS and Customer Service--are considered, it can be concluded that bus schedule information is most important on long bus routes, for which bus arrival times at stops--especially those far from the ends of the routes--are more likely to vary; and during times of low levels of service, when waiting times can be the greatest. Schedule information is also more needed by people making infrequent bus trips than by those who use the bus often to commute to work. To the extent that future marketing efforts and information systems can be targeted to these types of bus routes and passengers, their effectiveness can be maximized.

- When the total UTA system is considered, the existence of the CRIS system on just six routes had no significant impact on the number of calls to the Customer Service operators. Other more pervasive factors resulted in a net increase of total Customer Service calls from 1982 to 1984. Notwithstanding these overall trends, however, the reductions in Customer Service call rates on CRIS routes observed at the end of Phase I suggest that following the expansion of the CRIS system to all UTA routes, it will probably have a significant impact on reducing the need for the information services of the Customer Service Department.

- A study of the information on CRIS usage versus Customer Service calls suggests a number of factors which may have been inhibiting the more effective use of the CRIS system. Some of these factors were of a temporary nature:

  - With the system only operating on six routes in the region, regionwide media such as radio and newspaper advertising could not be used efficiently to inform residents of the system and how to use it;

  - Because the system was only in existence for a short time, including information on it in UTA materials such as route maps and in the area's telephone directory could not be accomplished for the entire test period.

  Other inhibiting factors are inherent in the differences between the Customer Service and CRIS systems:

  - The CRIS system has many telephone numbers, only one of which provides the information desired by a particular prospective bus user. All prospective users may use the same Customer Service telephone number. It is thus difficult to use bus route schedules, route maps, and other general means of providing transit information to inform the public of all details required to use the CRIS system.

- The CRIS system provides a narrower range of service information than that available from Customer Service.

- The CRIS system does not allow the flexibility, in the form of revised questions or additional detail, available to the Customer Service user.

A final difference between the two systems probably inhibits usage of the CRIS system by some people, while encouraging its use by others. Some may prefer dealing with a human provider of information, while others are comfortable with or even prefer the impersonality of the CRIS system's computer-generated message. The variation in CRIS usage by age group suggests that older people are more likely to fall into the former group, and younger people into the latter.

- Based on an analysis of the quantifiable costs and benefits observed in Phase I and projected to a complete CRIS system for Salt Lake City, the system is not expected to be cost-effective. In the long run, its annual benefits--due to the potential for reducing the budget of the Customer Service Department--will exceed its annual operations and maintenance costs by less than $13,000. In addition, its initial costs far exceed the small ridership gains due to the marketing activities carried out in Phase I.

- Not included in the cost-effectiveness analysis is any consideration of the impacts of the CRIS system on UTA's image as an innovative, forward-looking and progressive provider of transit services in Salt Lake City. In approving the expansion of the CRIS system beyond Phase I, the UTA Board apparently felt that the system would be a positive reinforcement of this image, making future local financial support and ridership increases more likely to occur.

The findings of this evaluation of Phase I of the Salt Lake City Buzz-a-Bus system provide a number of guidelines and cautions to other transit agencies considering the installation of a similar system. The basic question of whether or not such a system should be implemented must be answered based on local objectives, route characteristics, and funding characteristics. The Salt Lake City Phase I system did not result in the hoped-for ridership increases, but did provide other benefits locally judged to justify the costs of a complete system. Thus, the results reported here should not be the sole basis for other agencies to reach either positive or negative decisions concerning the implementation of a CRIS system.

The Salt Lake City experience provides a number of useful insights for other agencies that do decide to implement CRIS systems. Continued observation of the UTA project over time suggests, first of all, that other agencies would probably benefit from agreeing on a simpler contract with their system supplier. The advantages and disadvantages of an extended test period involving just a few bus routes should be considered carefully: the performance pricing features incorporated into this period proved to be advantageous to UTA from a cost point of view, but there were also significant disadvantages: delays in implementing a complete system, marketing difficulties, and the need for extended time periods for negotiations and decision-making.

The UTA experience also indicates the importance of a careful selection of test routes if a performance costing phase is included in the project. These routes should be agreed upon fully by both the transit agency and the system supplier. Ideally, the test routes as a group should represent the system as a whole, and should exhibit very stable service and ridership characteristics for a number of previous years. Route selection is also important if the final CRIS system will not serve the entire area. In this case, the routes to be included should be those for which benefits to passengers will be the greatest. The data collected on the usage of transit information sources in Salt Lake City indicate that routes with the following characteristics should be chosen: those which are longer than average, have lower than average frequency levels, are not express-only services, and provide service to a significant number of non-frequent travellers (for example, to shopping centers and recreational or amusement facilities).

Finally, the Salt Lake City results indicate the positive impacts of location-specific transit marketing, independent of whether or not a CRIS system exists. These impacts are typically short-lived and in Salt Lake City's case proved to be very expensive in relation to the benefits gained. However, if more cost-effective means of developing and distributing transit information of direct relevance to specific residential areas can be found, transit agencies can expect to experience small but positive impacts on bus route ridership levels.

1. Background and History of the Demonstration

1.1 DESCRIPTION OF THE DEMONSTRATION

The Utah Transit Authority (UTA) Computerized Rider Information System (CRIS) project involved the installation of an automated telephone service to quickly provide bus stop-specific schedule and service information to residents throughout the Authority's service region, which includes Salt Lake City and its surrounding suburbs, as well as the city of Ogden, Utah. Potential bus users obtain this information by calling telephone numbers assigned to specific bus stops or groups of stops. UTA's bus dispatchers have access both to the CRIS system and to the existing dispatch/communications system which includes radios on each bus. The dispatchers monitor bus drivers' reports of schedule deviations and in turn enter this information into the CRIS system. In this way the information supplied to potential passengers who call the CRIS numbers reflects actual operating conditions. The primary goal of the system was to increase ridership and passenger revenues by making up-to-date service information available to all potential users of the transit system. UTA implemented this system, initially on six test routes, on February 4, 1983 under the name of "Buzz-A-Bus." The contractor for hardware and software services is Teleride, a Canadian-based firm.

This computerized information system has the following functions:

- the general public can quickly obtain service schedule information for a specific location (one or more bus stops) by directly dialing an ordinary 7-digit telephone number;

- scheduled times of arrival are provided for the next two or three buses (depending on how soon the first bus will arrive) on each route serving the specified location;

- automatically generated computer voice responses provide up-to-date schedule information without the involvement of a telephone operator.

The system also has the following capabilities for updating and evaluation:

- The supplier can adapt the system to obtain schedule information directly from a computerized scheduling data base, if such a data base exists.
- When delays, detours, or service stoppages occur, bus dispatchers can select messages which indicate the amount of delay, the reason for the delay or stoppage, and/or a telephone number to call for additional information.
- The automated voice response vocabulary can be recorded and updated on-site to revise general information, advertising, transfer instruction messages, etc.
- The system can be "queried" to provide displays, reports and system utilization statistics including telephone line usage, call volumes and the system's current operational status.
- The system includes video display screens which show current status updates for all routes and provide the capability for radio dispatchers and customer information center clerks to retrieve schedule data on request.
- The system can be upgraded in the future for usage with an automatic vehicle monitoring system.

The Salt Lake City CRIS project is one of five automated passenger information systems which have been evaluated as part of the UMTA Service and Methods Demonstration evaluation program. The other four have been or are being implemented in Columbus, Ohio; Erie and Pittsburgh, Pennsylvania; and Albany, New York. These are the first automated voice response (AVR) telephone information systems for transit service in the United States. Previously-implemented AVR telephone information systems in North America are in Mississauga, Ontario (started in 1977-78) and in Ottawa and Carleton, Ontario (started in 1980).

1.2 PROJECT OBJECTIVES

For UTA, the primary objective which led to the decision to implement a CRIS system was a desire to increase transit ridership and, hence, passenger revenues. The CRIS system was expected to accomplish this objective by:

- expanding the availability and visibility of transit information services for potential riders in the community; and
- providing sufficient information to enable users to reduce waiting times at bus stops.

By expanding transit information for potential riders and providing a new means for them to increase their familiarity with bus routes and schedules, UTA hoped to attract new riders. By providing more information on arrival times at specific stops, UTA hoped to assist existing passengers already familiar with the bus routes. They are provided with the information required to improve their level of service, thereby tending to increase the number of transit trips taken.

CRIS systems are designed to aid users in reducing their wait times (and variability of wait times) in two ways. First, CRIS systems provide an alternative source of the bus schedule information also available from route maps and route schedule pamphlets. This source is most likely to aid potential riders who do not have the printed materials, those who have difficulty in understanding them, or those who cannot estimate arrival times at bus stops not specifically listed in these materials. When the CRIS system is used by these types of riders, their wait times can be reduced. Rather than arriving at their bus stop in a random pattern, riders can schedule their arrivals to coincide with the times provided by CRIS, after allowing for a "margin of safety". Second, by providing updated information on major schedule changes or delays, a CRIS system can minimize the extent to which passengers experience unexpected further delays waiting for a bus.

The intended advantages of a CRIS system are likely to be greater for bus routes that have longer headways (which would occur most in the off-peak periods) and for buses experiencing long delays reported by bus drivers to their dispatchers (which would occur most on relatively long routes and/or in times of bad weather). Thus, it was hoped that the Salt Lake City CRIS system would help to achieve the further impacts of:

- Increasing the economic efficiency of UTA's transit services by attracting new passengers during off-peak periods, when ridership may be below critical load factors and marginal revenues due to new riders may well exceed marginal costs.

- Decreasing the potential for overload on the operators of UTA's non-automated telephone information lines, especially during times of poor weather conditions. Although CRIS systems only provide bus schedule information--a limited subset of the information available from UTA's non-automated Customer Service Department--data on calls to this department indicate that fully 90 percent of them involve requests for schedule information. Even recognizing that a broader range of schedule information is available from Customer Service than from the CRIS system, UTA foresaw a significant potential for reducing calls to Customer Service.

1.3 ORGANIZATIONAL ROLES

The following organizations were involved in the funding, implementation and analysis of the Salt Lake City CRIS system:

- The Utah Transit Authority (UTA) was the local transit operator which implemented and continues to operate the CRIS system. UTA also maintained responsibility for internal evaluation of the initial system prior to deciding on its acceptance and expansion to all UTA routes. UTA also provided the data used in the system evaluation process.

- The Urban Mass Transportation Administration (UMTA), a unit of the US Department of Transportation (US DOT), provided a Section 3 grant for 80 percent of the cost to purchase and implement the CRIS system. In addition, UMTA's Service and Methods Demonstration program funded the evaluation effort.

- Teleride initially supplied and installed a six-route test automated passenger information system and radio communications/dispatch system improvements for UTA. Subsequently, it supplied and installed updates of the system following the test phase, expanding the system to all UTA bus routes.

- The Transportation Systems Center (TSC), another unit of the US DOT, was responsible for managing the evaluation of the UTA CRIS system. This involved scoping the evaluation effort, approving the evaluation plan, monitoring the consultant's work and reviewing all documentation of the evaluation process, including this Final Report.

- Cambridge Systematics, Incorporated (CSI) was the consultant firm charged with evaluating the UTA CRIS system, as agreed upon with TSC. CSI assembled and analyzed data provided by UTA and prepared this document as a report on the evaluation process and its conclusions.

1.4 THE DEMONSTRATION SETTING

1.4.1 The Utah Transit Authority

UTA was established by the Utah Legislature in 1970, taking over the stock of the former Salt Lake City Lines. It now operates with local sales tax support in the three-county area of Weber, Davis and Salt Lake Counties, including a population of approximately 910,000 within a service area of over 2,100 square miles. Currently, a portion of the sales tax in the three-county area--0.25 percent of sales--supports the UTA. Legislation is pending to increase this to 0.50 percent of sales. During this evaluation study, the UTA maintained three operating divisions: the Central and Meadowbrook divisions within the Salt Lake City system, and a separate Northern division operating in the City of Ogden, 25 miles north of Salt Lake City. In January 1985, UTA expanded its service area to include the city of Provo, adding 10 bus routes.

1.4.2 Service Levels

During this evaluation, UTA's three divisions together operated 34,000 service miles daily (10 million service miles annually) with a fleet of 341 motor buses. A total of 108 routes serving over 5,000 different bus stop locations were covered. There are 72 routes within the Salt Lake City system, including 29 which are primarily commuter routes operated only a few times daily, mainly during peak periods. The Odgen division includes 36 routes, 14 of which run infrequently or only at peak periods. Reflecting local geography and travel patterns, the dominant orientation of the Salt Lake City bus routes is north-south, with a designated "East-West Grid System" of routes to serve transfers and crosstown flows.

Total daily passenger trips average 60,000 on weekdays and 21,000 on Saturdays. Trips to and from work account for 63 percent of ridership. Sunday service is minimal. During this study, annual ridership was around 16 million annually, with the Salt Lake City system accounting for nearly 85 percent. The annual ridership level declined about three percent in 1982, the year prior to this evaluation.

A number of service improvements and expansions took place at UTA just prior to or following this evaluation. On January 1, 1983, "Nite Owl Service" was implemented to serve the central city district. This service was quite successful, resulting in a systemwide increase in ridership of six percent. New regular weekday and Saturday service to shopping malls, resulting in enthusiastic support on the part of the mall businesses, was begun in May

1984. A new downtown terminal was constructed; its official opening took place in November 1984. Fortunately, none of these major service changes occurred during the CRIS evaluation period.

1.4.3 Fares

Basic fares for adults were constant during the evaluation period: 50 cents during peak hours (6:30-9:00 AM and 3:30-6:00 PM), and 40 cents for off-peak hours. For senior citizens and the handicapped, the corresponding fares were 25 cents and 20 cents. Transfers were free. Monthly passes were $22 for peak period commuter service, $18 for regular adult passes, $13 for students and $9 for senior citizens and the handicapped. Fares were last increased in July 1981.

1.4.4 Recent History

UTA experienced tremendous growth in 1976 and 1977, as the fleet size was tripled. By 1978, that rapid growth had led to severe maintenance and service problems, as the system outgrew the capacity of the operations facilities and management structure which existed at that time. During the next three years, new facilities were constructed and a radically new management structure was initiated, focusing strongly on implementing computerized productivity and cost control systems unique in the transit industry. These changes included a new vehicle maintenance control program, a new labor scheduling method, and computerization of all payroll and related functions, with a substantial trimming of the administrative staff. In 1981 and 1982, there were substantial decreases in the frequency of road service calls for buses, decreases in worker absenteeism and turnover, and increases in labor productivity. During the evaluation period, there was a fairly high on-time destination arrival statistic of 92 percent for the system as a whole.

1.4.5 Agency Goals

Having increased operating efficiency in the previous four years, UTA began in 1982 to give particular priority to securing revenue by building ridership and community support. This reflected the agency's strong belief in the importance of marketing transit services, particularly through service and schedule information services. In addition to disseminating this information through printed schedules, UTA improved its telephone information center. During the evaluation period, this center was staffed by 19 operators handling 3,000 calls daily, 90 percent of which included requests for schedule information. UTA hoped to improve the quality of its customer information services and outreach significantly by providing an automated passenger information system.

1.5 PROJECT HISTORY

1.5.1 Project Inception

In late 1981, three events occurred which had a strong bearing on the Utah Transit Authority's decision to implement a CRIS system:

- A search began for more aggressive ways to market the Authority's transit services, to counter the effects of two fare increases in 1981: a large decrease in daily ridership and a projected budgetary shortfall of 30 percent.

- UTA's new Administration and Repair Facility was completed at a cost of $17 million, $6 million less than its estimated cost, 80 percent of which was funded by an UMTA Section 3 capital grant.

- UTA staff members were introduced to CRIS systems at the annual meeting of the American Public Transit Association.

As a result of these events, the UTA staff developed a plan to use a portion of the remaining Administration and Repair Facility project budget to acquire and operate a CRIS system. The primary objective of the system was seen as increasing transit ridership by more effectively providing information on transit services. A number of secondary objectives were also cited: to reduce the costs of providing customer information, to provide the basis for controlling operational costs through optimized service levels and vehicle/driver productivity, and to provide improved communications control and operations monitoring for UTA's bus dispatch centers. This plan was ratified by the Executive Committee of the UTA Board of Directors on December 30, 1981.

In April, 1982, UTA requested approval from UMTA to transfer $770,000 of their project budget from the contingency line item to the "purchase and installation of new computer hardware" line item. This request, in addition to subsequent modifications (made following the final determination of contract costs and the complete costing of all non-contract system elements) which increased the total budgeted funds available for a CRIS system to $963,370, were approved by UMTA. These funds were allocated as follows:

Staff costs for CRIS system administrative support, progress evaluation, and reporting	$ 88,249
System installation and start-up costs[1]	52,000
Telephone costs (one year)	49,870
Hardware and software maintenance (one year)	48,000
Contract costs	725,251
Total Costs	$963,370

As in all portions of UTA's overall Administration and Repair Facility project budget, 80 percent of the total cost ($770,696) was provided by the

[1] System installation and start-up costs included computer room modifications, cables and conduits, video display installation, bus stop inventory and file data entry.

UMTA grant; the remaining 20 percent ($192,674) was provided by UTA as the local share.

1.5.2 Contractor Selection

The process of selecting a contractor to provide a CRIS system began by sending out requests for statements of qualifications (RFQs) to the following firms in late February, 1982:

Burroughs
Digital Equipment Corporation
Forum Communications
General Electric
Honeywell
International Business Machines
Motorola
National Cash Register
Rolm
Transmax
Teleride Corporation
Univac

Also, the RFQ announcement was published in four journals: Telephone Engineer & Management, Computer Business News, Passenger Transport, and the Salt Lake Tribune. Responses were particularly encouraged from firms with specific expertise and experience in installation of public information systems and radio/telecommunications systems.

Perhaps because of UTA's stress on telecommunications rather than computer hardware expertise, most of the larger computer companies such as IBM, Burroughs, DEC, Honeywell, and Univac did not respond to the RFQ. The 14 firms that did respond were:

Aegis Systems Corporation
Chase, Rosen & Wallace
Comsis
Forum Communications
General Electric
IOCS

McDonnell Douglas
Motorola
Simcom
System Development Corporation
Teleride
Transmax
Wilson Hill Associates
Wismer & Becker

Each of these 14 firms were then evaluated by UTA's General Manager, the CRIS Project Director, a representative of the Board of Directors, and representatives of the following UTA departments: Grants Administration, Data Processing, Planning, Finance and Marketing.

Each evaluator ranked the fourteen firms with respect to each of the following criteria which had previously been assigned the relative weights shown:

- Overall experience (30 points): specialized experience, technical competence, and actual installation experience.
- Evidence of the firm's innovative creativity (25 points): the capability to develop and apply innovative techniques and/or advanced-technology solutions.
- The availability of off-the-shelf operationally proven hardware and software systems (20 points).
- The firm's familiarity with the transit industry, operational considerations and problems applicable to the project (15 points).
- The firm's capacity to perform the proposed project work in a timely and responsive manner (10 points).
- The past record of performance on contracts and projects of a similar nature (5 points).

Two finalists were chosen from the list of 14 firms: Simcom and Teleride. In August, 1982, the Manager of Data Processing and the CRIS Project Manager visited other sites such as Columbus, Erie and Toronto to learn more concerning CRIS system needs. Also that month, requests for proposals were sent out to Simcom and Teleride with responses due on September 13. On September 17, both Simcom and Teleride were invited to Salt Lake City to make 90-minute oral presentations of their proposals.

In the final evaluation these two firms were then judged on seven criteria:

- the firm's overall experience (15 points),
- the firm's direct experience on similar projects (15 points),
- the ability to supply the specific services requested (50 points),
- current workload and ability to serve UTA's needs in a timely fashion (10 points),
- overall responsiveness of proposal (5 points), and
- oral presentation (5 points).

Evaluations were made by the CRIS Project Manager as well as the managers of each of UTA's administrative departments. Most evaluators were in favor of the Teleride proposal by a significant margin due to the judgement that it exhibited a greater level of experience in the field of CRIS systems. Teleride was thus chosen to receive the UTA CRIS contract. In October, Teleride, having been notified of the contract award, made a three hour presentation on the Teleride 2000® system to UTA. On December 31, 1982, Teleride signed the contract with UTA to provide CRIS services; UTA signed two weeks later (January 17, 1983).

1.5.3 Contract Provisions

The UTA-Teleride Automatic Telephone Information System Agreement provided the basis for the provision of the UTA CRIS system by Teleride. The agreement is a complex document with many provisions, contingencies, and dates.

Its most important features are summarized in Table 1-1. Both Teleride's and UTA's responsibilities are shown chronologically in each of the agreement's phases. These phases, and their expected progression, are:

- Implementation; during which Teleride agreed to install a test system for six routes and UTA agreed to make payments of approximately $467,500. This phase could continue for up to 180 days.

- Phase I; during which the initial six-route system was operated and its impacts on ridership determined. Teleride agreed to conduct a marketing program during this phase and UTA agreed to pay an additional $87,500. This phase was scheduled to continue for at least 180 days. Both parties could extend the phase under particular conditions; the total time for Phase I actually was 480 days (16 months).

- Phase II; 180 days in which Teleride agreed to extend the system to include all Salt Lake County bus routes and UTA agreed to make additional payments of $120,000.

- Phase III; 90 days in which Teleride agreed to extend the system to all UTA bus routes in Salt Lake, Davis, and Weber Counties. Also, UTA agreed to make a final payment of approximately $50,000.

The total period of the agreement was designed to be approximately 21 months, depending on the amount of time taken by Teleride for the various phases. If either party exercised its option to extend Phase I, however, the total time could extend to as much as 27 months. The total cost was estimated to be $725,251, with variations possible depending on the actual costs of bus stop signing and travel by the Teleride staff. Higher costs than those estimated in these areas require prior UTA approval. Estimated costs by cost category are shown in Table 1-2.

A supplemental agreement was also executed, providing for a loan from Teleride to UTA of $165,050, to be made within 30 days of the execution date

TABLE 1-1: Summary of the UTA-Teleride Agreement

Activity	Project Schedule: Per Agreement	Project Schedule: Actual
Execution Date	1/17/83	1/17/83
Implementation Phase	30-180 days	19 days
1. Teleride-UTA meeting to: ● designate Phase I test and control routes ● select methodology for establishing ridership performance ● designate base period for ridership performance		
2. Teleride implements system on Phase I test routes		
3. UTA responsibilities: ● choose equipment site ● provide telecommunications services ● provide transit schedule and status information for test and control routes ● make payments totalling $330,000 ● make additional payments totalling $187,500		
Phase I	180-360 days	480 days
1. Teleride establishes Phase I Test start date		2/4/83
2. UTA conducts one or two Phase I demonstration tests		
3. If either demonstration test is successful, UTA must accept the system for use in Phase I		
4. If both tests are not successful, UTA may reject the system and be refunded all hardware and software costs, and the contract will be terminated		
5. Teleride implements a marketing program approved by UTA: ● to inform potential test route users concerning CRIS ● to inform potential control route users concerning schedules		1/83, 3/83, 1/84

TABLE 1-1: Summary of the UTA-Teleride Agreement (Cont'd)

Activity	Project Schedule: Per Agreement	Project Schedule: Actual
Phase I (continued)		
6. First Test period is completed		7/31/83
7. First test period ridership Increase Factor[a] is determined to be less than 0.03. UTA's options are: • accept the system, pay \$37,500, and proceed to Phase II • reject the system and, if all Phase I costs have not been paid, have it removed by Teleride. • reject the system and, if all Phase I costs have been paid (\$555,069), receive title to all hardware • allow the Test period to be extended for a single additional 180-day period		
8. UTA chooses to extend Phase I and schedule a second Test period		
9. Second Test period is completed		5/31/84
10. Second Test period ridership increase factor is determined to be less than 0.03. UTA elects to accept the system, pay \$37,500, and proceed to Phase II		
Phase II	180 days	–[b]
1. Teleride responsibilities: • implement the system for all routes in Salt Lake County • install video schedule monitors in CBD and at airport		
2. UTA conducts Phase II demonstration tests until the system passes, or until UTA accepts the system at its (non-passing) level of performance		
3. UTA makes payments totalling \$120,182		

TABLE 1-1: Summary of the UTA-Teleride Agreement (Cont'd)

Activity	Project Schedule: Per Agreement	Project Schedule: Actual
Phase III	90 days	– [b]
1. Teleride implements the system for all UTA routes		
2. UTA conducts Phase III demonstration tests until the system passes, or until UTA accepts the system at its (non-passing) level of performance		
3. UTA pays remainder of system cost, approximately $50,000		

[a] The Increase Factor (IF) is defined as:

$$IF = \frac{RT_t}{RT_b} - \frac{RC_t}{RC_b}$$

where:

RT_x = Ridership level on all CRIS test routes for any consecutive 180 days during period x.

RC_x = Ridership level on all CRIS control routes during the same 180 days.

t = Phase I Test period

b = Base period, as agreed upon in the Implementation Phase.

[b] The start of Phase II and III was delayed until after the writing of this report.

TABLE 1-2: Estimated Costs in the UTA-Teleride Agreement by Cost Category

Cost Category	Phase I	Phases II & III	Total
System hardware	$227,598	$ ---	$227,598
Labor and overhead	83,168	4,712	87,880
Travel[1]	45,000	5,000	50,000
Proprietary software	50,000	---	50,000
Stop numbering[1]	10,000	15,000	25,000
System software	6,473	---	6,473
Hardware delivery	4,500	---	4,500
Video display option	20,000	58,000	78,000
Marketing	108,330	87,470	195,800
Contract Cost Totals	$555,069	$170,182	$725,251

1 Estimates subject to revision based on actual costs incurred.

of the main agreement. Monthly payments on this loan were scheduled to begin after the start of Phase II. Each payment is to equal the fraction of UTA revenues attributable to the ridership increase due to the CRIS system. (As measured in Phase I by the Increase Factor defined in Table 1-1.) Payments were to continue until the entire principal amount plus 10 percent interest would be repaid. The maximum total interest amount was set at $17,950. If the Increase Factor were less than 0.03, however, Teleride agreed to waive repayment of this loan. The net effect of this supplemental agreement was that UTA could obtain the CRIS system at a minimal initial cost to the Authority:

- If the system were successful in increasing ridership three percent or more on the Phase I test routes, the 20 percent local share ($192,674) would be paid out of increased fare revenues.
- If the system did not increase ridership at least three percent, nearly all of the local share ($165,020) would be absorbed by Teleride.

UTA had two basic types of options which resulted in most of the contingencies in the main agreement:

- Whether or not to accept the CRIS system for each numbered phase, even if the system should fail its demonstration test.
- Whether or not to accept the CRIS system at the conclusion of Phase I, even if the system should have a measured Increase Factor of less than 0.03.

The second set of options is the most important one, since the probability of the system not functioning according to its technical specifications was significantly lower than the probability of it having an Increase Factor less than 0.03. Table 1-3 summarizes the courses of action open to UTA in the latter eventuality, and their cost implications. UTA's acceptance of the

TABLE 1-3: UTA's Options for a Phase I Increase Factor of Less than 0.03

		Total System Cost Implications			UTA Cost Implications	
UTA Option	CRIS System Implications	Contract Costs	Non-Contract Costs	Total	Local Share[a]	Net UTA Cost[b]
1. Accept system and make an additional $37,500 contract payment	Proceed to Phase II	$725,251	$238,119	$963,370	$192,674	$27,624
2. Reject system, but pay an additional $37,500 contract payment	UTA would take title to all hardware and agreement would be terminated (no Phase II or III but UTA could continue system operation)	$555,069	$187,954[c]	$743,023	$148,605	-$16,445
3. Reject system, make no further payments	Teleride would remove hardware, agreement would be terminated, system would cease operation.	$517,569	$187,954[c]	$705,523	$141,105	-$23,945
4. Extend test period 180 days, then measure a new Increase Factor	Phase I would continue	-[d]	-[d]	-[d]	-[d]	-[d]

[a] Twenty percent of total CRIS-related costs.

[b] Assumes no repayment of the Teleride loan of $165,050.

[c] Assumes only the Phase I portion of UTA's evaluation costs would be incurred, in addition to eight rather than twelve months of UTA labor expenses and system maintenance.

[d] Cost implications would depend on the results of the subsequent test period and on the option UTA would exercise at that time.

system under these conditions would result in the total local share of costs being just $27,624. A decision to reject the system and keep its hardware would result in UTA having a net cash income of $16,445. By rejecting the system and not making a final Phase I payment of $37,500 ($30,000 provided by the UMTA grant and $7,500 provided by UTA), UTA's net cash income would be $23,945. Thus, the effective local cost of $227,598 of computer and communications hardware (as shown in Table 1-2) would be only $7,500.

The complexities of the UTA-Teleride agreements placed requirements on both parties to monitor and maintain the CRIS system's effectiveness in a timely and careful fashion. One aspect of this evaluation was the observation and assessment of this monitoring by both UTA and Teleride during Phase I of system operation.

1.5.4 System Startup

The execution date of the project was January 17, 1983, the day on which UTA signed the contract with Teleride. Contract provisions called for Teleride to install and implement the Phase I system within 180 days of the execution date. However, within just 20 days (on February 4, 1983), the entire system for Phase I was installed. This rapid rate of implementation was possible because another Teleride client, the Fort Wayne Public Transportation Corporation, decided to put off installation of its system until November 1983, just prior to the start of winter. Hence, Fort Wayne's hardware became immediately available for installation at UTA, which eagerly took advantage of the opportunity to borrow the hardware, with Teleride's permission, until a

UTA-specific CRIS computer with more memory and storage capabilities would become available.

Due to its own work schedule, Teleride immediately sent an installation team consisting of a hardware engineer, a software engineer, and a project manager to Salt Lake City to install the system. In two hectic weeks of around-the-clock shifts, Teleride and UTA worked together to install the hardware, enter data base information into the computer, and train UTA's staff to operate the system. By February 5th, the system was completely operational. Teleride personnel were no longer required on-site, and a minimal level of UTA staff support was needed.

1.5.5 Route Selection

The selection of CRIS test routes for Phase I began long before the system was implemented. In August 1982, UTA's CRIS project manager met with the General Manager and the directors of data processing, planning, and finance, to discuss route selection. It was decided that CRIS should initially be implemented on six test routes, and that six control routes should also be defined for study and evaluation during Phase I. Routes were chosen after considering vehicle headways, type and length of route, geographical area and residential patterns. Table 1-4 shows the characteristics of the selected routes. Figure 1-1 provides a map of all Phase I routes.

Test and control routes having similar characteristics were paired to allow evaluations to be done on a route-by-route basis. In January 1983, during the two weeks of hectic implementation of CRIS, UTA and Teleride representatives met, as called for in their agreement, and concurred in their approval of the routes selected by UTA in August.

TABLE 1-4: CRIS Test and Control Route Characteristics

Test	Control	Headway (minutes)	Type	Length	Geographical Area	Residential Type
9-Ninth East	10-Fifth East	20	Through	Medium	East	Established
11-13th East	27-Fort Union	60	Radial	Long	East	Mixed
19/20-Rose Park	16/17-Glendale	20(40)[a]	Through	Short	West	Established
39-E/W 39th So.	40-E/W 45th So.	30	Crosstown	Long	East/West	Mixed
41-West Jordan	42-Dixie Valley	30/60	Radial	Long	West	New

[a] Routes alternate on a reverse loop.

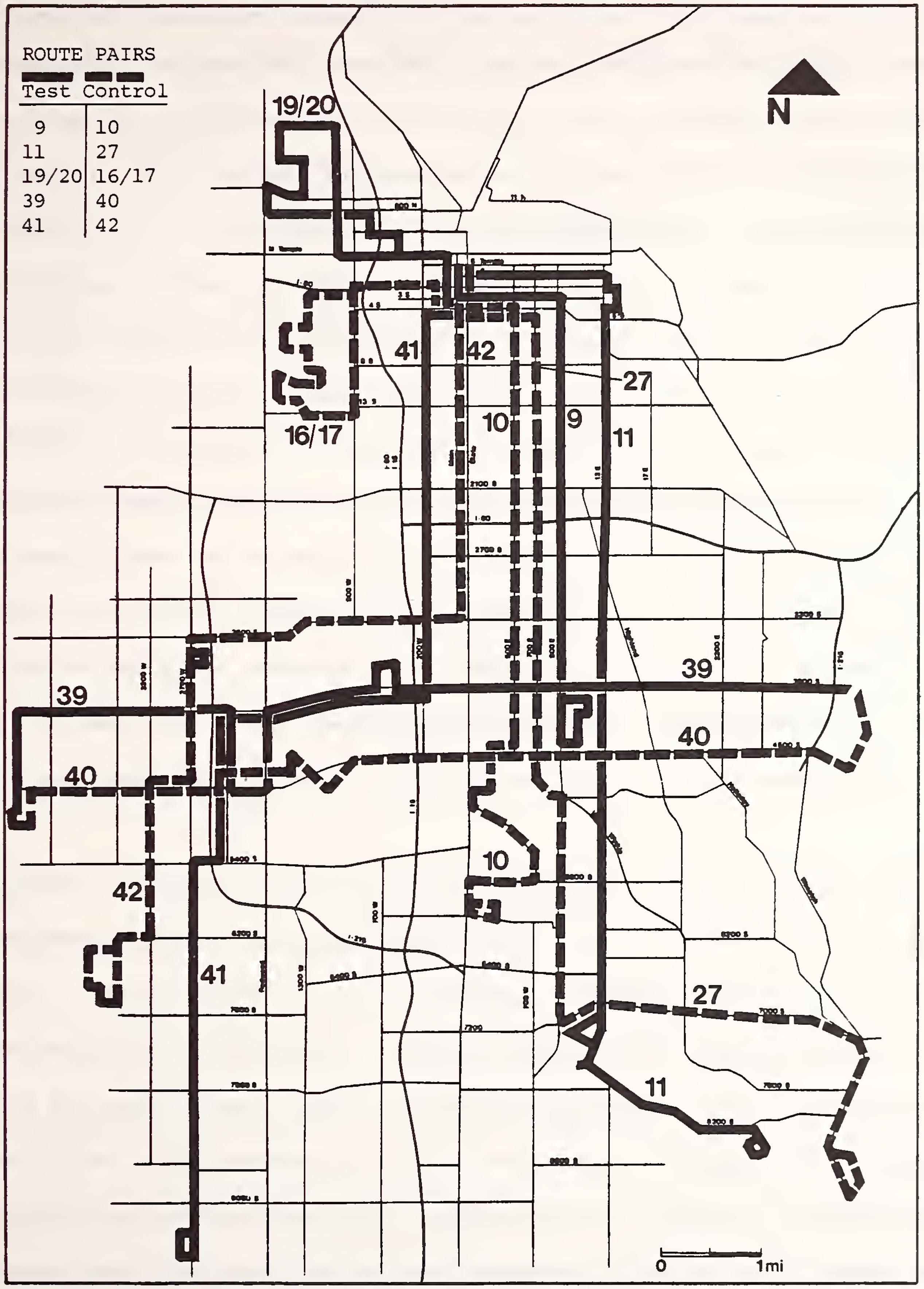


FIGURE 1-1: CRIS Phase I Test and Control Routes

1.5.6 Marketing

The CRIS agreement called for the marketing of both test and control routes by Teleride before and during the Phase I test period. In addition, Teleride was obligated to use a local advertising agency for any portion of the marketing effort not carried out by Teleride itself. Teleride thus subcontracted to ET AL, a Salt Lake City advertising agency.

The first marketing objective was to determine a name to replace CRIS or Teleride 2000®. After a search for a name which would be simple and would appeal to the average Salt Lake City worker, "Buzz-a-Bus" was finally selected.

Advertisements of "Buzz-a-Bus" in the form of newspaper articles, eight-foot wide billboards on the back of buses and bus cards inside the buses next appeared in late January. Also, all bus stop signs on the test routes were revised to include information on Buzz-a-Bus and how to reach it by telephone. On February 4, public officials including Congressmen, the Port Director, and Mayor's representatives, along with the UTA senior staff, took part in a ceremony in downtown Salt Lake City to officially introduce the system to the public.

The major marketing campaign began just one week before the official opening, with direct mail pieces sent to approximately 48,000 households, split evenly between households along the test and control routes. Table 1-5 shows the distribution of mailings by route. The mailings were directed to households within two blocks of each Phase I route. The contents of the mail packages to the CRIS test routes consisted of a description of CRIS, instructions on how to use CRIS, and stickers on which patrons could write the telephone number to be called to ascertain bus arrival times for their stops.

TABLE 1-5: Direct Mail Packets Sent by Route, January 1983

Test Route Number	Number of Household Mailings	Control Route Number	Number of Household Mailings
9	3,924	10	6,563
11	4,114	27	4,124
19/20	7,975	16/17	5,124
39	4,015	40	4,492
41	3,471	42	3,762
Totals	23,939	Total	23,907

The packets sent to areas served by the control routes consisted of the regular transit and schedule information for the routes and also an introduction or reintroduction to the UTA system. Examples of the marketing materials and bus stop sign information used by UTA are provided in Appendix A.

After the Buzz-a-Bus system had been operating for a month, plans were made to carry out an on-board survey on each test route, to determine user awareness and usage of the CRIS system. (See Section 4.3.) The major conclusion reached by Teleride after analyzing the survey results was that most riders learned of the system through bus stop signs or bus advertising; few had been informed by the earlier mailing. This suggested to Teleride that few non-riders were then aware of the service; this suggestion was consistent with the relatively low CRIS call rates at that time and the initially disappointing ridership results for the Buzz-a-Bus test routes. It was thus concluded that additional direct distribution efforts should be carried out to inform those living near the test routes of the existence of Buzz-a-Bus and how it could be used. The second information packet was distributed by Boy Scouts under the supervision of the UTA staff during the third week in May 1983.

1.5.7 Operations During the First Test Period

After beginning on February 4, 1983, the first test period of Phase I continued through the month of July. As discussed in more detail in Section 4.1, ridership results steadily improved during the first four months, through May. Early in June, however, Salt Lake City experienced heavy rains, rapid snow melting in the surrounding mountains, and thus unprecedented amounts of flooding. The results were severe disruptions of all aspects of local transportation, including the Buzz-a-Bus test and control routes. The immediate effect was a much higher rate of Buzz-a-Bus calls, as daily service changes and many new bus riders made the information provided by Buzz-a-Bus more useful and therefore more frequently accessed.

Unfortunately, for reasons which remain not fully understood, UTA's systemwide ridership decreased more than usual during the summer months of June and July. More importantly, these changes were generally much more negative on the CRIS test routes than on the control routes. The net result was that the contractually-defined increase factor (change in ridership on test routes minus change in ridership on control routes) for the entire first test period was negative, far below the three-percent goal specified in the UTA-Teleride agreement.

Thus, at the originally-scheduled end of Phase I, UTA could exercise any of the options shown in Table 1-3. Alternatively, they could accede to Teleride's recommendations at that time that their agreement be re-negotiated. After two months of deliberations by the UTA staff and Board, the agency decided to select Option 4 shown in Table 1-3, calling for a second Phase I test period. This new test period was scheduled to begin on December 1, 1983, providing time for an expanded marketing program to be carried out.

1.5.8 Operations During the Second Test Period

As preparations began for the second CRIS test period, a disagreement arose between Teleride and UTA concerning the most appropriate means of increasing the effectiveness of the CRIS marketing effort. Up until this time, the UTA Marketing Department had played a major role in selecting the format and style of written marketing materials, and the means of distributing these materials in the areas served by the test routes. At this time, however, failure to reach agreement on these issues by Teleride and UTA, coupled with Teleride's contractual responsibilities for CRIS marketing, resulted in the Marketing Department's withdrawal of its involvement in these areas.

Teleride's new marketing activities were concentrated in the third week of January 1984, when materials were distributed door-to-door in the residential areas served by both test and control routes. The combination of winter weather and the new marketing activity resulted in a significant increase in the number of CRIS calls--from 2,564 calls in December 1983 to 4,344 calls in January 1984, an increase of almost 70 percent. Ridership on the CRIS routes also increased, but not as dramatically. The December-January increase in ridership was 13 percent. The second test period ended on May 31, 1984. For nearly every month, ridership on both test and control routes increased over the previous year, as it did for the system as a whole. The increase was greatest, however, on the control routes. As a result, the CRIS route increase factor of the entire test period was again negative. UTA again had an opportunity to select Options 1, 2, or 3 as shown in Table 1-3.

1.5.9 UTA's Decision Concerning Phase II

At the conclusion of the second six-month test period in Phase I, the Buzz-a-Bus Project Manager at UTA recommended against accepting the Teleride CRIS system, citing the apparent failure of the test routes to exhibit a significantly higher increase in riders, relative to the control routes. The UTA Board, however, decided to proceed with Phase II of the project (Option 1 in Table 1-3). The Board termed the ridership results inconclusive; their reasons for not exercising either of their options to cancel the contract were the following:

- The contract incorporates a significant marketing effort which in itself is valuable to UTA.

- The contract provides computer hardware with a high value to UTA; this hardware can be used for additional purposes by the agency.

- In January 1985, UTA would be expanding to serve the Provo area. Without CRIS, this would necessitate increases in staffing and hours of service for the manual information services provided by the Customer Services Department. With CRIS, this expansion would probably not be required.

Thus, as this report is being prepared, work continues on installing new computer hardware and additional software at UTA, in preparation for the initiation of the Buzz-a-Bus system on all UTA routes by December, 1985.

2. CRIS System Description

2.1 FUNCTIONAL CAPABILITIES

2.1.1 User Functions

UTA contracted with Teleride, Inc. to provide a Teleride 2000® system. From the users' viewpoint, the capabilities of the system are as follows: Upon dialing a telephone number 264-XXXX, where XXXX is the stop number of the bus route of interest to the caller, a computer-generated voice will respond with the route number and stop (to reassure the caller) and the scheduled arrival time of the next two buses. If the scheduled arrival time is within 60 minutes, the computer-generated voice will respond with the number of minutes until bus arrival. If the scheduled arrival time is greater than 60 minutes, the voice will respond with the time of arrival, to eliminate any possible confusion about the correct time. The system may also be instructed to inform users of schedule changes and delays, as well as their causes.

2.1.2 Peak Use Capacities

The Teleride system is capable of handling 10,000 calls per hour without displaying a busy signal, while all calls are answered within 3 seconds. An experiment carried out by UTA in which 25 staff members called CRIS simultaneously for the same bus stop information was performed, resulting in no busy signals for any of the callers.

2.1.3 Updating Capabilities

CRIS uses information on delays and detours provided by bus operators via two-way radios, which were previously standard equipment at UTA. The Authority's operating procedures call for the operators to notify their dispatchers whenever they are running more than seven minutes late. This information is received by the bus dispatchers, who normally enter it into the CRIS system on a route-specific basis and also provide it to the Customer Service Department for use by its information operators. Information on schedule changes can also be specified on a stop-specific basis by the dispatchers. If delays are wide-spread (for example, due to a severe snow storm), a single systemwide message is keyed into CRIS, rather than many route-specific messages. All status updates can be input using menu-driven software.

2.1.4 Messages Available

The system allows for the voice generation of a number of types of information. These include each of the following:

- Scheduled Time Information: The system generates the scheduled arrival or departure time for the bus at the stop dialed by the transit user. A message containing the following segments is generated: initial greeting, confirmation of the stop which the customer has dialed, route name and number, schedule time of the next two to three buses, and message termination.

- Status Messages: In addition to or instead of the scheduled time information, status messages are used whenever there are significant changes from the normal operating schedule or if there is no operation at the time of the call.

- Delay Information: Dispatchers are able to insert into the status message both the amount of delay and the reason for the delay, selecting from eight categories of reasons.

- Detours and Diversions: Callers can be advised of detours or diversions and can be given an alternative telephone number for additional information.

- No Service Messages: Callers can be advised about no service at a stop, the reason for lack of service, and when service or availability of information will resume.

- Special Service Messages: These messages provide additional information to callers, such as when passes are going on sale, and other information of interest. A wide range of service messages (e.g., a short weather or temperature report, notice of special events, advertising, public service notices, etc.) are possible.

- Schedule and Fare Changes: Callers can be advised about the date of schedule and/or fare changes and provided with the Customer Service telephone number for additional information.

2.1.5 Schedule Data Base

The system maintains route-specific schedule data for five classifications of service: regular weekday, Saturday, Sunday, night and holiday. Changes from one service type to another occur without any disruption in telephone service.

2.1.6 Reporting Capabilities

CRIS generates six types of reports for UTA:

- rate of utilization for telephone trunk lines
- analysis of call holding times due to "busy" telephone numbers
- calls by zone and time period
- calls by area and time period
- scheduler and supervisor log
- incident log

Each of the above reports are saved for four days in the computer's memory and a hard copy of each going back six months is saved by UTA, available for further analysis. During this evaluation, UTA made little use of the CRIS data bases or reports for other aspects of their operations. They did, however, hope to take advantage of this information more in Phase II and III as its coverage extended to all bus routes. The trunk utilization and holding time analysis reports are important indications of when the system is approaching its capacity limits. The "calls by zone" or "area" and "time period" reports focus on the volume of telephone calls, indicating changes in the use of the CRIS system. The scheduler and incident logs, on the other hand, provide valuable data on the schedule reliability of the bus routes.

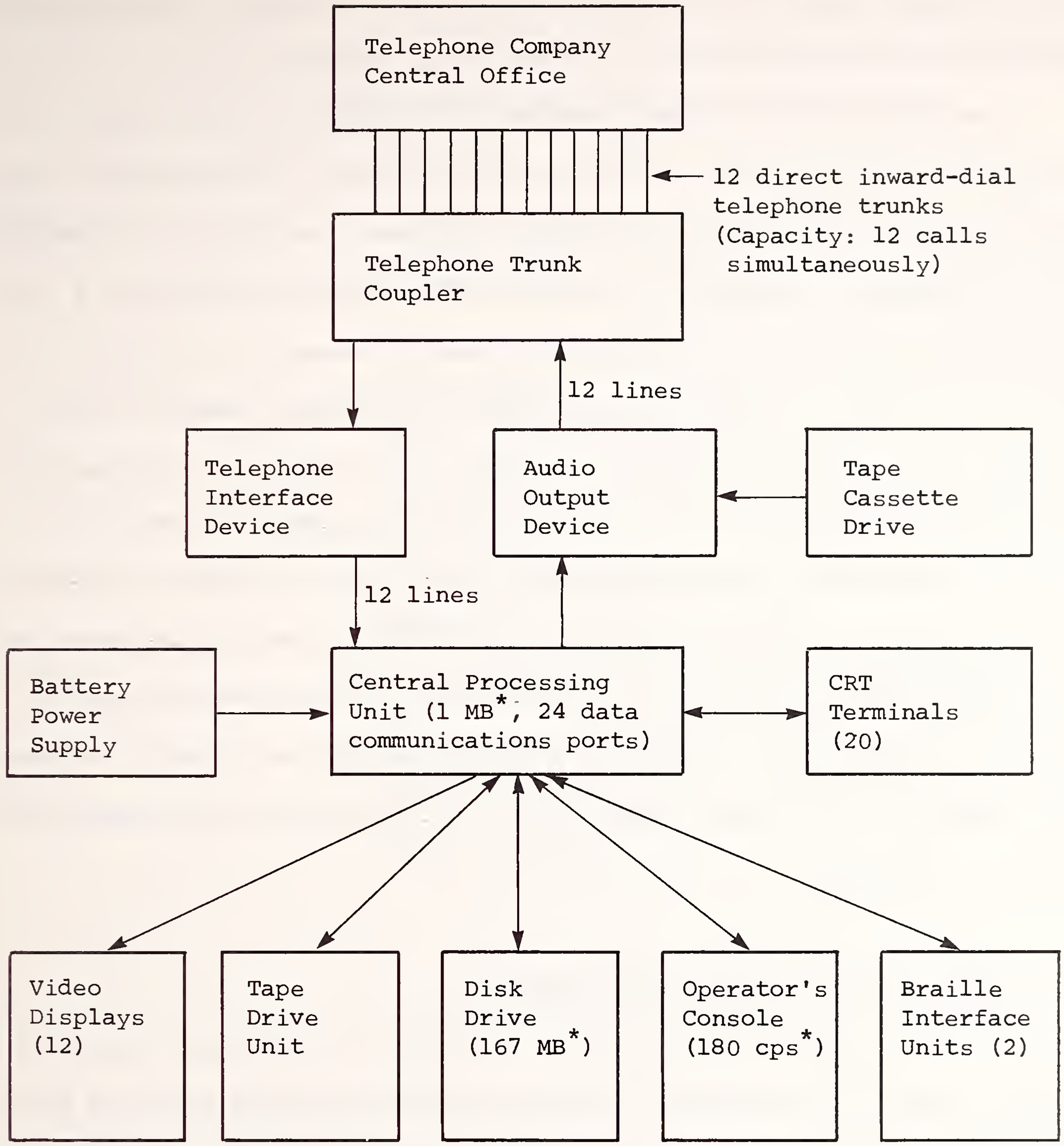
2.1.7 Other Functional Capabilities

Other CRIS capabilities are the following:

- Messages can be automatically shortened when there is a heavy demand on the system.
- The system is field upgradable to be integrated with an automated vehicle monitoring (AVM) system.
- The automated voice response vocabulary can be recorded, entered, and updated on-site.
- The data base of schedule information can be edited on-site.

2.2 HARDWARE

Figure 2-1 provides an overview of the various hardware components making up the CRIS system and their interactions. A telephone trunk coupler which accomodates up to 8 telephone connections receives and transmits telephone messages. Upon reception of a telephone call, the telephone interface device translates the telephone number into machine readable form for the host computer. The host computer then selects the relevant messages from the tape cassette drive. Electronic signals from the host computer are transmitted into the audio output device to operate the tape cassette drive, which loads the vocabulary from solid-state memory which houses thousands of different syllables that are pasted together by the host computer. This device then transmits the messages from cassette back to the telephone trunk coupler and the caller. All of this takes place in as little as four seconds. Normally,



*Key: MB = 1,000,000 bytes
cps = characters per second

FIGURE 2-1: CRIS System Hardware Configuration users perceive much less delay than if a human operator had to look up the schedule for a particular route to answer their questions.

Also included with the host computer are input/output ports which are connected to CRT terminals and the auto-answer modem. The dispatcher, upon receiving update information from the bus operators, can key the information into the computer to update the stored schedule data on location via a CRT terminal or remotely via the auto-answer modem. Because it is possible to access the computer remotely for updating, bus operators themselves could possibly provide update information directly to the computer. Although this would require additional training for the operators and expensive on-board hardware, and thus is not now available in Salt Lake City, this "automatic" updating procedure could in the future be an integral part of the system for a very large number of routes. Also connected to the host computer are the operating console (which also acts as the printer for the reports), and magnetic tape and disk drives. Table 2-1 lists the major hardware components of the UTA CRIS system.

2.3 STAFF TIME AND RESOURCE REQUIREMENTS

In stark contrast to the two-week around-the-clock effort to bring up the system, running and maintaining the system has required little if any UTA staff time. The UTA project manager roughly estimated the time actually spent by the dispatcher in keying in the updates on the order of one-half hour per day. Some days, if there are considerable delays, the dispatcher may spend several hours keying in scheduled information updates. On other days, he may spend no time at all. During the flooding in June 1983, the dispatcher keyed in informational and schedule updates caused by five detours for several hours on the day the detours were implemented. However, since the detours remained

TABLE 2-1: CRIS System: Major Hardware Component List

Quantity	Item
1	Central Processing Unit
1	Console Printer
1	Disk Drive
1	Tape Drive
2	Data Communications Ports
20	Video Display Terminals
1	Auto Output Device
1	Battery Backup Unit
1	Telephone Interface Device
12	Line Couplers
1	Battery Backed Up Clock
12	Airport-Type Video Display Units/Controllers
2	Braille Interface Units

in effect for two weeks, there was no need to update the information until the detours were lifted.

Nevertheless, when CRIS is available for the entire UTA 108-route system, there will probably be a need for one or two other dispatchers who should handle the majority of CRIS system operations. This individual would be responsible for the status updates for 18 times the number of routes for which the current dispatcher is responsible. Assuming on average that 12 person-hours/month are needed for updating six routes, 216 person-hours/month will be needed in order to maintain updates for the entire system. Although theoretically (assuming uniform distribution of delay reporting), an additional dispatcher can probably handle this, the volume of delay reporting can be very high at particular times (e.g. peak period in bad weather), resulting in a definite need for additional personnel in order to maintain an adequate reserve capability to make all required system updates.

Teleride reported that in their five citywide systems (Ottawa, Mississauga, Kitchener, Brantford, and Guelph), the schedule update and computer operations functions have not led to any significant staffing requirement. The schedule update function is carried out as part of the computer schedule development program in each transit agency with a Teleride system.

Besides the needs for updating the schedules to reflect delays, there is also a need for a person within UTA to maintain the system in running order. Although system crashes are very rare, staff members with crash-recovery abilities must be available. These individuals should also be responsible for maintaining files of the six types of reports generated by CRIS. A reasonable estimate would indicate that twenty hours per month would be required from UTA personnel to provide these services. The person who will probably continue to be responsible for this is the present CRIS project manager. The total additional staff time needed for maintaining and running a full CRIS system in Salt Lake City is expected to be approximately 240 person-hours per month.

2.4 RELIABILITY CHARACTERISTICS AND BACKUP CAPABILITIES

During Phase I, the CRIS system proved to be very reliable. For the entire Phase I test period the system never crashed although the clock stopped once and a cause for this never found. Similarly, the system's backup capabilities were hardly used because the system never crashed.

Originally, however, there were recurring hardware problems with the automatic capability following power failures. Instead of taking place immediately after a power surge, the restart process typically required ten minutes to be completed. In July 1984, the central processing unit was replaced by another unit with an improved automatic restart capability. Since then, there have been no reported problems with the system restarting process. Nevertheless, concern over this problem has prompted continuous monitoring of the computer, especially on weekends and during bad weather.

Due to data collection limitations, the accuracy of predicting bus arrival time can not be evaluated firmly, especially with only the six Phase I test routes included in the system. Nevertheless, a simple test was conducted by the UTA staff. Repeated calls were made for information for the stop outside the UTA building over a five-day period. The scheduled headway at this stop was 30 minutes. After each call, the next bus was observed to arrive within two minutes of the stated time. No record was kept of whether or not either the reported times or the actual times for these bus arrivals varied from the published schedule.

3. Traveller Impacts-Observed Data

3.1 BUS RIDERSHIP TRENDS

3.1.1 The Importance of Ridership Data

A major concern of the Salt Lake City CRIS evaluation was trends in bus ridership at various levels of detail. There were three primary reasons for the emphasis placed on this measure of system performance:

- As for any transit operator, total system ridership is crucially important to UTA because it is directly related to farebox revenues.
- From the point of view of the entire Salt Lake City metropolitan area, system ridership levels measure the effectiveness of the agency in providing urban mobility and in reducing traffic congestion, air pollution and energy consumption due to automobiles.
- Specifically with respect to the CRIS project, the level of relative changes in ridership levels on test versus control routes was chosen by UTA and Teleride as a primary measure of the effectiveness of the CRIS system. Other system characteristics and impacts were recognized as also being important, but the value of a ridership-related Increase Factor (defined below) was accepted as a crucial measure. If this measure failed to reach a specified minimum value, UTA would have the option, after Phase I, of rejecting a full CRIS system and thus incurring only a minimum cost for the limited Phase I operations. If this measure did exceed the specified minimum value, UTA would not have this option and would instead be obligated to accept the full system.

This section reviews ridership data from various perspectives, each related to one of the reasons for the importance of these data discussed above.

Bus ridership trends are presented first in general, systemwide terms, and then progress toward increasing detail for the CRIS test and control routes. By providing 1982 through 1984 data, the basis is provided for computing various Increase Factors, including the specific factor which is called for in the UTA-Teleride agreement to provide an agreed-upon measure of the extent to which the CRIS system achieved its desired ridership objectives in Phase I.

The contractually-specified Increase Factor plays an important role in this review. The agreement defines a Cumulative Increase Factor (CIF) as:

$$\frac{TA-TB}{TB} - \frac{CA-CB}{CB}; \text{ or equivalently } \quad \frac{TA}{TB} - \frac{CA}{CB}$$

where:

TA = Ridership on all CRIS test routes during a test period
TB = Ridership on all CRIS test routes during the same months in the year prior to the test period
CA = Ridership on all control routes during the test period
CB = Ridership on all control routes in the prior year

The contractual agreement between the Utah Transit Authority and Teleride states that UTA would be obligated to follow through with Phase II of its CRIS implementation only if, after a six-month test period in Phase I of the project, the Cumulative Increase Factor (CIF) equaled or exceeded 0.03. In addition to the Cumulative Increase Factor defined in the agreement, monthly increase factors were computed, providing a means of monitoring the performance of the CRIS system on a continuing basis throughout Phase I.

Although the UTA has used the systemwide monthly daytime ridership measure for many years to monitor system usage, a monthly measure was judged to be inappropriate for determining the Increase Factors called for in the UTA/Teleride agreement. For these factors to be accurate reflections of annual trends, it was necessary to avoid year-to-year variations in the numbers of weekdays and Saturdays per month. UTA and Teleride agreed on the use of an alternative measure termed <u>pseudo-week ridership</u>. This measure was defined as five times the average of two weekday counts made by UTA in a particular month, plus the single Saturday count made each month. Pseudo-week ridership thus represents an estimate of the ridership level during a week without holidays in a particular month. Because this measure was used by UTA as the basis for its measurement of CRIS impacts, it is also used throughout this report for all analyses of test and control route ridership levels.

The UTA-Teleride agreement provided for one or two six-month test periods in Phase I. The second test period was elected by UTA as one of its options following the failure of the CIF to exceed 0.03 in the first test period. This chapter summarizes the ridership results for the entire period from February 1982 through May 1984, including the two test periods. The dates of the first test period were from test system implementation on February 4, 1983 through July 31, 1983. The second test period began December 1, 1983 and continued until May 31, 1984.

3.1.2 Statistical Significance of Transit Ridership Measures

Due both to the randomness of travellers' behavior and to errors in measurements, all observed transit ridership data exhibit a variability which must be considered whenever two data values are compared. Measures of this variability can be used to assess the statistical significance of absolute and percentage differences in ridership values, and of Increase Factors as these are defined in the UTA-Teleride agreement. Appendix B outlines the method used in this study to identify statistically significant differences in both percentage changes in ridership and Increase Factors. Except where noted in this section, none of the percentage changes in ridership or Increase Factors were statistically significant at the 95 percent confidence level.

3.1.3 1981-1984 Systemwide Ridership Trends

Trends in UTA systemwide ridership during the 3.5 year period before and during Phase I of the CRIS system were monitored using two measures. The first measure is monthly total daytime systemwide ridership, a statistic available for this entire period. Daytime ridership was selected rather than total ridership to eliminate an important exogenous factor which is highly relevant to the evaluation of the effectiveness of the CRIS system. In December 1982, "Night Owl" service was begun on many UTA routes, extending their daily period of operation beyond the previous 7 PM. A more consistent comparison of passengers by month for an equivalent level of service is provided by systemwide counts which do not include the new nighttime services. Figure 3-1 shows the trend in monthly daytime systemwide ridership for 1981-1984.

The second measure of systemwide ridership was daytime pseudo-week ridership, selected to provide a measure consistent with that used to evaluate the CRIS test and control routes. At the systemwide level, this measure was only available for the period from January 1982 through May 1984.

From 1981 to 1983, monthly UTA daytime systemwide ridership showed a decreasing trend. The annual average value for this measure decreased from 1.37 to 1.30 million passengers during this period. However, there was an increasing trend in ridership from 1983 to 1984. For the first five months of 1983, daytime ridership averaged 1.38 million passengers per month, while for the same five-month period in 1984 it averaged 1.48 million, a statistically significant increase of 7.2 percent. The same percentage change occurred in systemwide pseudo-week ridership during this time period.

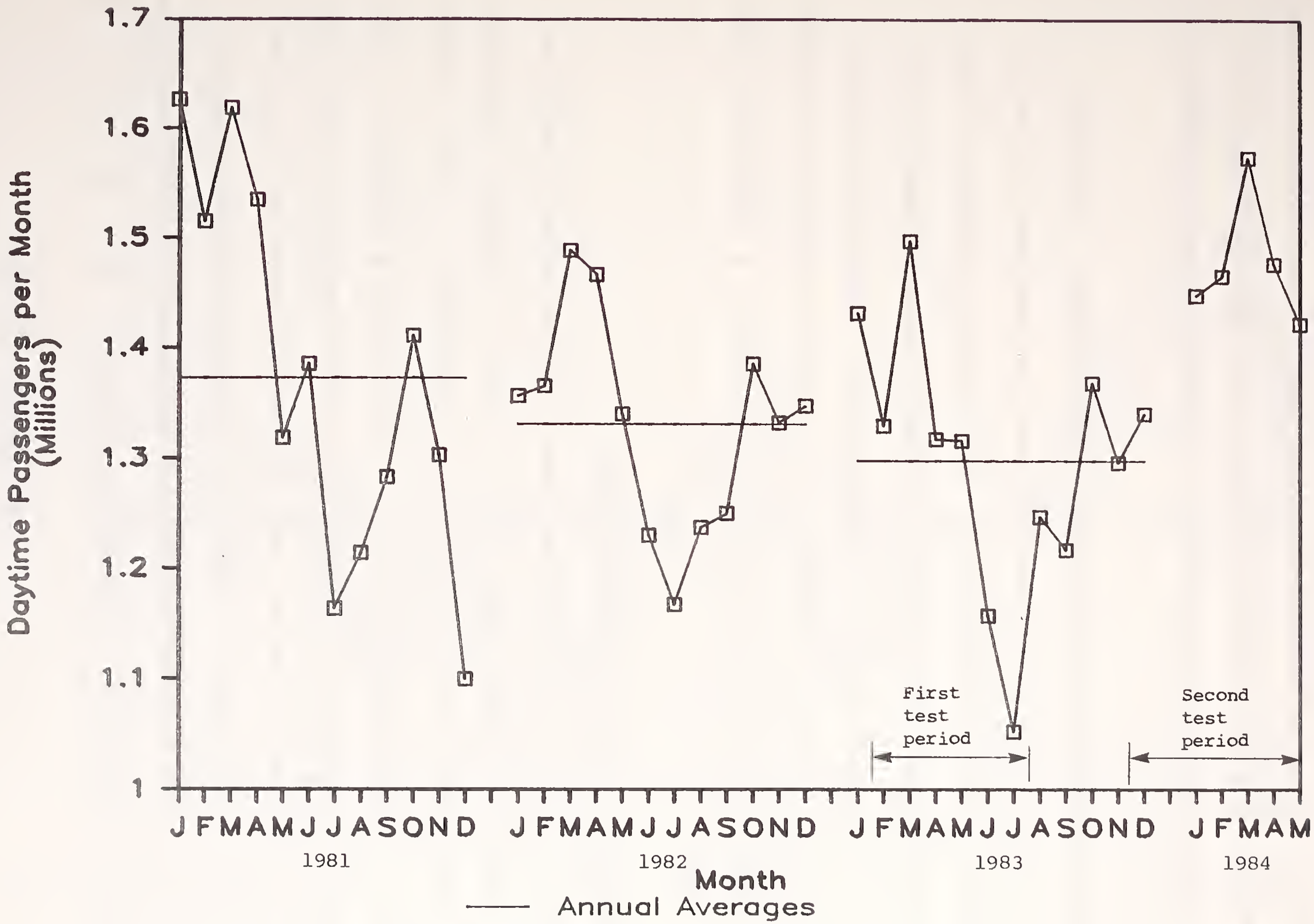


FIGURE 3-1: UTA Daytime Systemwide Ridership by Month

Figure 3-1 also shows a continuing seasonal pattern in ridership. This measure is generally at its highest levels during late fall, winter and early spring. The lowest monthly totals are typically recorded during the summer months, when both students and workers take their vacations. In addition, some regular riders may walk or use bicycles when the weather is pleasant.

During each month of the first test period (February - July 1983), total UTA daytime pseudo-week riders decreased from the level in the corresponding month for the previous year. For the entire February to July period, daytime pseudo-week ridership decreased by a statistically significant 5.0 percent. Conversely, during the second test period (December 1983 - May 1984), increases occurred in every month. For the entire period, daytime pseudo-week ridership increased by 6.1 percent, a statistically significant value.

3.1.4 Ridership on Test and Control Routes

Both test and control route pseudo-week ridership values by month exhibited a seasonal pattern similar to that of monthly systemwide ridership for 1982 through 1984, dropping off precipitiously during the summer months. As depicted in Figure 3-2, both groups of routes showed a decrease in ridership from 1982 to 1983, with the 1983 values for the February to July first test period averaging 3.6 percent lower for the test routes and 2.2 percent lower for the control routes. However, these changes were less negative than the 5.0 percent decrease in systemwide pseudo-week ridership during the same period, as discussed in the previous section.

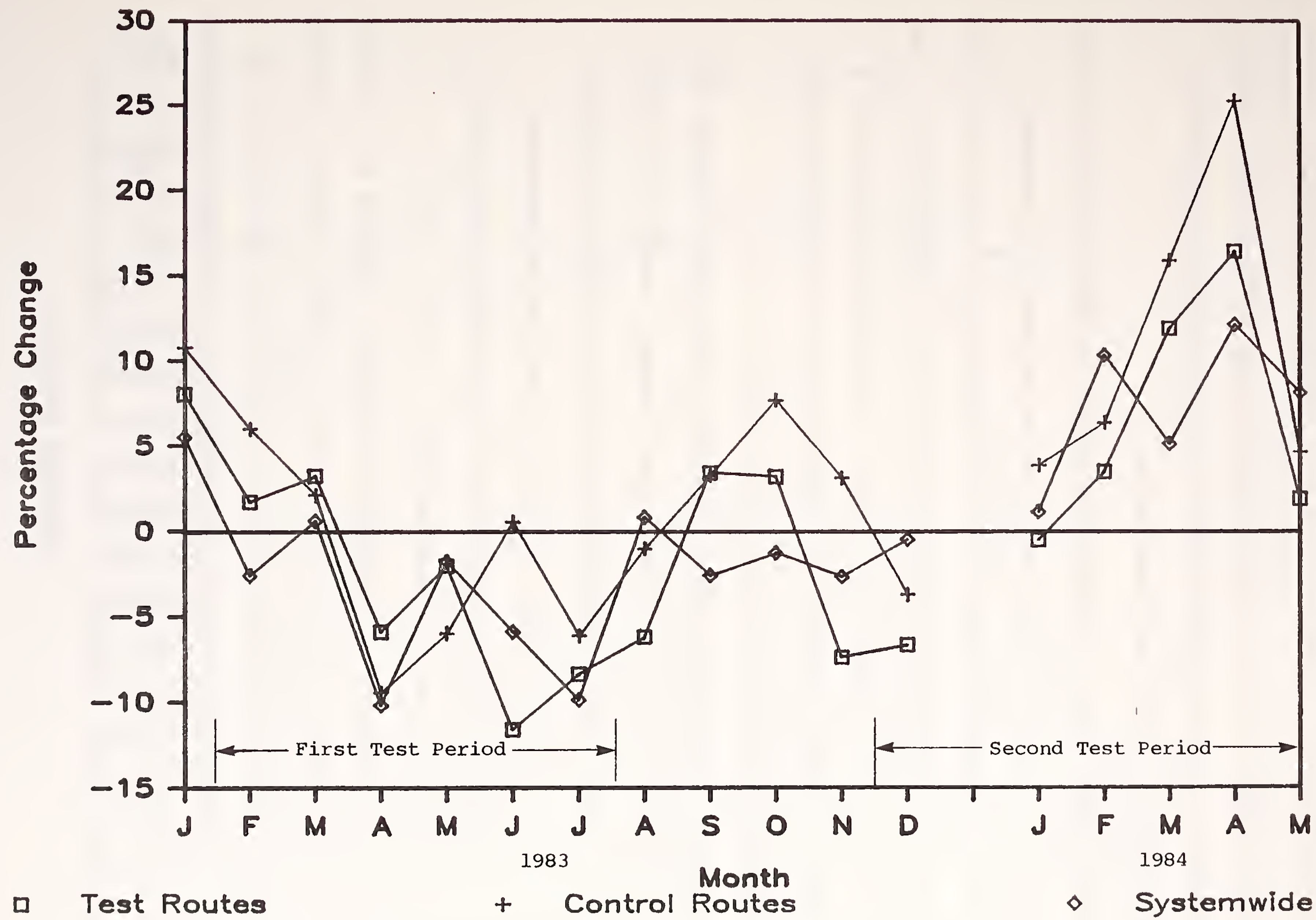


FIGURE 3-2: Weekly Daytime CRIS Route Ridership - 12 Month Percent Change

In contrast, both groups of routes showed an increasing trend in ridership from 1983 to 1984, with the 1984 values for the December to May second test period averaging 4.2 percent higher than in 1983 for the test routes and 8.3 percent higher for the control routes. Again, these changes were in the same direction as the positive change of 6.1 percent for systemwide pseudo-week ridership during the same period.

As seen in Figure 3-2, the general pattern of monthly changes for both test and control routes was quite similar to the pattern for systemwide riders. The most important result is that in each of the second test period months, the control routes had larger positive rates of change than the test routes, whereas in three months of the first test period--March, April and May--the rates of change for the test routes had either larger positive or smaller negative values than did the control routes.

From February 1983 to May 1984, a 16-month period which includes both test periods, systemwide daytime pseudo-week ridership averaged 314,100, a decrease of 0.1 percent from the average for the same 16-month period 12 months prior (i.e., February 1982 - May 1983). Test route pseudo-week ridership decreased by the same percentage, but the control route value increased by 3.2 percent over the same period.

As depicted in Figure 3-3, the varying trends in ridership for the test and control routes during the first test period resulted in Monthly Increase Factors (MIF's) which were negative for the first month, positive for the next three, and then negative for the final two months. By May, the Cumulative Increase Factor (CIF) reached a peak of 0.011, still 0.019 points less than UTA's goal of 0.030. In June and July, the CIF measure returned to

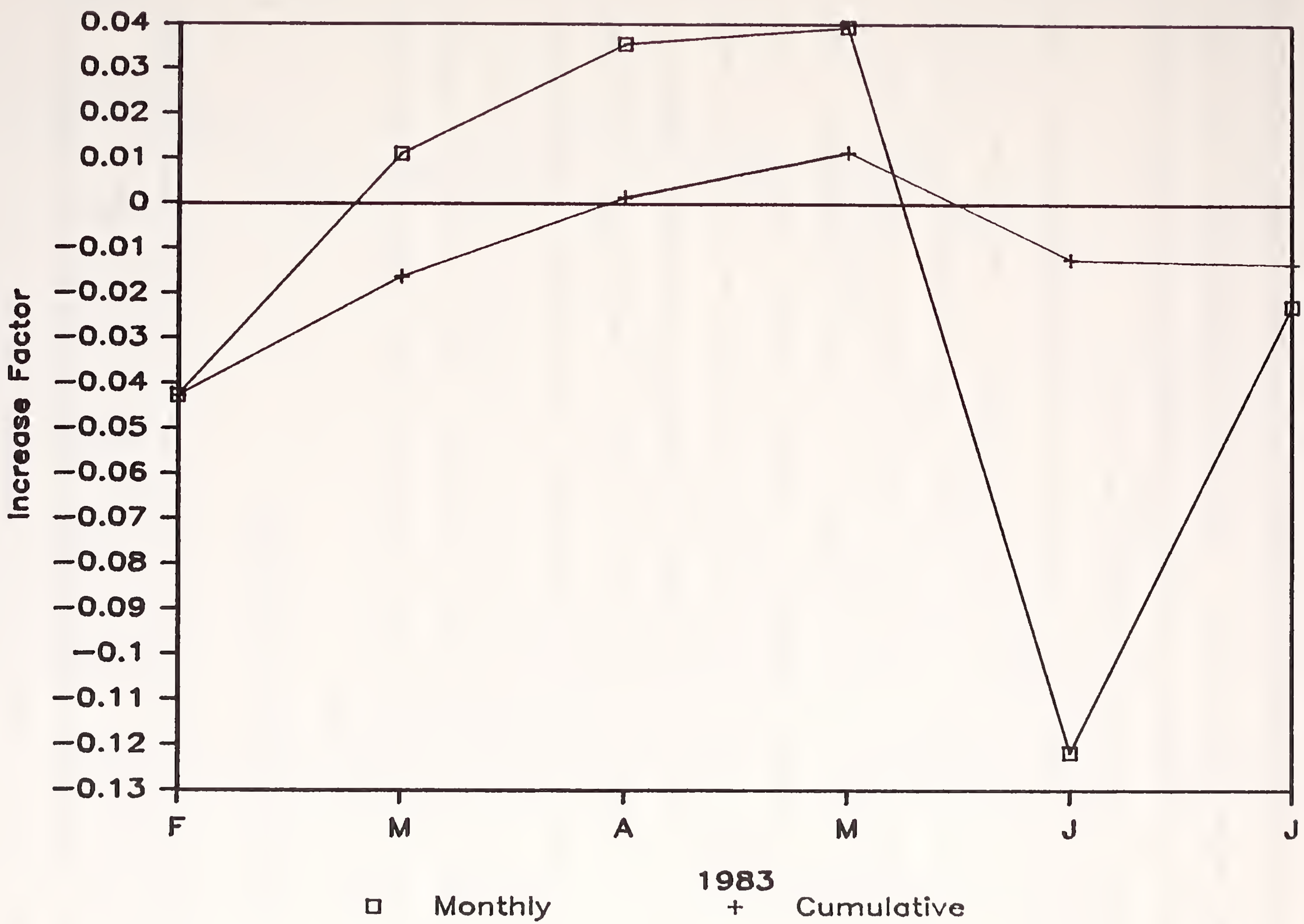


FIGURE 3-3: Increase Factors: First Test Period

negative values. At the end of the first test period, the contractually-specified CIF value stood at -0.013. UTA thus had the option of ending its CRIS system and its contract with Teleride, extending Phase I, or continuing to other phases of the project. Since the UTA considered the CRIS system results to be inconclusive based on the ridership evidence, they decided to extend Phase I for another six-month test period.

However, in the second test period, as indicated by Figure 3-4, negative Monthly Increase Factors prevailed throughout, ranging from -0.029 in December and February to -0.088 in April. By the scheduled end of the second test period, the contractually specified CIF value stood at -0.041, significantly lower than the 0.030 goal. UTA could choose whether to end its CRIS contract with Teleride or continue to the next phase of the project, extending CRIS to all Salt Lake City routes. The latter alternative was chosen, based on the UTA Board's assessment that although ridership results were definitely disappointing, failing to demonstrate earlier expectations of ridership benefits from the CRIS system, they did perceive other benefits justifying full implementation. The benefits cited included increased activities in the areas of marketing, additional computer hardware, and reduced needs for the manual information system provided by UTA's Customer Service Department.

3.1.5 Trends in Riders by Time Period

First Test Period--Because CRIS systems are expected to have greater impacts on weekday off-peak and Saturday ridership than on peak period levels, ridership data were collected separately for each of these time periods. During the first test period, there was a decreasing trend in

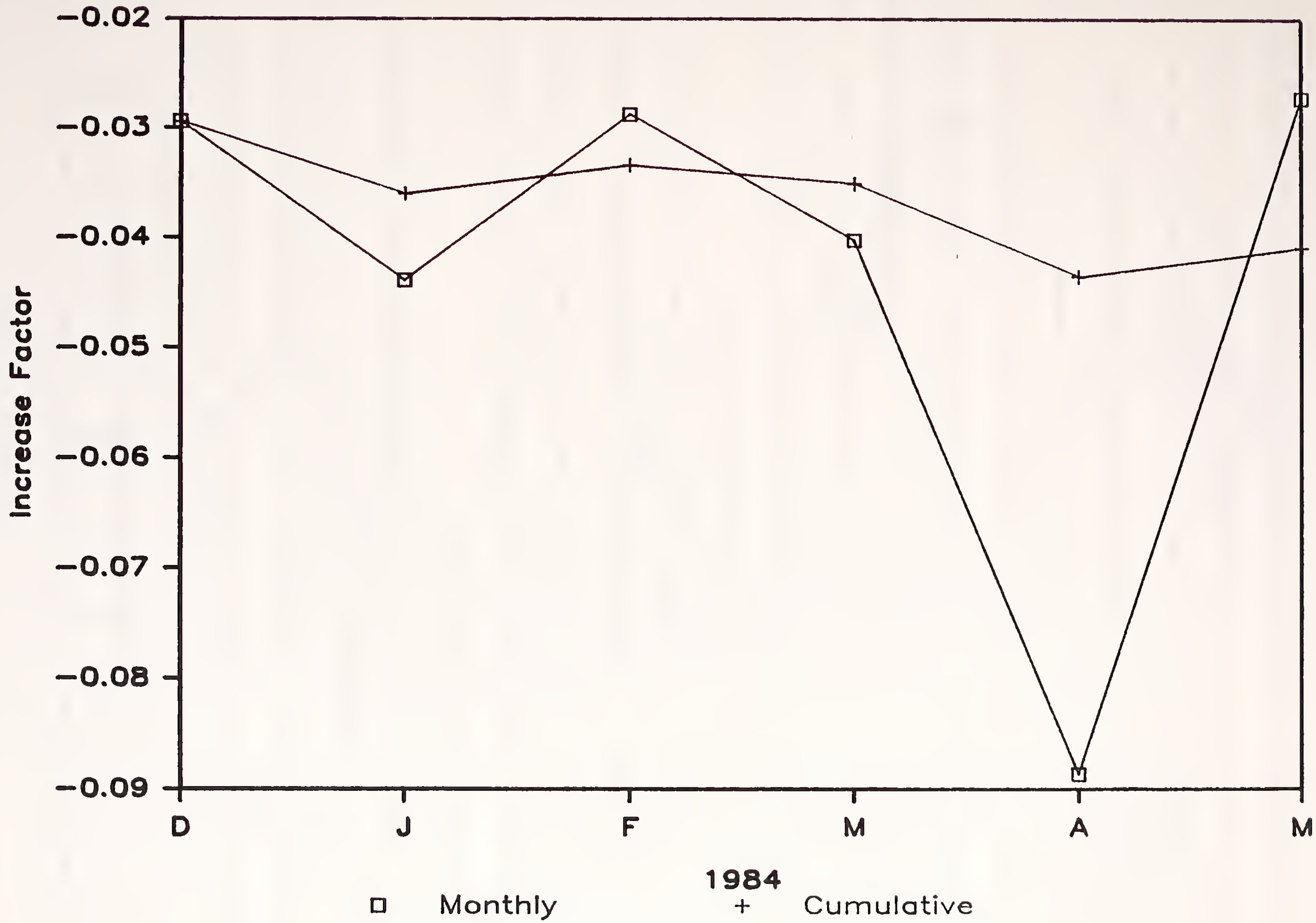


FIGURE 3-4: Increase Factors: Second Test Period

weekday peak period ridership from 1982 to 1983 for both groups of routes, in contrast with the increases in the total weekly data in the initial months of the period. For the six-month period there was a statistically significant decrease of 9.6 percent in peak period ridership from 1982 to 1983 for test routes, and a decrease of 6.2 percent for control routes. By contrast for the same period, total pseudo-week test and control route ridership decreased by only 3.6 and 2.2 percent, respectively.

In contrast to the decreases in weekday peak period and pseudo-week ridership for both groups of routes from 1982 to 1983, 1983 weekday off-peak ridership instead generally increased from that of the previous year for the first half of the test period, before decreasing during the last half. For the entire first test period, weekday off-peak riders increased by 1.0 percent on test routes and 1.1 percent on control routes.

For the test routes, Saturday ridership increased by 8.0 percent for the six-month period. For the control routes the increase was 0.3 percent. The average Saturday ridership increase on test routes is especially noteworthy, considering pseudo-week test and control route ridership decreases of 3.6 and 2.2 percent, respectively.

The Increase Factors by time period and by month for the first test period are shown in Figure 3-5. The importance of weekday peak travel, with a negative CIF (-0.035), is reflected in the negative value of the CIF for total riders (-0.013) in spite of a positive value for the Saturday time period (+0.077) and a value for weekday non-peak riders little different from zero (-0.001). Also, the only CIF having a value greater than the contract-specified value of 0.030 is the value of +0.077 for Saturday riders.

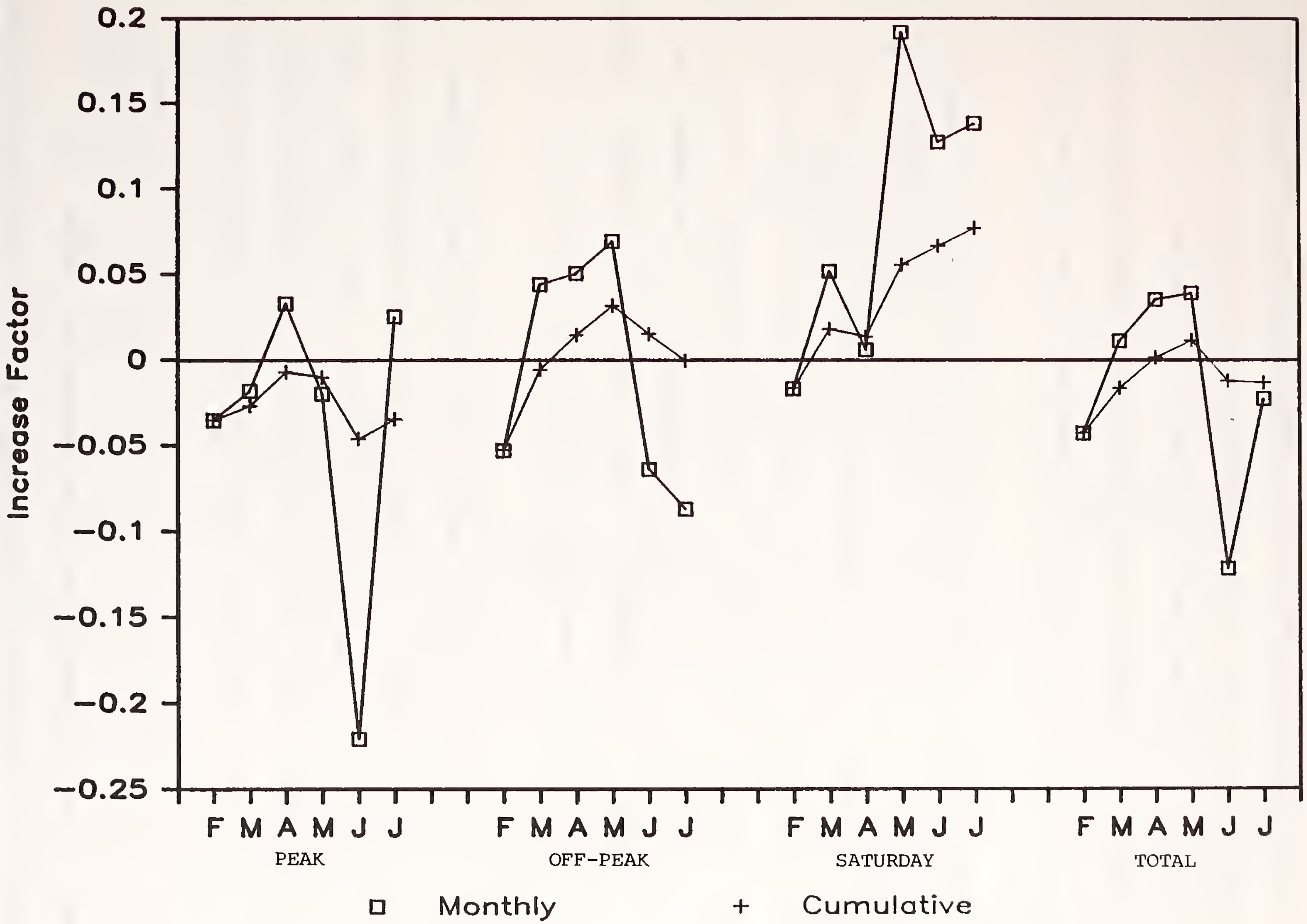


FIGURE 3-5: Increase Factors by Time Period: First Test Period

Second Test Period--There was a clearly increasing trend in daytime peak ridership from 1983 to 1984 for both groups of routes, reversing the negative trends found from 1982 to 1983. For the six-month second test period, there is an increase of 3.9 percent in peak period ridership from 1983 to 1984 for test routes and an increase of 6.9 percent for control routes. However, for the same period, total pseudo-week test and control route ridership increased by greater percentages, 4.2 and 8.3 percent, respectively.

Increases were also found for off-peak ridership for both groups of routes in 1984. During the six-month test period, off-peak period ridership increased 3.5 percent on test routes and 10.3 percent on control routes, accentuating the trends found in the first test period. Whereas relative gains were made for control routes in both peak and off-peak periods, relative gains were made for test routes on Saturdays during the second test period, continuing the trend from the first test period. Saturday ridership in 1984 increased by 10.2 percent for CRIS routes and by 3.6 percent for control routes.

The Increase Factors by time period and month for the second test period are shown in Figure 3-6. As shown, relative gains were made for CRIS routes on Saturday in five of the six months and in the final cumulative factor, but relative losses during the two weekday periods more than outweighed these gains, resulting in large total relative losses incurred for the CRIS routes.

3.2 USAGE OF THE UTA COMPUTERIZED RIDER INFORMATION SYSTEM

As part of its reporting capabilities, the CRIS system records the number of calls per day, per week, and per month by time of day and by route.

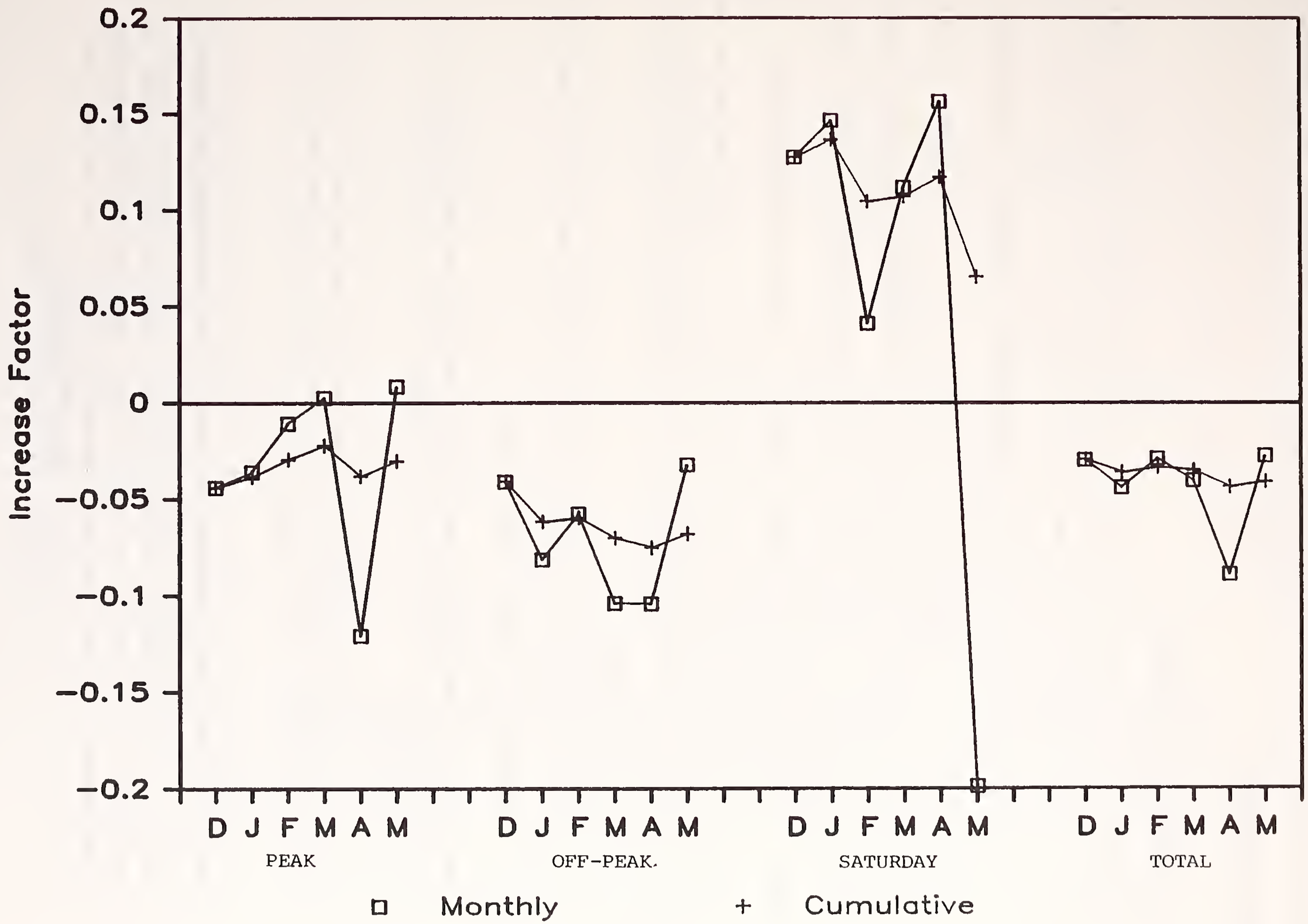


FIGURE 3-6: Increase Factors by Time Period: Second Test Period

In this section, statistics such as the number of calls and number of calls per passenger are presented by route, month and time period. Also, the CRIS usage rates are compared to corresponding rates of schedule inquiries to Customer Service.

3.2.1 Trends in CRIS Calls

A total of 6269 calls were made to the CRIS system in February 1983, the month in which CRIS was implemented (see Figure 3-7). This figure dropped to 2,026 calls in July 1983, the last month of the first test period. After reaching a low of 1,641 calls in October 1983, it increased to 4,344 calls in January 1984, the month during which marketing took place during the second test period. By the end of the second test period (May 1984), this figure decreased from the January peak to 2,461 calls per month. On a per passenger basis (see Figure 3-8), an average of 57 CRIS calls per 1000 passengers were made in February 1983, 11 in October 1983, 28 in January 1984, and 17 in May 1984.

There appear to be three reasons for the 70 percent drop in the CRIS call rate from February 1983 to May 1984:

- Seasonality: People are more likely to call in the winter months when the weather is less pleasant and bus service may be less reliable.

- Trend: Passengers' need for schedule information may be less as they become more familiar with the schedules through their initial uses of the CRIS system.

- Curiosity/Marketing Impacts: A large number of calls to CRIS in February 1983 were undoubtedly made out of curiosity (brought about by a combination of the newness of the system and by the large initial marketing effort) rather than to obtain needed information. Similarly, at least a small portion of the decrease from January to May 1984 was apparently due to the reduced impact over time of the January marketing efforts.

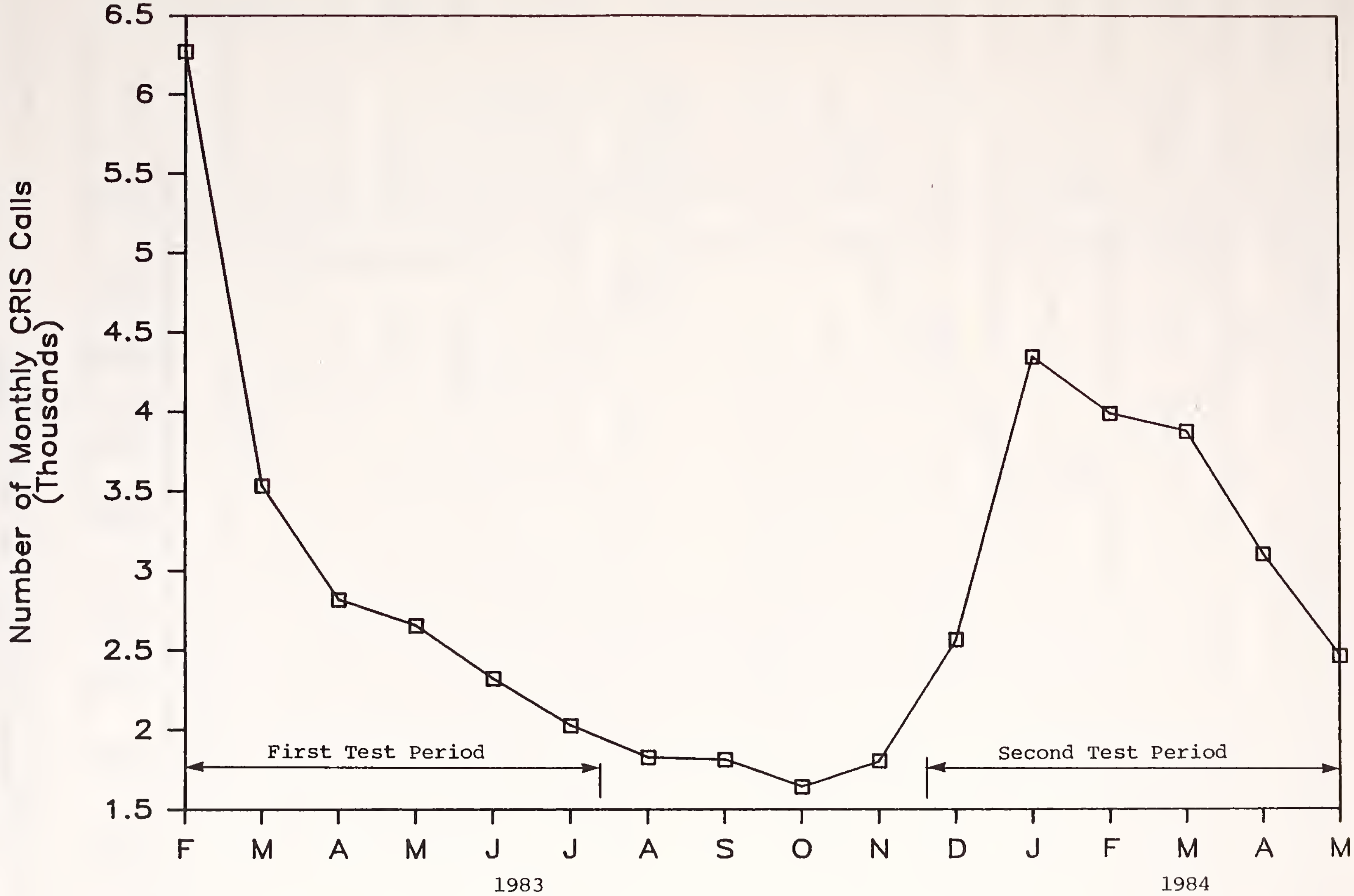


FIGURE 3-7: Total Monthly CRIS Calls

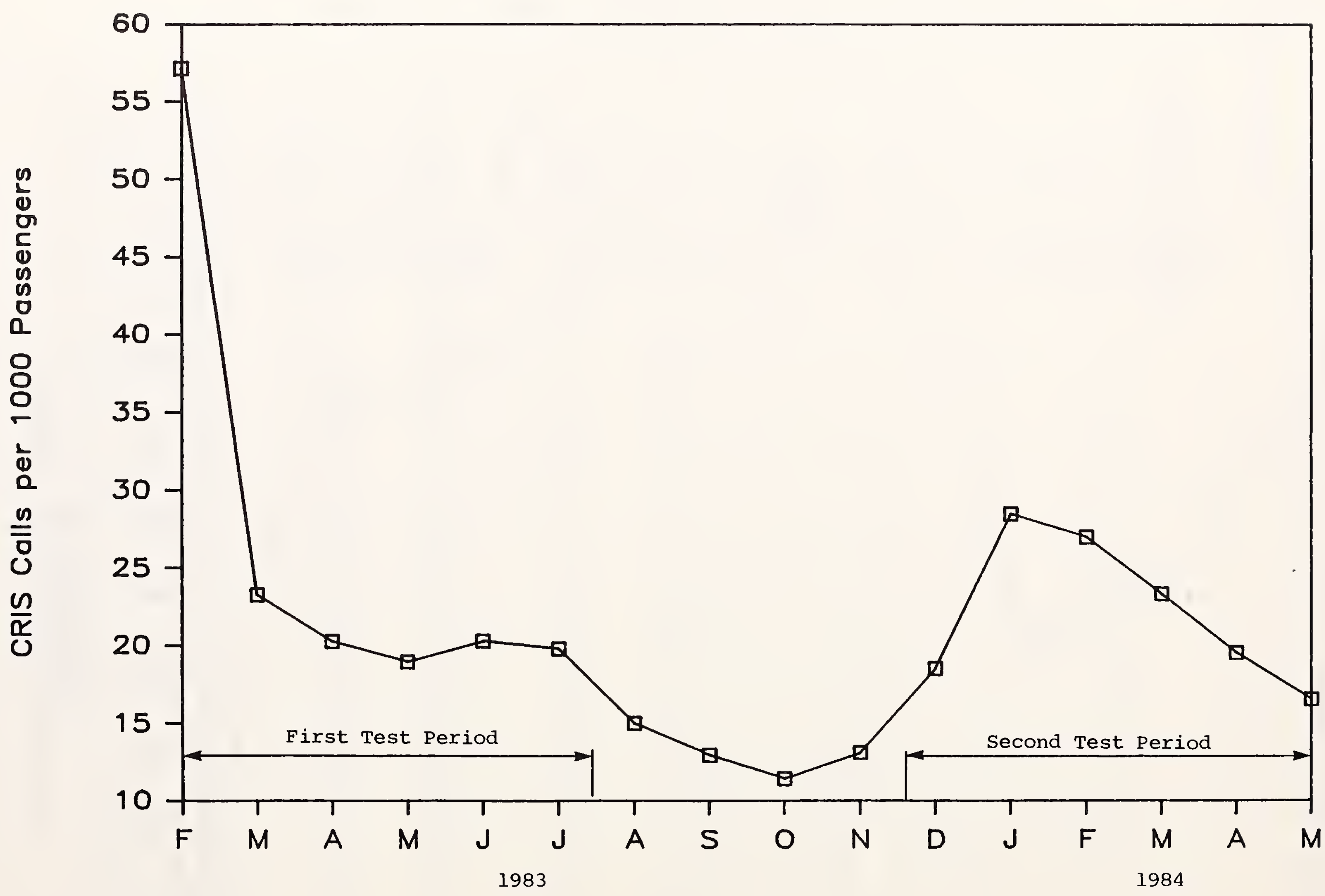


FIGURE 3-8: Average CRIS Calls per 1,000 Passengers

Seasonality and trend factors clearly account for some of the drop in the CRIS call rate. As indicated in Section 3.4.1, the schedule inquiry rate to Customer Service decreased by only 46 percent from February 1983 to May 1984. A comparable decrease in the CRIS call rate due to seasonality and trend would also have been expected. The larger drop in the CRIS call rate indicates that a large percentage of the calls in February 1983 were motivated by curiosity generated by the Buzz-a-Bus marketing and public information efforts. Assuming that the 46 percent decrease applies to CRIS calls as it does to Customer Service calls, 14 of the 57 CRIS calls per 1000 passengers in February 1983 (24 percent of the total), can be classed as curiosity calls. As described in Section 4.2, three factors--trend, seasonality (weather), and the Buzz-a-Bus marketing efforts--were found to explain most of the variation in the volume of daily CRIS calls.

3.2.2 CRIS Calls by Route

The calls per passenger rate for each CRIS route decreased substantially from February 1983 to May 1984, the last Phase I test month. As illustrated in Figure 3-9, there was a negative correlation in both months between the values for frequency of bus service, as measured by bus trips per day, and the CRIS call rate. This was also found to be true for Customer Service inquiries (see Section 4.3). As headways decrease and expected wait time is reduced, riders apparently find it less necessary to call the CRIS system for schedule updates.

3.2.3 CRIS Calls by Time Period

The distribution of CRIS calls over the day reflects a declining trend in off-peak calls as a percentage of all daily calls; in April 1983, 45 percent of the calls were made during the daytime off-peak hours. On a rate

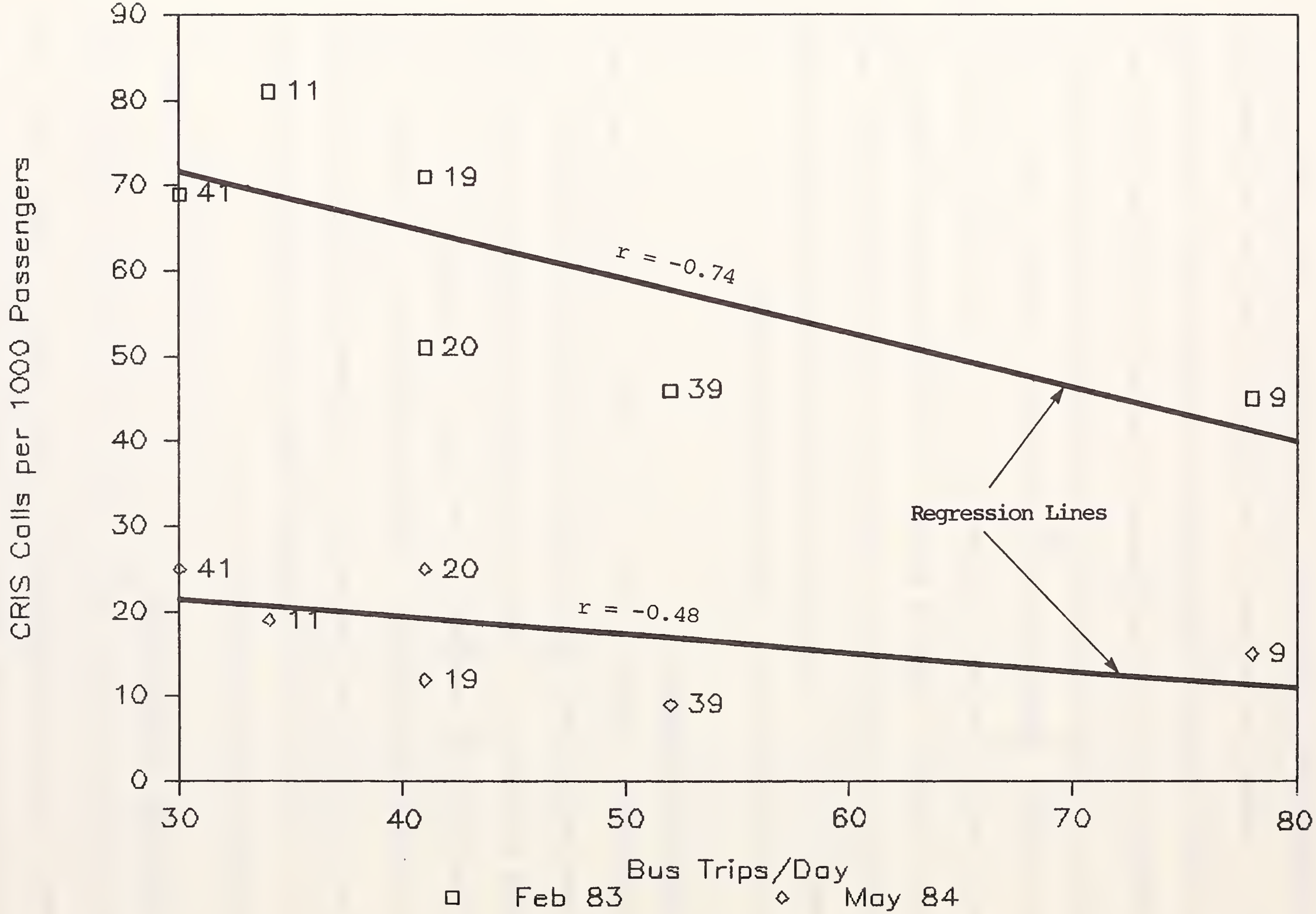


FIGURE 3-9: CRIS Call Rates by Route versus Bus Trips by Route

per passenger basis (see Figure 3-10), the CRIS call rate was noticeably highest for the off-peak[1] in each month of the first test period. In July 1983, for example, the CRIS rate was 23 calls per 1000 passengers for the off-peak compared to 9 for the morning peak and 14 for the afternoon peak. The higher rates found for the off-peak during the first test period indicated that CRIS was used by the greatest share of passengers when the level of bus service was lowest. This was consistent with the relative benefits to be gained, in wait time reductions, during the peak and off-peak periods.

However, after July 1983 the CRIS off-peak rate fell to 16 calls per 1000 passengers by May 1984, the end of the second test period, while the AM peak rate increased to 15 and the PM rate remained at 14. A possible explanation for this decrease in the off-peak rate is that off-peak riders who previously used Buzz-a-Bus increased their knowledge of the bus schedules through their initial uses of CRIS, and thus became less dependent on the CRIS system as Phase I continued.

3.2.4 Comparison of CRIS and Customer Service Call Rates

A rate of inquiries to Customer Service that is comparable to the CRIS calls per passenger rate is that for schedule inquiries (see Section 3.4). In February 1983, the CRIS rate of 57 calls per 1000 passengers for the six test routes was quite comparable to the inferred systemwide rate for

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[1]The CRIS call rate measure in the nighttime period is questionable since only one route (No. 9) offered "night-owl" service. It appears that the calls in this period can be placed in the curiosity category. No tabulations of Saturday CRIS calls were made by UTA.

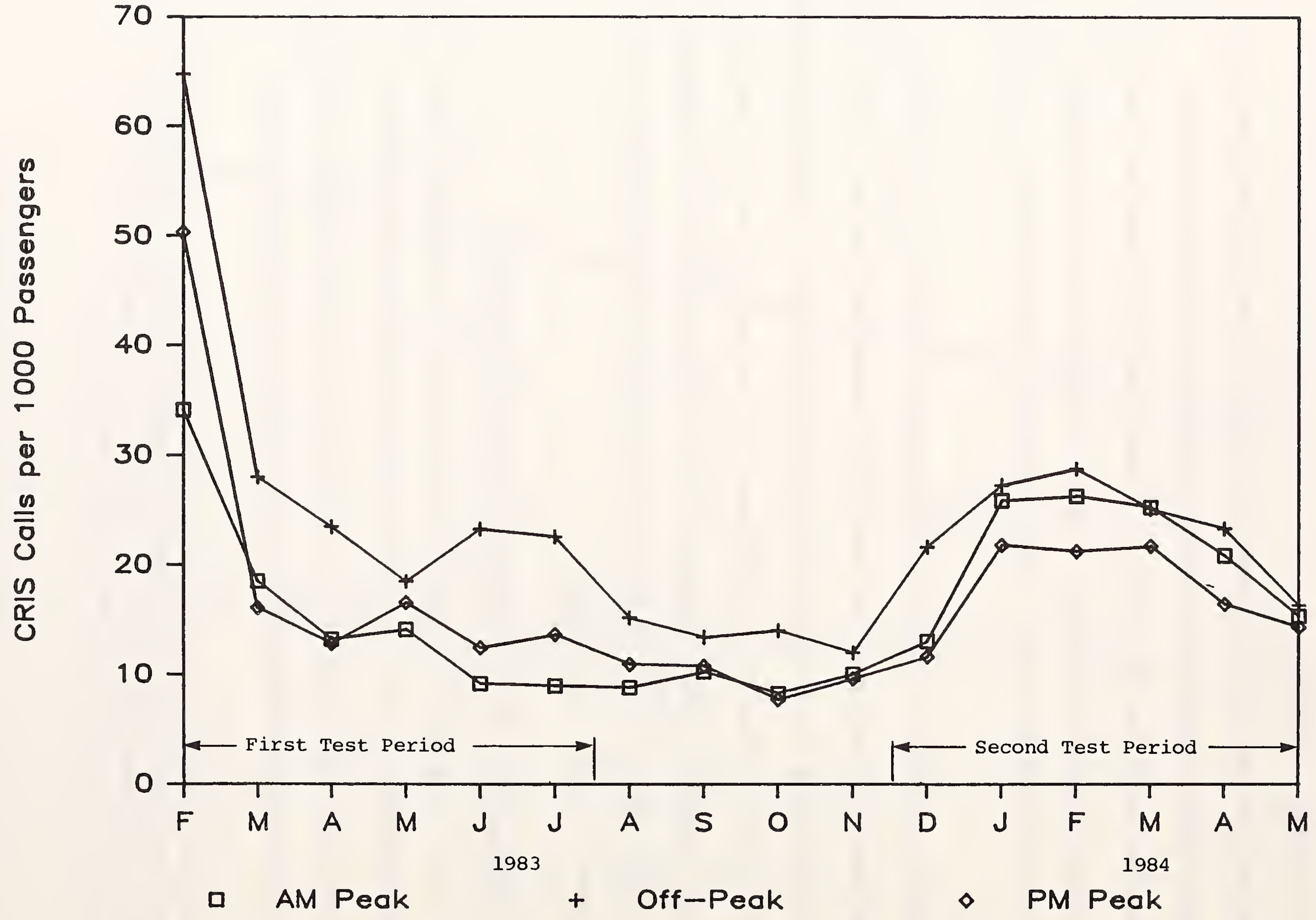

FIGURE 3-10: CRIS Call Rates by Time Period

Customer Service schedule inquiries, which is 72 inquiries per 1000 passengers.[1] (See Figure 3-11.) From February 1983 to May 1984, however, the CRIS rate decreased to 17 while the Customer Service rate only declined to 39. The large decline in the CRIS rate is attributed to the large number of curiosity calls made to CRIS in February. Comparison of the more normal usage patterns in May 1984 indicates that the CRIS rate of 17 calls per 1000 passengers is less than half of the corresponding Customer Service rate of 39, reflecting passengers' continuing preference for using and/or increased knowledge of how to obtain information from the Customer Service Department rather than from the CRIS system.

The relatively low CRIS call rate in the first test period suggests that the system was being underutilized by the CRIS route riders. Figure 3-11 shows, however, that the fraction of total requests for schedule information made using CRIS increased as time went on. In sum, although the CRIS call rates did not increase over time and thus continued to be lower than Customer Service schedule inquiry rates, a substantial number of riders on CRIS routes found it less and less necessary over time to call Customer Service for schedule updates. In fact, Customer Service rates were approximately 33 percent less for CRIS test routes than for control routes at the end of Phase I. The data presented in Sections 3.4 and 4.3 show that CRIS

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[1]The observed systemwide rate of Customer Service calls in February 1983 was factored by the following characteristics observed in call data collected in March 1983: route inquiries per call = 1.31 and schedule inquiries per route inquiry = 0.951. The corresponding characteristics for 1984 calls, used to estimate the number of schedule inquires in that year, were: route inquiries per call = 1.08 and schedule inquiries per route inquiry = 0.955.

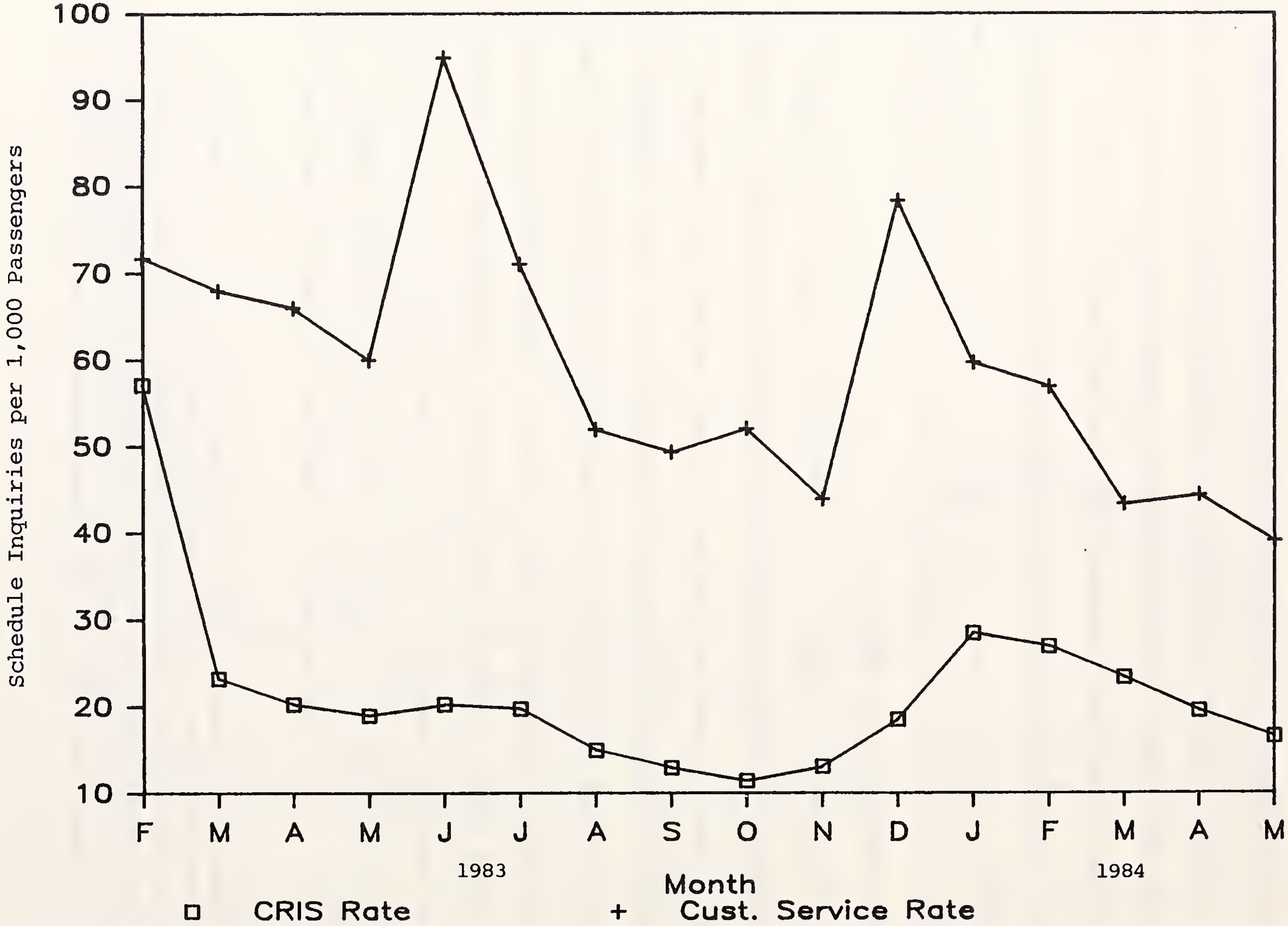


FIGURE 3-11: CRIS Call Rates and Customer Service Schedule Inquiry Rates

had a sizable effect in reducing the Customer Service call rates on CRIS test routes during the second test period for a range of bus service levels.

Although it would be instructive to determine how changes in Customer Service Inquiry Rates on CRIS test routes varied prior to CRIS implementation, this cannot be done with precision. Route-specific Customer Service inquiry logs are not normally kept by the UTA's Customer Service Department. It is known, however, that on a systemwide basis, calls to Customer Service increased by 22 percent from 1982 to 1983 (see Section 3.4.1). This increase was more than offset by the 51 percent decrease in the Customer Service call rate on CRIS routes from 1983 to 1984.

3.3 AWARENESS OF CRIS AMONG TRANSIT USERS

3.3.1 Introduction

In March, 1983 an on-board survey was conducted on each of the CRIS test routes to obtain information on the level and patterns of use of the CRIS system. The survey instrument shown in Appendix C was distributed by UTA staff members to riders as they boarded buses. After filling out the questionnaire, the respondent could either return it to the survey team member or mail it postage prepaid to UTA. Out of approximately 3000 questionnaires distributed to the 6155 passengers on the six test routes, 1100 were returned, for an overall sample rate of 18 percent. Sample rates by route ranged from 9.8 to 34.2 percent. Seventy-four percent of the respondents were normally peak hour bus users, the remaining 26 percent normally only made bus trips during non-peak hours. Figure 3-12 provides information on the demographic characteristics of the respondents.

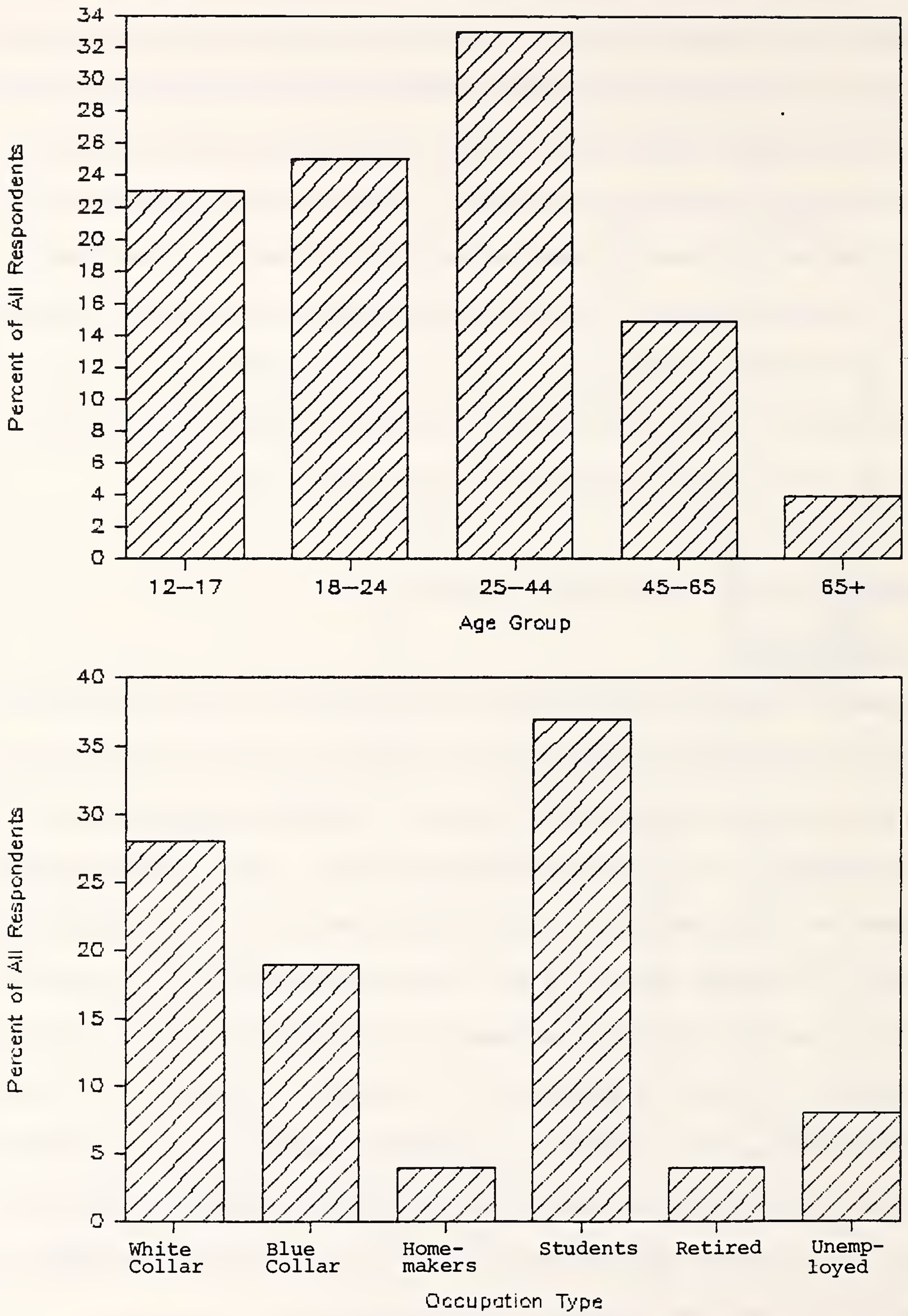


FIGURE 3-12: Demographic Characteristics of On-Board Survey Respondents

3.3.2 Knowledge of the CRIS System

Sixty-six percent of the respondents had heard of Buzz-a-Bus prior to the survey. This figure varied only slightly across routes from a low of 64 percent to a high of 69 percent. Of those respondents who knew about Buzz-a-Bus, only 19 percent first heard of it through the direct marketing effort. (See Figure 3-13.) Four of the six test routes had relatively low percentages of respondents hearing about CRIS through flyers in the mail. The combined value for the two remaining routes was very large--40 percent. Since these two are the shortest test routes, it suggests that the coverage and effectiveness of the direct mail marketing effort depended strongly on route length.

The most effective means of informing transit users about CRIS were bus advertising and bus stop decals, mentioned by 28 and 25 percent of the respondents, respectively. A significant seven percent of respondents who knew about Buzz-a-Bus first heard of it through UTA's Customer Service Department.

Only 28 percent of the respondents knew the Buzz-a-Bus telephone number for the bus stop near their home and thus could readily use the CRIS system for trips starting at home. By bus route, this knowledge ranged from a low of 20 percent to a high of 43 percent.

3.3.3 CRIS Usage Rates

The penetration rate for the CRIS system was defined by Teleride as the percentage of transit riders (respondents) who reported using CRIS more than once. For all survey respondents, this penetration rate was only 21 percent (see Figure 3-14). The penetration rate was highest for younger respondents (ages 12-24) and very low for senior citizens (all respondents over 65).

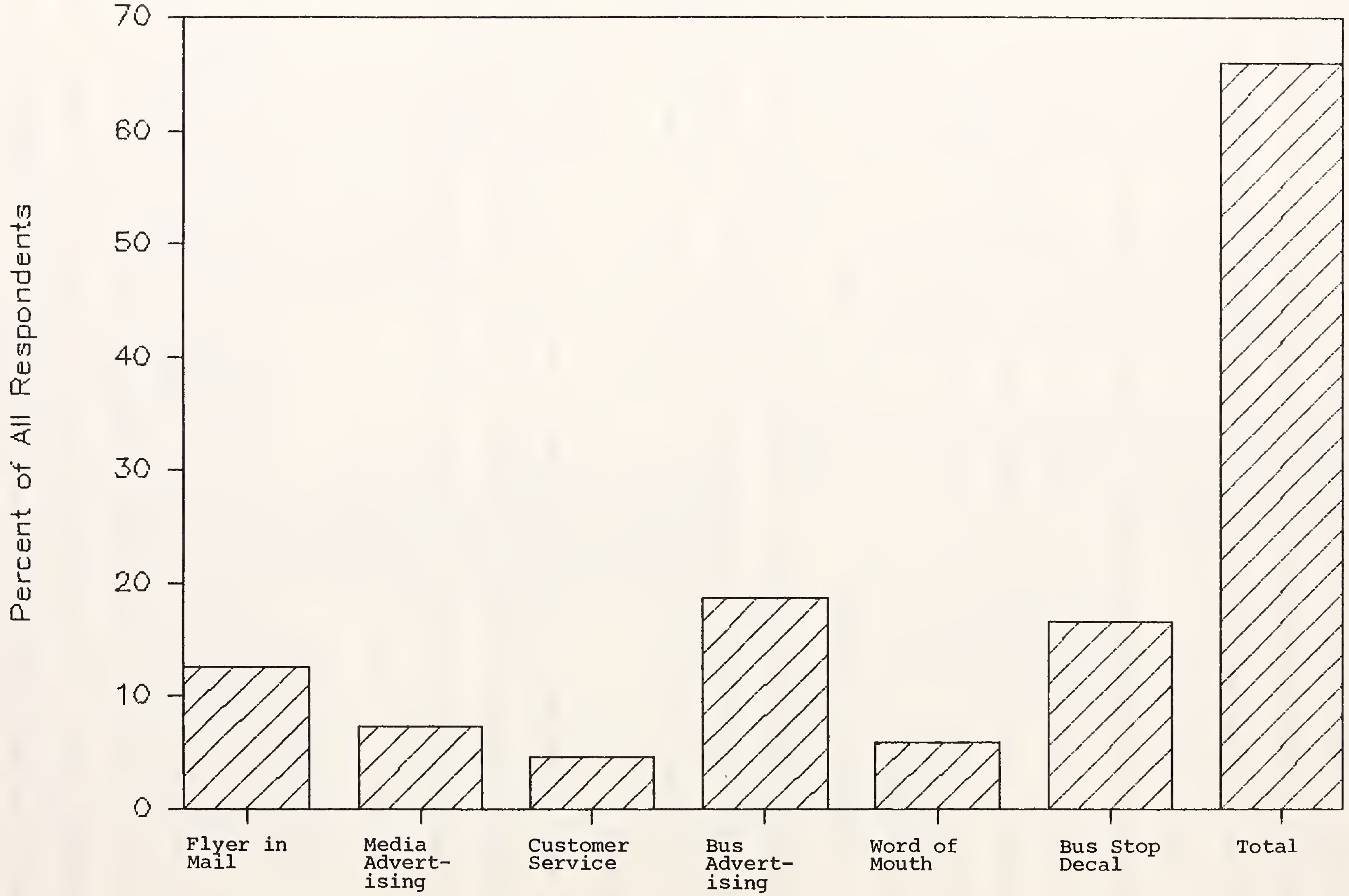


FIGURE 3-13: Means of Learning about the CRIS System

Penetration was relatively high among those not employed on a full-time basis, ranging from 22 to 30 percent for these groups. This suggests a correlation between CRIS usage and leisure or non-work time. The more non-work time bus riders had, the more likely they were to have used the CRIS system more than once.

Surprisingly, the penetration rates did not differ between off-peak and peak period riders. Twenty-one percent of both peak and off-peak riders used Buzz-a-Bus more than once. Similarly, CRIS penetration rates were nearly equal for all categories of bus usage frequency. For those who first heard of CRIS through Customer Service and the direct mail campaign, the penetration rate was relatively high, 31 and 30 percent, respectively. The lowest penetration rate was for those who were first informed of CRIS through media advertising (9 percent). The penetration rate was approximately 20 percent for riders informed by the remaining sources: bus advertising, word-of-mouth, and bus stop decals. The high penetration rate for those who were first informed by Customer Service reflects accustomed use of dial-up information service by this group and therefore a direct substitution of the CRIS system for inquiries concerning bus service. The reltively high penetration rate for those first informed by the direct mail campaign reflected the successful transfer of detailed personalized instructions and/or the use of marketing items such as Buzz-a-Bus stickers and pins to encourage the use of the CRIS system.

3.3.4 Frequency of CRIS Usage

The reported frequency of CRIS usage is shown in Figure 3-15. Of those who have used CRIS, nearly half have only used it once. Responses to the

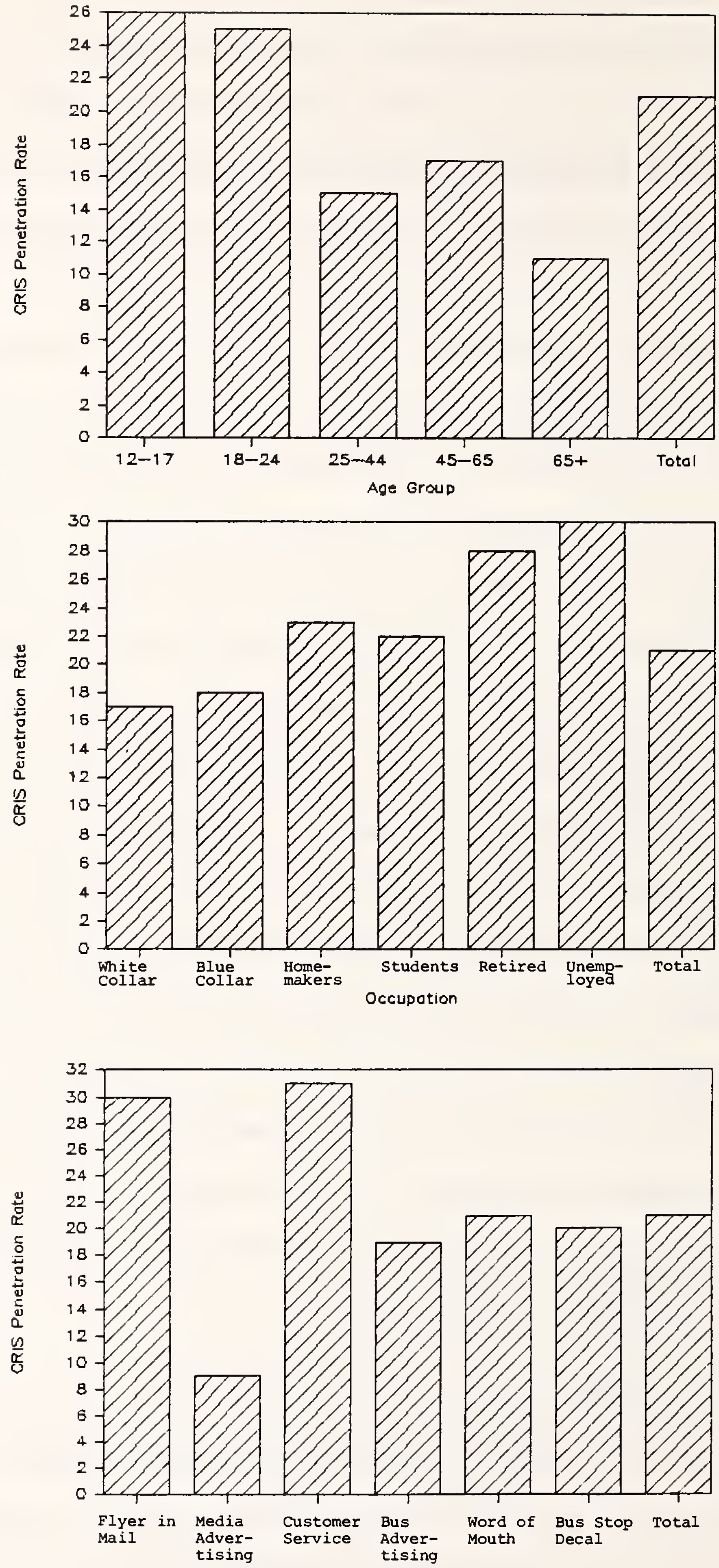
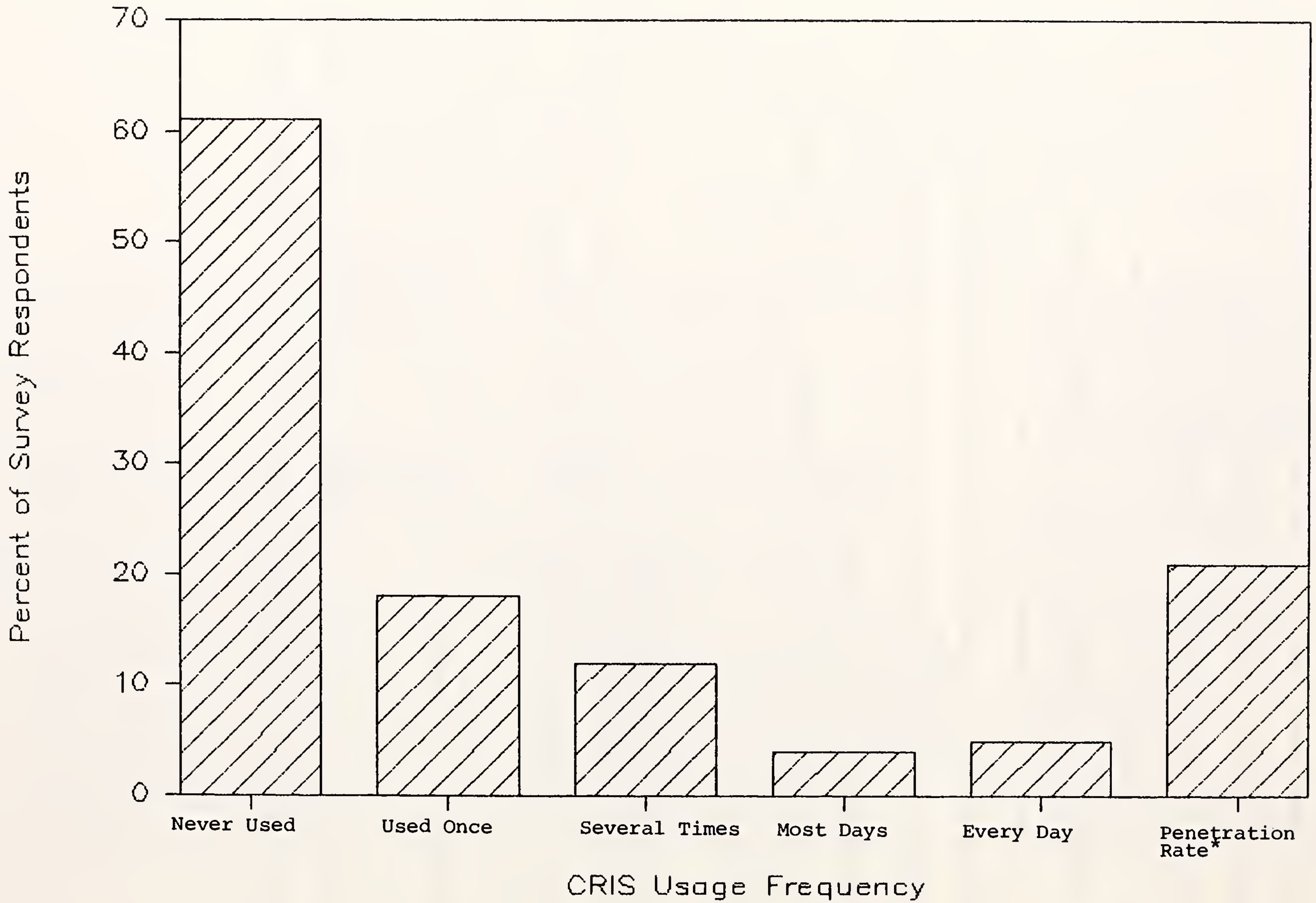


FIGURE 3-14: CRIS Penetration Rates

survey question on the use of Buzz-a-Bus on the last trip provide an alternative measure of current CRIS usage. Factors such as initial curiosity-type calls and experimentation with CRIS may cause the penetration rate to be an overstated measure of current CRIS use. As shown in Figure 3-16, the responses indicate that 19 percent of infrequent bus riders (one to two rides a week) used Buzz-a-Bus on their last trip, compared to only seven percent of frequent bus riders (more than six rides a week), reflecting higher utilization of CRIS among riders who are more likely to be unfamiliar with the bus schedule. In addition, the survey data indicate that 16 percent of off-peak bus riders used CRIS on their last trip compared to only 11 percent of peak bus riders, reflecting higher CRIS utilization during periods when bus frequencies are lower and expected wait times can be reduced the most.

3.3.5 Understanding the CRIS Message

In the March 1983 survey, only 72 percent of the transit riders stated that the voice quality was sufficient for them to understand the CRIS message on the first try. This measure ranged from 86 percent for the 18 to 24 age group down to 48 percent for seniors over 65. Based on these results, an effort was made to improve the Buzz-a-Bus vocabulary during April 1983. Following this work, phone calls made to the system by the evaluation team revealed noticable improvements in the quality of the computer-generated speech.



*Used CRIS more than once

FIGURE 3-15: Frequency of CRIS Usage

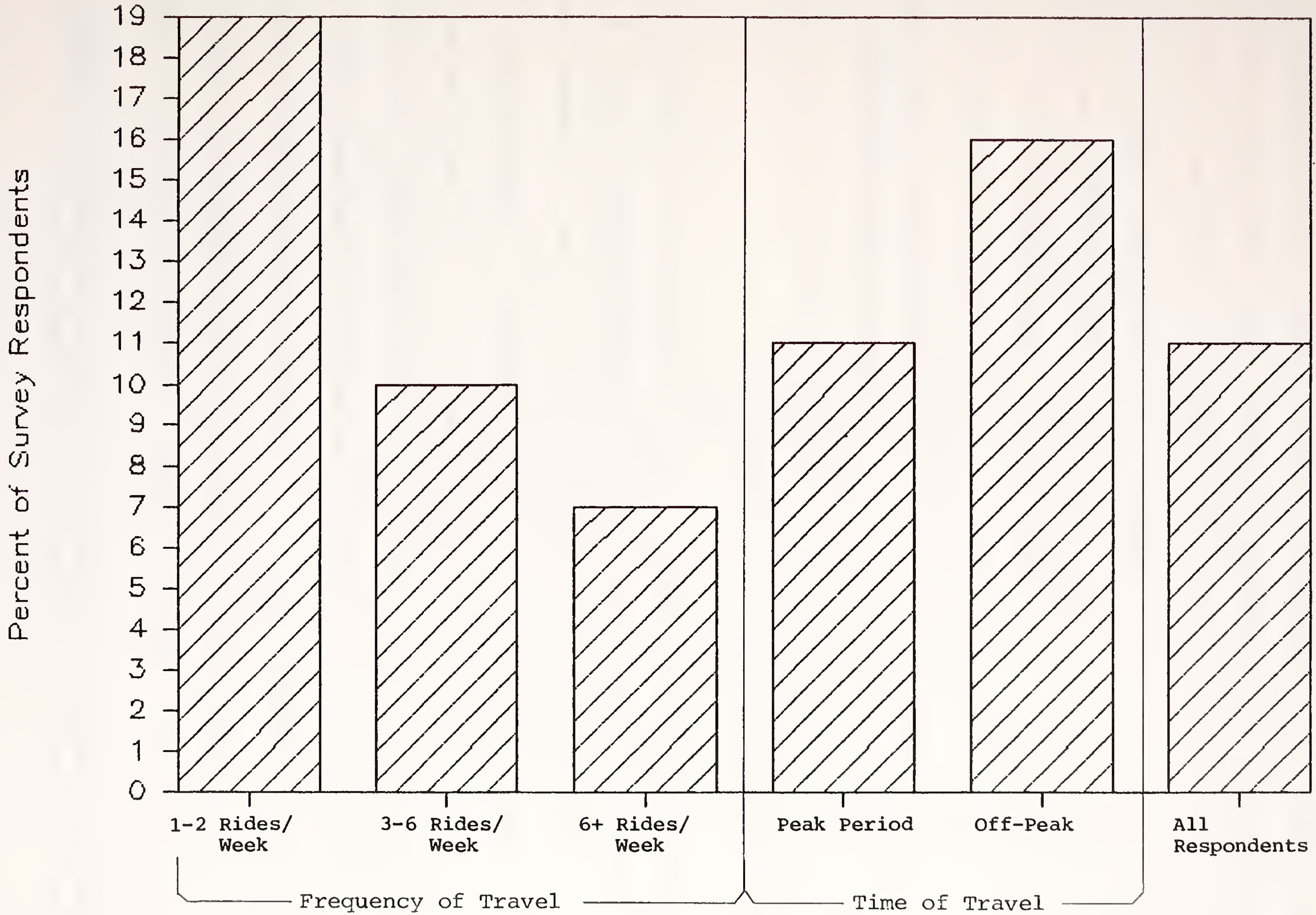


FIGURE 3-16: Usage of CRIS for Last Bus Trip

3.4 IMPACTS OF THE CRIS SYSTEM ON UTA'S CUSTOMER SERVICE DEPARTMENT

3.4.1 Systemwide Trends in Customer Service Calls

The Utah Transit Authority has a large Customer Service Department, staffed by a total of 20 telephone operators. They receive calls from 6 AM to 7 PM, Monday through Saturday; the "daytime" operating hours of UTA's Salt Lake Division. Over 90 percent of all calls include requests for schedule information; many of these also include requests for stop locations and routing information.[1] Less frequent types of calls only involve requests for stop locations and routing information (but not schedules), complaints, and/or commendations. For every fifteen-minute time interval during the operating hours of the Customer Service Department, the number of calls received by Customer Service is recorded by computer. These figures are then aggregated by day and by month.

Customer Service Call Rates--As shown in Figure 3-17, the trend in the total number of Customer Service calls per passenger changed in the 2.5 year period ending in May, 1984. From 1982 to 1983, this rate increased from an annual average of 43 to 54 calls per 1000 passengers. During the first five months of 1984, however, this rate declined to 46.5. The sharp increase from 1982 to 1983 can be attributed to the improvements made in the telephone system used by the Customer Service operators at the end of 1982. At that time a new telephone system with automatic hold and sequential answering features was installed. It is more difficult to explain the reduction which has taken place from 1983 to 1984. Customer Service retains its high

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[1]Based on a sample of telephone logs recorded from March 14 to March 24, 1984. See Section 3.4.2.

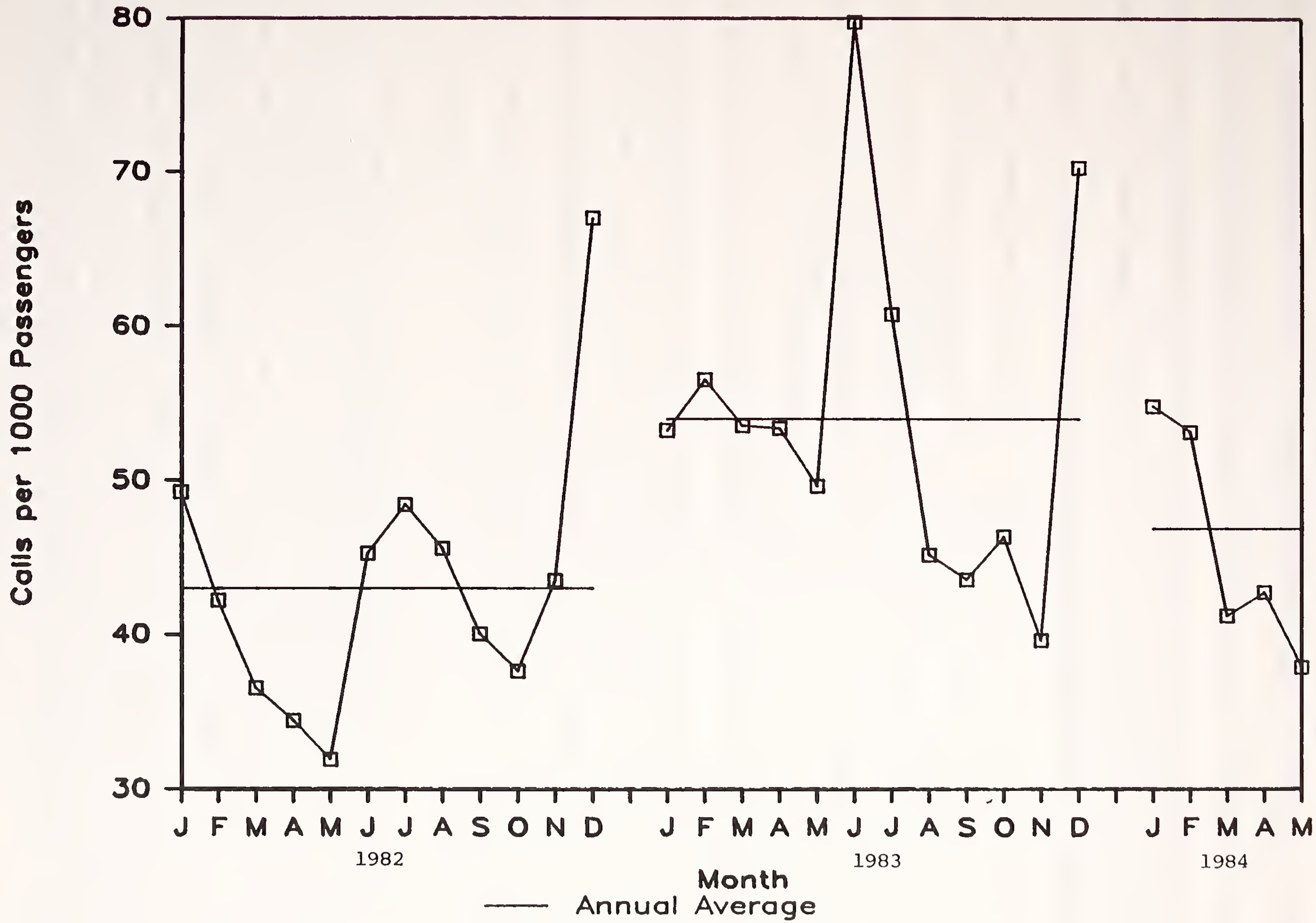

FIGURE 3-17: Customer Service Calls per Passenger by Month

level of service, but the reduction in calls is much greater than that of the CRIS call rate. It may be that UTA's service patterns have stabilized and its pool of users is not changing rapidly, reducing riders' needs for transit information. These overall trends coupled with the fact that CRIS route ridership represents a low share of overall systemwide ridership make it difficult to determine whether or not the CRIS system has affected the total number of calls to the Customer Service Department.

Besides these year-to-year trends, Figure 3-17 shows that the frequency of calls also depends very much on seasonality. Uncertainty of bus service is a critical determinant of a person's decision to call the Customer Service Department for schedule information. During the winter season, people are more likely to call for information because delays caused by the weather are more frequent and because waiting outdoors for a bus is more onerous. During the summer, more calls appear to be made by customers as infrequent pleasure trips by transit are planned. Also, in June 1983, severe flooding in Salt Lake City caused extensive cancellation and revision of bus service. The result was a sharply increased volume of calls to Customer Service.

Customer Service Route-Specific Inquiry Rates--Route-specific data on the usage of UTA's non-automated information system are available from two representative samples of calls to UTA's Customer Service Department which were collected as part of the CRIS evaluation process. During the first CRIS test period, telephone logs were kept by the department's operators from February 28, 1983 through March 12, 1983, one month after system implementation. Four months into the second test period, logs were kept from

March 14 through March 24, 1984. In each case, these logs were taken from 9 AM to 6 PM for a 15 minute random time interval during each even hour on Monday, Wednesday, and Friday and during each odd hour on Tuesday, Thursday, and Saturday. The telephone log sheets provided spaces for each operator to fill in the date, day of week, and time period at the start of each log session. As calls were received, the operator checked one or more purposes for the call and recorded the routes asked about. The purposes provided on the log sheet were the following:

- routing
- scheduling
- stop location
- fare
- complaint
- other
- no bus information requested

The telephone logs revealed that calls to Customer Service frequently include requests for information on more than one route and/or involve more than one purpose. On average, the first sample of Customer Service calls (March 1983) indicated that callers asked about 1.31 routes and that 95 percent of the route inquiries involved requests for scheduling information. The corresponding figures for the second sample of calls (March 1984) were 1.08 routes per call and 96 percent, respectively.

Since the major purpose of the CRIS system is to give schedule updates by route, direct comparison of the rate of total Customer Service calls per passenger to the rate of CRIS calls per passenger is not accurate. Instead, comparison of the rate of CRIS calls per passenger should only be made with a Customer Service call rate with a similar unit of measurement--this unit is schedule inquiries per passenger. In comparing CRIS and Customer Service call rates however, it must be remembered that a broader range of information is available from Customer Service--not only the arrival times of the next two buses, but also details on the schedule for other time periods can be obtained. Assuming that the call characteristics observed in the two operator log surveys represented points in time which determine trends in these characteristics for the five-month January to May period, the rate of schedule inquiries to Customer Service per 1000 passengers is estimated to have changed from 49 in 1982 to 67 in 1983 and back to 49 in 1984.

3.4.2 Trends by Route Type

Of the 3,377 Customer Service inquiries recorded during the first test period, 403 (12 percent) were on CRIS test routes and 398 (12 percent) were on control routes. However, in the second test period, out of the 1,956 inquiries observed, only 184 (9 percent) were on CRIS test routes, while 240 (12 percent) were on control routes. When these observed inquiries are factored to represent an average entire day of Customer Service calls and divided by thousands of daytime riders per day by route group, an "inquiries per 1000 daytime passengers" rate is obtained, providing a means of comparing the various groups of routes. For the first test period, for all UTA Salt Lake City routes, this rate is 68 (see Figure 3-18). The rate ranges from a low of 66 for all routes excluding the CRIS test and control routes to 68 for the CRIS test routes to a high of 83 for the CRIS control routes. For the second test period, for all UTA Salt Lake City routes, this rate is only 47. The rate ranges from a low of 32 for all CRIS test routes to 48 for all control routes to a high of 49 for all non-CRIS (test and control) routes. Although the frequency of inquiries to the Customer Service Department was the same for patrons of CRIS test routes as it was for the system as a whole

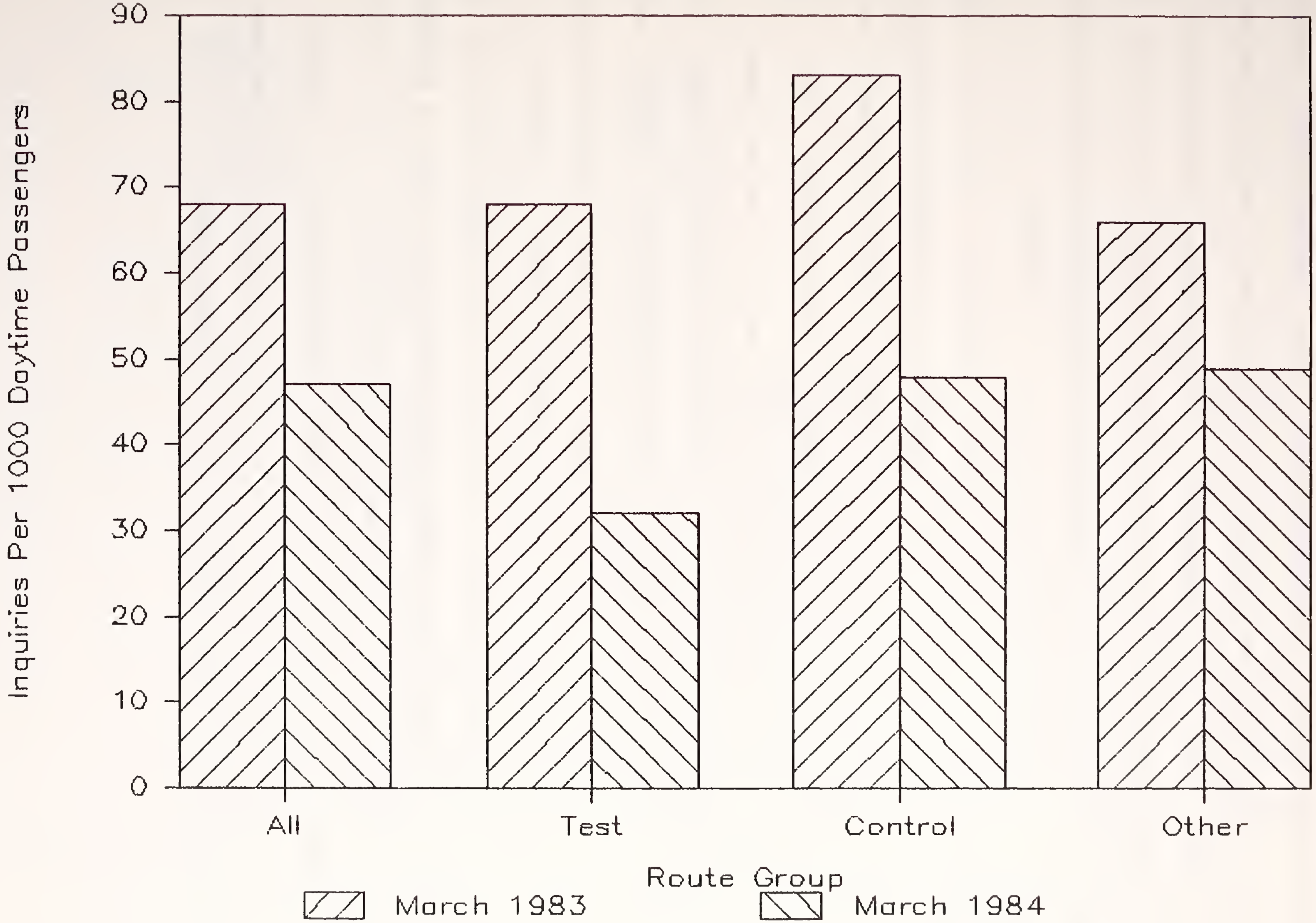

FIGURE 3-18: Daytime Inquiry Rates by Route Group

during the first test period, it was sizably lower for the test routes than for the control routes. Since the CRIS test routes and control routes have similar characteristics (for example, service miles, service hours, and number of bus trips) comparison of these two route groups in terms of Customer Service inquiry rates is most appropriate. This comparison indicates that after a "learning period" which was taking place during the first sample of Customer Service calls, the CRIS system did tend to reduce Customer Service inquiries. As bus users became more familiar and comfortable with using CRIS and accepted it as a reliable source of information, they found it less necessary to call the Customer Service Department for schedule information.

A total schedule inquiry rate is obtained for CRIS test routes by adding the CRIS call rate to the Customer Service schedule inquiry rate. As shown in Figure 3-19, when comparing CRIS test routes to control routes, CRIS availability appears to have had some impact in reducing Customer Service schedule inquiries one month after CRIS implementation. However, when comparing CRIS test routes to other routes (which exclude the CRIS test and control routes), it appears that CRIS availability merely increased the total number of schedule inquiries. On the other hand, based on the rates in March 1984, by 13 months after system implementation the number of schedule inquiries to Customer Service decreased for the CRIS routes. Also, the difference between the total number (CRIS plus Customer Service) of schedule inquiries for CRIS test routes and the number for control routes increased slightly--from six to twelve more calls per 1000 passengers.

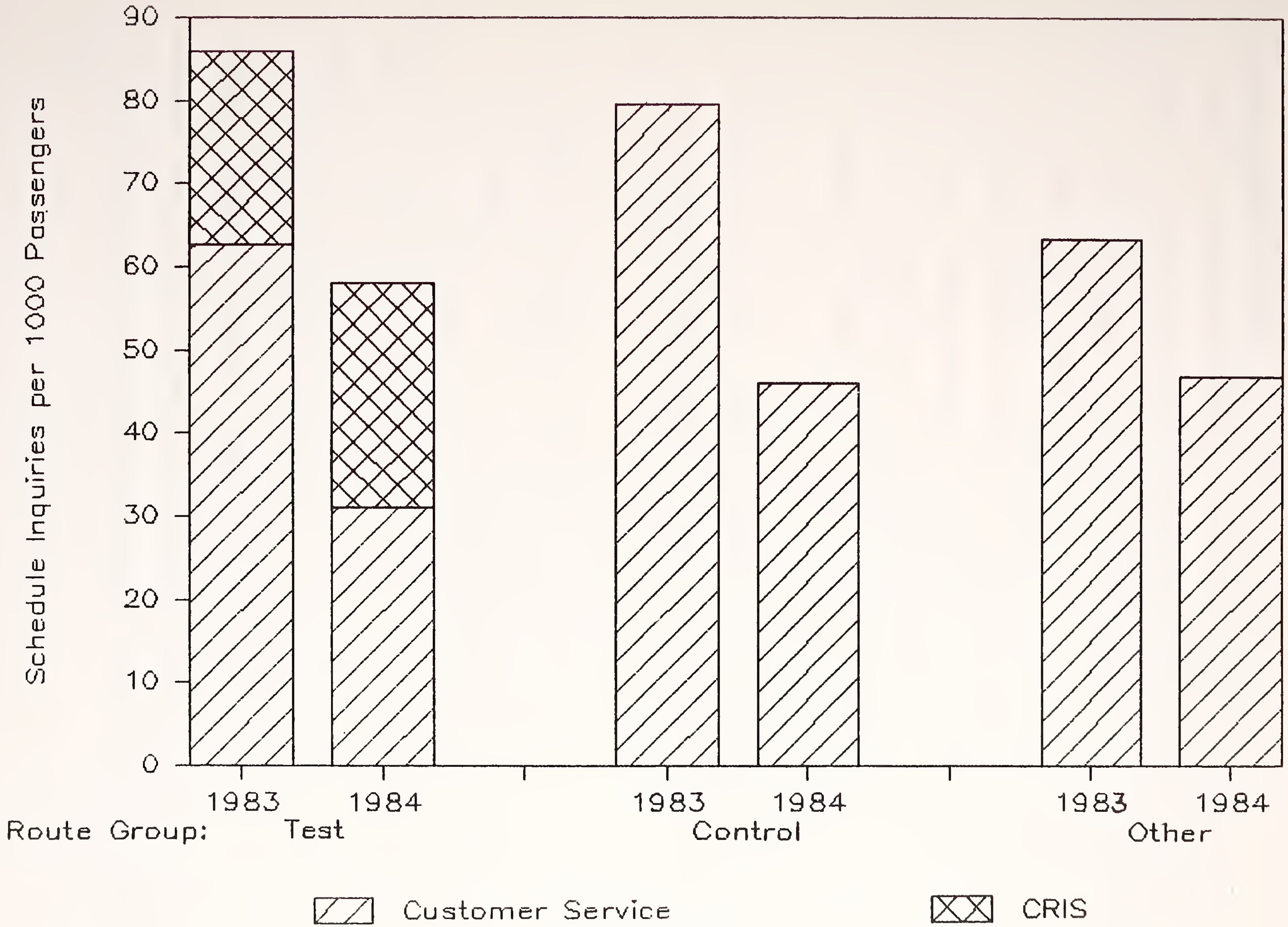

FIGURE 3-19: Total Schedule Inquiries per Passenger

4. Traveller Impacts - Multivariate Analysis

4.1 UTA RIDERSHIP MODELS

From the aggregate analyses of ridership trends, it appears that CRIS implementation has no significant impact on ridership levels. Instead, a number of factors exogenous to the CRIS system appear to have greater impacts on ridership levels than CRIS. These factors, among others, may include unemployment rates or employment levels, seasonality, fare levels, and gasoline prices. Several models were estimated using these factors to predict two weekday count measures as dependent variables: total CRIS test route ridership and total control route ridership. A discussion of the development of these models appears in Appendix D. Three of these models were selected as the best of those estimated; they are summarized in Table 4-1. The following sections describe these models and their implications for this evaluation.

4.1.1 Effects of Economic Conditions

Local economic conditions, represented by the average monthly unemployment rate in the Salt Lake City - Ogden Labor Market Area (LMA), have a large and statistically significant impact on both dependent variables. The coefficient of the unemployment rate variable, UERATE, is negative, indicating that increases in the unemployment rate are associated with decreases in ridership levels, as expected. This result is accentuated due to the fact that bus riders typically have below-average incomes and those in low-paying and blue-collar positions are usually the first to be laid off during recessions.

TABLE 4-1: Structural Ridership Equations

		CRIS Test Routes		Control Routes
Dependent Variables:		PAXCRISA	PAXCRISA	PAXCNTLA
Coefficient Values with t-statistics (in parentheses):				
Constant		8210	8551	10090
UERATE	Unemployment Rate	-149* (-2.4)	-142* (-2.2)	-152* (-2.5)
TEMP	Temperature	-25.5* (-6.9)	-26.4* (-7.2)	-14.0* (-4.1)
PFAREA	Bus Fare	-11420* (-3.2)	-11386* (-3.2)	-15124* (-4.6)
PGASA	Gasoline Price	4327 (1.6)	3666 (1.1)	-1191 (-0.4)
CRIS	CRIS System Dummy	____	139 (0.6)	65 (0.3)
VOLCRIS	Volume of CRIS Calls	0.0716 (1.1)	____	____
SPRING	Season Dummy	315* (2.4)	323* (2.5)	180 (1.5)
Point Elasticity with respect to:				
fare		-0.26	-0.26	-0.40
gas price		+0.33	____	____
volume of CRIS calls		+0.01	____	____
R^2:		0.69	0.68	0.61
Standard Errors of Estimate:		412	416	385
F-Statistics:		16.8	16.3	11.8

* Signifies statistical significance at the 95 percent confidence level.

4.1.2 Temperature, Seasonality and Trend Effects

The coefficient of the mean monthly temperature variable, TEMP, has a negative sign in each regression model. In each case, temperature has a very large and statistically significant impact on the dependent ridership variable. The existence of a causal relationship between the temperature and bus ridership is rather doubtful, however. Instead, it is more likely that during the summer months, when average temperatures are relatively high, students are out of school and more people are taking vacations; thus ridership falls for reasons only indirectly connected with the Salt Lake City weather. The temperature variable is used not so much for any causal reasons as to capture systematic seasonal fluctuations (however caused) in the number of riders.

Seasonality also has fairly sizeable effects on ridership. For each group of routes modelled, ridership is generally higher during the spring months, as represented by the dummy variable SPRING, all other factors being equal. Test route ridership is 5.0 to 6.8 percent higher while control route ridership is 3.2 percent higher during these months.

A trend variable, increasing by one for each month after January 1980, was also tried, but did not enter significantly in any of the final regression equations.

4.1.3 Effects of Fare Levels

Three fare increases took place in UTA's basic fare since January 1980, a 15¢ to 30¢ increase in February 1980, an increase to 40¢ in January 1981, and an increase to 45¢ in June 1981. The variable PFAREA represents fare levels in real dollars (discounted to reflect inflation rates). The coefficients for this variable have a fairly large and statistically significant impact on all three ridership variables. The fare level coefficients have negative signs, as expected, implying that ridership changes are negatively correlated with fare changes. At the mean values of all observations, the point elasticities for fares are -0.26 and -0.40 for test and control routes, respectively. These values imply that for a ten percent increase in the fare level, decreases in test route and control route ridership of 2.6 and 4.0 percent, respectively, would be expected.

4.1.4 Effects of Gasoline Prices

In contrast to the effects of fare levels, the impacts of gasoline prices (variable PGASA) on ridership are not sizeable. The coefficient value for gasoline prices is insignificant in each equation, and also has the wrong sign in the equation for control route ridership. This insignificance is not surprising: gasoline price measures the cost of automobile transportation, a substitute to bus travel, and thus, is not as likely to have an impact as the direct cost of bus travel.

4.1.5 Effects of CRIS Implementation and Volume of CRIS Calls

Two variables were defined to provide measures of the impacts of the CRIS system on UTA ridership:

- CRIS - a variable set to one in each month during which the CRIS system was operating (February 1983 through May 1984); otherwise set to zero

- VOLCRIS - the number of CRIS calls per month.

The statistically insignificant coefficient for the CRIS variable indicates that implementation of the automated system had no significant effect on CRIS test and control route ridership. However, it appears that the level of Buzz-a-Bus system usage as measured by VOLCRIS, the volume of monthly CRIS calls, may have some impact in increasing the ridership levels on CRIS test routes. Although not statistically significant, the coefficient value of the volume of CRIS calls is plausible, suggesting that a doubling in the volume of monthly CRIS calls may be associated with a one percent increase in CRIS test route ridership.

4.1.6 Effects of Marketing

The factors discussed above explain 60 to 70 percent of the variation in weekly ridership on the CRIS routes. The limitations of the data (two counts per month) provide little basis for separating the impacts of the CRIS marketing activities, especially as these varied with time after the marketing took place. A study of the residuals (observed riders minus predicted riders) of the ridership models did indicate that the average residual in the first month after a marketing effort was only slightly positive, having two negative values and one positive value for the three marketing activities. The average represents an increase of less than 0.1 percent of average weekly riderhip. The second month following the marketing efforts was more consistently positive--the average increase was 2.4 percent. By the third month, the average residual became negative, implying no further marketing impact.

In summary, there was very limited evidence that CRIS marketing activities have had a positive impact on CRIS route patronage. To the extent that this impact could be observed, it appeared to be most significant in the second month following the marketing activity. Due to the limited availability of data, nothing could be said about the relative impacts of alternative marketing strategies on CRIS route ridership.

4.2 CRIS USAGE MODELS

4.2.1 CRIS Usage Patterns

Monthly variations in the rate of CRIS calls per 1000 passengers were previously shown in Figure 3-8. Peaks in the CRIS call rate can be associated with the three CRIS marketing activities, which occurred in January and May 1983 and in January 1984. Also, increases in CRIS usage tend to be correlated with periods of colder weather. To go beyond these aggregate analyses of variations in CRIS calls, linear regression was used as a tool which statistically takes into account all available weather and marketing data on a daily basis and allows more interactions between variables to be considered. See Appendix E for a discussion of the development of regression models of CRIS usage rates.

4.2.2 Multivariate Analysis Results

More than two-thirds of the variation in the number of CRIS calls was explained by base/trend, weather, and marketing variables (see Table 4-2). Most of the hypothesized impacts proved to be statistically significant; each is discussed in the sections which follow.

Base/Trend Variables--The number of calls received on Sundays was much less than that received on weekdays and Saturdays. CRIS use on holidays, in addition, was significantly less than that on non-holidays. Overall, a negative trend over time was prevalent, showing a decrease of about 13 calls per day every month.

TABLE 4-2: Regression Results: Daily CRIS Calls Versus Weather and Marketing Factors

Independent Variable	Coefficients	t-Statistics
CONSTANT	166	
SUNDAY	-96.0*	-15.05
HOLIDAY	-35.0*	-2.57
TREND	-.044	-1.86
AVGTEMP	-.943*	-6.33
PRECIP	-17.1	-1.07
MRKTG1W1	274*	11.87
MRKTG1W2	161*	9.06
MRKTG1W3	145*	8.16
MRKTG1W4	71.6*	4.34
MRKTG2	50.1*	1.96
MRKTG2W1	62.8*	3.70
MRKTG2W2	31.5	1.42
MRKTG2W3	-11.3	-0.67
MRKTG3	102*	6.13
MRKTG3W1	62.2*	3.62
MRKTG3W2	34.2*	1.96
MRKTG3W3	54.7*	2.95
MRKTG3W4	84.8*	4.90
R2	.674	
$\bar{R}^2$	.642	
Standard Error of Equation (CRIS calls per day)	43.8	
Mean value of Dependent Variable (CRIS calls per day)	111.	

* Signifies statistical significance at the 95 percent confidence level.

Weather--Temperature had a statistically significant impact on the number of CRIS calls, but precipitation's impact was not statistically significant. For every 20 degrees drop in temperature, approximately 19 more calls per day are received by the CRIS system.

First Marketing Activity/System Startup--As seen in Table 4-2, the combined impact of the first marketing activity and of curiosity calls following system startup diminished as time elapsed. Two hundred fewer calls were received in the fourth week (MRKTG1W4) than in the first week subsequent to system startup as a result of the diminished effect of these two factors. The results for the remaining market activities suggest that both information calls and curiosity calls were higher immediately following the first marketing effort, but do not provide a measure of the relative importance of these two factors.

Second Marketing Activity--Impacts of the second marketing activity were less pronounced than those of the first marketing activity, reflecting both the lack of the curiosity effect and the limited scope of the marketing effort (i.e., direct distribution to an area served by just two of the CRIS routes). Statistically significant impacts were discovered only for the actual marketing period and the first week following this period (MRKTG2, MRKTG2W1).

Third Marketing Activity--Impacts of the third marketing activity were found to be very large and statistically significant, reflecting the extensive scope and personalized nature of the door-to-door handout method on all the routes. It should be noted, however, with respect to each of the marketing efforts, that there is no clear statistical evidence that the increases in CRIS calls was accompanied by increases in bus ridership. (See Section 4.1.) The implication is that the marketing efforts resulted in a more intensive use of CRIS by existing bus riders rather than in the attraction of new riders.

4.3 CUSTOMER SERVICE INQUIRIES

4.3.1 Introduction

As discussed in Section 3.2.2, the level of bus service for a route, reflected in an operating parameter such as bus trips per day, appears to be inversely related to information inquiry rates via telephone calls to the CRIS system. This suggests that the same might be true for calls to UTA's Customer Service Department. To test the validity of this hypothesis, linear regression was used as a tool which statistically takes into account all available route-specific data and allows interactions between variables to be considered. Regressions were run with two Customer Service inquiry rates as the dependent variables (total inquiries and schedule inquiries) and with route type (CRIS or non-CRIS) and various measures of level of bus service as independent variables. This procedure provides a means of determining the effects of CRIS in reducing or increasing calls while taking into account route characteristics and levels of service. See Appendix F for a discussion of the development of these models.

4.3.2 Results--1983 Data Set

As shown in Table 4-3, the estimated coefficients for the CRIS variable (equal to one for CRIS routes and zero otherwise) in both regressions are small and insignificant, indicating that CRIS had little or no effect in

TABLE 4-3: Customer Service Regression Results for the First Test Period

Independent Variable	Coefficients and t-Statistics: Total Inquiries Per 1000 Passengers (TINQPP) as Dependent Variable	Schedule Inquiries Per 1000 Passengers (SINQPP) as Dependent Variable
Constant	111	106
CRIS	6.70 (0.48)	2.75 (0.21)
LENGTH	0.981 (1.75)	0.918 (1.71)
EXPRESS	-112* (-6.56)	-107* (-6.54)
NEXPTP	-1.112* (-3.13)	-1.04* (-3.24)
Number of Observations	70	70
R2	0.485	0.487
F	16.25	14.41
Standard Error of Equation	31.5	30.1
Mean value of dependent variable (unweighted average)	56.2	53.1

* Signifies statistical significance at the 95 percent confidence level.

decreasing the inquiry rates. On the other hand, whether the route is express (EXPRESS), and number of trips for non-express routes (NEXPTP) are estimated with statistical significance to be prime determinants of the inquiry rates.

Although not statistically significant at the 95 percent level, the regression results suggest that the length of route (LENGTH) may also have a sizeable impact on the inquiry rates. As hypothesized, the inquiry rates tend to increase as route length increases. The estimated difference in the total inquiry rate, for example, between the route with the average route length (15.7 miles) and one with the greatest route length (44 miles), all other factors being equal, is in the range of 12 to 44 inquiries per 1000 bus passengers. (The range is defined as plus and minus one standard deviation from the expected difference of 27.) When these values are compared with the unweighted mean value of 56 total inquiries per 1000 riders, they indicate that the impact of route length is imprecise but potentially large.

The estimated coefficients of EXPRESS and NEXPTP can be analyzed together. The significantly negative coefficients for the EXPRESS variable indicate that the inquiry rate is sizeably lower for express routes, supporting the hypothesis that most of the riders of these routes are familiar with their operations. The schedule inquiry rate for the average express route is typically 64 per 1000 riders less than the corresponding rate for the average non-express route.

When comparing only non-express routes, the results indicate that inquiry rates decrease as route trips increase. The schedule inquiry rate, for example, decreases an estimated 1.04 per route trip. Therefore, the predicted schedule inquiry rate for a non-express route with the average number of non-express trips (43.3) is 35 inquiries per 1000 passengers higher than a route with the largest number of trips (76.7), if all other factors are equal.

4.3.3 Results--1984 Data Set

As shown in Table 4-4, the estimated coefficients for the CRIS variable for the second test period in both regressions, unlike those for first test period, are large and have negative signs, implying that fewer Customer Service calls are made on the CRIS routes than on all other routes, all other factors being equal. However, like those for the first test period, the estimated coefficients for the CRIS variable in the second test period are not statistically significant. The length of a route (LENGTH), whether the route is express (EXPRESS), and number of trips for non-express routes (NEXPTP) are estimated to be statistically significant determinants of the inquiry rates. However, the percentage of variance explained as measured by the R^2 statistic is appreciably less than that found in the regressions for the first test period.

TABLE 4-4: Customer Service Regression Results for the Second Test Period

Independent Variable	Coefficients and t-Statistics: Total Inquiries Per 1000 Passengers (TINQPP) as Dependent Variable	Schedule Inquiries Per 1000 Passengers (SINQPP) as Dependent Variable
Constant	74.1	67.2
CRIS	-16.8 (-0.89)	-15.6 (-0.83)
LENGTH	1.93* (2.94)	1.92* (2.90)
EXPRESS	-99.1* (-4.41)	-92.4* (-4.15)
NEXPTP	-0.952* (-2.11)	-0.856 (-1.92)
Number of Observations	74	74
R2	0.268	0.251
F	6.32	5.78
Standard Error of Equation	43.1	42.7
Mean value of dependent variable (unweighted average)	41.5	39.7

* Signifies statistical significance at the 95 percent confidence level.

5. Economic Evaluation

5.1 UNDERLYING ASSUMPTIONS

The first step in carrying out an economic evaluation of the CRIS system involved specifying the assumptions underlying this evaluation. Each of the assumptions described in this section represents a projection of what will happen in the future. Each was chosen to represent the evaluators' best estimate of the system's economic value rather than either an optimistic or pessimistic view of the net worth of the system.

5.1.1 Entire System Impacts Versus Phase I Impacts

Because Phase I of the UTA CRIS system was only a preliminary test prior to its extension to all bus routes, it is not appropriate to evaluate the system's economics only in terms of Phase I costs and benefits. Many of the costs incurred in Phase I were only required to provide the capacity for a complete CRIS system serving all bus routes. Thus, the basic assumption is that the economics of the final system should be evaluated, and that the observed Phase I impacts can be extrapolated to the final system. The impacts which must be extrapolated to carry out the complete-system economic analysis are the following:

- changes in ridership on CRIS routes
- system operating costs
- changes in calls to Customer Service for schedule information
- changes in ridership due to CRIS-related marketing activities

The specific extrapolations made in each of these areas are discussed in Section 5.2.

5.1.2 Benefits Based on Non-CRIS Usage of the CRIS Computer

Although UTA did not experience any benefits of having the CRIS computer and CRIS data files as additions to their computing power during Phase I, the possibility of these benefits does exist as the CRIS system is expanded to all UTA bus routes. This will be particularly true for the Customer Service telephone operators, who will be able to use the CRIS database in an on-line mode to provide information on route delays and deviations and as a reference source on route schedules. These uses are likely to improve the operators' ease of answering inquiries, but are not expected to reduce the average time per telephone call (presently just 55 to 75 seconds) appreciably. Also, to be fully implemented, these call-answering procedures will require at least ten more terminals for the telephone operators than are provided for in the present agreement. In this analysis, therefore, no benefits are assumed for Customer Service usage of the CRIS computer.

The UTA data processing staff recognizes the possibility of additional non-CRIS uses for the CRIS data sets and computer, but sees no specific ways in which the CRIS computer is likely to be used for non-CRIS data processing at the same time that it supports the CRIS system. Other experts in the area of transit information systems agree with this staff assessment. Reflecting this situation, the base estimate of the expected value for the CRIS data sets and additional computing power is zero. In addition, however, sensitivity analysis is used to test whether or not this estimate is critical.

5.1.3 Changes in System Benefits Over Time

For a number of reasons, the continuing CRIS benefits are not expected to reach their "steady-state" levels immediately upon implementation of the complete system. First of all, as observed for the Phase I test routes, decreases in calls to Customer Service are expected to become larger over time. Secondly, management responses to these decreases in the form of staff reductions will probably exhibit an additional lag. This will be especially true because UTA's current plans call for Customer Service staff reductions only by attrition and reassignments, rather than by dismissing any present employees. Finally, any potential benefits due to additional computer capabilities will also take time to be realized. This time will be required for the staff to recognize specific areas of uses for the new capabilities, for procedures to be developed in these areas, and for these procedures to be applied as part of the normal activities of the UTA planning and operations staffs.

To reflect the gradual phasing in of continuing CRIS system benefits, the economic analysis is based on the assumption that the ultimate or steady-state benefits in the areas of reduced Customer Service costs and additional computer capabilities will be reached only after five years of system operation. During these five years, both types of system benefits will increase linearly, starting out at zero in the first year of operation. The analysis also assumes that full system operation will begin late in 1985 and thus that the full level of continuing benefits will occur in 1990.

5.1.4 Economic Life of the System

The expected economic life of the CRIS system depends on how long its hardware and software components will remain useful. System hardware includes the computer, telecommunications interface devices, and telecommunications services. Only the first two of these elements represent purchased equipment which will eventually require replacement. Typically, computer hardware retains its usefulness as long as it is properly maintained. Computer manufacturers usually stop providing maintenance support for particular machines after approximately ten years, however. To be consistent with this usual practice in the computer industry, the economic analysis assumes a useful life of ten years for the CRIS system computer and telecommunications interface devices. All other elements of the system, including telecommunications services and software, are effectively leased or licensed by UTA rather than purchased. By paying the monthly charges associated with the telecommunications services and the monthly maintenance fees associated with the software, UTA ensures the continuing usefulness of these system elements. Thus, no economic life must be assigned for them. However, since these leased or licensed elements are likely to require replacement when the computer is replaced to maintain compability, the economic life of the entire CRIS system was assumed to be tied to the life of its computer. Thus, a ten-year economic analysis period is used, with an assumed salvage value of zero.

5.1.5 Discount Rates and Inflation Factors

In order to compute the present value of streams of future system costs and benefits, it is necessary to take into account the time value of money. For this analysis, the discount rate used is ten percent, a rate which is Federally-approved for this purpose.[1]

In addition to discounting future costs and benefits, it is also necessary to account for inflation when dollar values in different years are stated. Rather than to attempt to predict future rates of general inflation, all future costs and benefits can be stated in "real", or constant dollars. The base year for which all constant dollar values are given is 1983, the first year of the UTA-Teleride contract. In this analysis future benefits are generally assumed to remain constant, after the growth discussed in Section 5.1.3, when expressed in constant dollars.

On the other hand, costs and benefits which depend on UTA's labor rates and operating costs could possibly change, when expressed in constant dollars. This change would reflect different rates of increase in transit costs than the general level of inflation. The economic analysis was designed to allow for these differences, but a study of UMTA Section 15 data for 1978 (the first year these data were available) and 1983[2] indicated that after inflation is accounted for, the costs per employee for both UTA and for all U.S. operators of 250 to 500 buses changed very little over this period. In both cases, total salary plus fringe benefit costs per employee in deflated dollars actually declined slightly:

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[1]Office of Management and Budget, "Discount Rates to be Used in Evaluating Time-Distributed Costs and Benefits," Circular No. A94, revised March 17, 1972.

[2]"National Urban Mass Transportation Statistics: First Annual Report," Transportation Systems Center, Report No. UMTA-MA-06-0107-81-1, May 1981 (contains UTA data for the year 1978); "National Urban Mass Transportation Statistics: 1983 Section 15 Annual Report," Transportation Systems Center, Report No. UMTA-MA-06-0107-85-1, December 1984.

-0.4 percent annually for UTA and -0.9 percent annually for the industry. Similarly, total operating costs per employee also declined: -0.6 percent annually for UTA and -0.1 percent annually for the industry. Reflecting these findings, the base value chosen to represent future labor and operting cost increases in real dollars was zero. Sensitivity analyses were carried out, however, to determine the impacts of rates of cost inflation greater than inflation in general.

Inflation rates must also be considered in evaluating CRIS system costs and benefits which have occurred since project initiation in 1983 and its costs which are scheduled to occur in 1985. All of these dollar values have been converted to "real" 1983 dollars, the same basis used for all future costs and benefits. Values for both 1984 and 1985 have been adjusted to 1983 dollars using an annual inflation rate of 4.3 percent, which corresponds to that actually measured between 1983 and 1984.

5.2 SYSTEM COSTS AND BENEFITS

A number of categories of CRIS system costs and benefits were estimated, based on the general assumptions discussed in the previous section. The nature and magnitudes of each of these are discussed in this section. Two types of costs and benefits were estimated: initial, or one-time, values and continuing values. The initial costs and benefits are those associated directly with the aspects of the UTA-Teleride agreements (such as UTA payments and marketing benefits) which will not continue over the life of the CRIS system.

5.2.1 Initial System Costs

There were three components of initial costs: the payments specified in the UTA-Teleride contract, the reduction in these costs represented by a forgivable loan from Teleride to UTA, and the costs incurred by UTA to support system start-up and to pay for essential components of the system not provided by the Teleride contract. Table 5.1 shows the incidence of these costs by year and by cost category. Initial costs associated with system installation and testing were originally scheduled to be incurred in 1983 and 1984, but actually extended through all of 1985. Although information on the exact levels of expenditures by year was not available from UTA, the contract provisions imply that 67 percent of the initial costs were paid in 1983, 5 percent in 1984, and 28 percent in 1985. The proceeds of the Teleride loan were applied to scheduled UTA payments entirely in 1983. UTA support costs were originally expected to span just twelve months, but with the exception of bus stop inventorying and file data entry for Phases II and III, all were spread over the 16 months of Phase I, from February 1983 through May 1984. The allocation by year shown in Table 5.1 assumes equal monthly expenditures during Phase I for these costs. As shown in the table, total initial system costs were $798,320 in current-year dollars, or $776,391 in 1983 dollars.

5.2.2 Initial System Benefits

The only non-continuing benefit of the CRIS system was the increase in passenger revenues due to the extra transit marketing done in connection with system start-up. As discussed in Section 4.1, the three waves of marketing done during Phase I apparently increased ridership on the CRIS routes by a total of 7.5 percent of a normal month's ridership level.

TABLE 5-1: Initial System Costs and Benefits

Cost/Benefit Category	1983	1984	1985	Total
	Year Incurred by UTA[1]			
System Costs				
Teleride contract[2]	$ 485,918	$ 36,263	$ 203,070	$ 725,251
UTA loan from Teleride	-165,050	-	-	-165,050
UTA support costs				
staff costs	60,671	27,578	-	88,249
installation/start up	29,083	-	22,917	52,000
telephone costs	34,286	15,584	-	49,870
hardware and software maintenance	33,000	15,000	-	48,000
Total initial costs	$ 477,908	$ 94,425	$ 225,987	$ 798,320
System Benefits				
Revenue increases due to transit marketing	5,753	2,876	6,967	15,596
Costs and Benefits in 1983 Dollars[3]				
Initial costs	$ 477,908	$ 90,570	$ 207,913	$ 776,391
Initial benefits	$ 5,753	$ 2,759	$ 6,410	$ 14,922

[1]With the exception of last two rows, all costs and benefits are in current-year dollars. Costs are as specified in the UTA-Teleride agreements.

[2]See Table 1-2 for further details on contract costs by category and phase.

[3]Based on actual 1983-84 and assumed 1984-85 inflation rates of 4.3 percent.

Assuming the same effects on the control routes and using an average fare of 45 cents per bus trip, the increased revenue due to Phase I marketing was estimated as $8,629, occurring partially in 1983 and partially in 1984. If similar returns are projected for the marketing efforts in Phases II and III, a value of $6,967 is obtained; this initial benefit is expected to occur in 1985. Table 5.1 shows the distribution of these benefits by year in current-year dollars, derived from the values just discussed, which total $15,596. The table also shows the subsequent conversion to constant 1983 dollars, totalling $14,922.

5.2.3 Continuing System Costs

Continuing costs and benefits were originally scheduled to begin upon the completion of the UTA-Teleride agreement in late 1984, but probably will not begin until 1986. Estimates of these have been valued in 1983 dollars, to be consistent with the time of the original contract. Continuing costs consist of three components: UTA labor for system operation, telephone equipment rental, and hardware and software maintenance. Each of these are discussed in the remainder of this section; Table 5.2 provides a summary of the estimated values.

UTA Labor--As discussed in Section 2.3, it is estimated that the continuing operation of the full CRIS system will require 216 hours per month of dispatcher's time to provide status updates at the system, route and bus stop levels whenever these updates are needed due to route deviations and delays. Also required will be 24 hours per month of system manager's time to maintain the computer hardware and software and to obtain and monitor its periodic system reports. The corresponding costs to UTA were estimated based on UTA labor rates specified in its 1982 budget for support

TABLE 5-2: Continuing System Costs and Benefits

Cost/Benefit Category	Value[1]	First Year Incurred	Frequency	Constant-Dollar Variation Over Time
System Costs				
UTA Labor	$ 51,008	1986	Annually	None
Telephone equipment rental	44,376	1986	Annually	None
Hardware and software maintenance	59,040	1986[2]	Annually	None
System Benefits				
Revenue increases due to CRIS services	0	-	-	None
Additional computer capabilities	0	-	-	None
Savings in Customer Service Department	167,333	1990	Annually	1985-1990: Linear increase from 0 to $167,333 After 1990: Remains at $167,333

1 In 1983 dollars.

2 Contract provisions calling for these costs to begin in 1984 were deferred as the completion of Phases II and III was delayed until 1986.

costs. These rates were converted to 1983 dollars based on the 3.2 percent inflation from 1982 to 1983. The resulting hourly wage and fringe benefit rates expected in the first year of system operation (1986) are $16.82 for the System Manager and $17.81 for dispatchers. Total labor costs in 1986 are thus expected to be $51,008. For the base case, these costs in 1983 dollars are expected to remain constant in each year following 1986. Sensitivity analyses were also performed in which these costs were predicted to increase by fixed percentage levels to reflect alternative levels of cost inflation at UTA.

Telephone Equipment--In mid-1985, UTA received a quotation from the local telephone company of a total rental cost of $4019 per month for the following equipment needed for the CRIS system:

- 12 trunk lines
- 12-line call ability
- direct inward dialing
- 5000 phone numbers
- 1 Ogden data line and foreign exchange

The corresponding annual cost in 1983 dollars is $44,376. These costs are expected to remain constant throughout the life of the CRIS system.

Hardware and Software Maintenance--The UTA-Teleride agreement specifies continuing monthly maintenance costs of $3,420 for system hardware and $1,500 for system software. Both costs are indexed to U.S. inflation rates in the contract, with increases scheduled annually on the anniversary of the start-up date for maintenance services. This start-up date is defined as 30 days after system installation, which is UTA's case occurred in February, 1983. The contractual rates thus represent 1983 dollars. Based on these values, the continuing annual costs for system maintenance are $59,040. These costs will remain constant, in terms of 1983 dollars, thoughout the life of the CRIS system.

5.2.4 Continuing System Benefits

UTA's decisions to acquire the CRIS system and expand it beyond Phase I were based on their expectation that they would realize each of the following types of continuing benefits:

- Passenger revenue increases duë to CRIS services
- Additional computer capabilities
- Savings in UTA's Customer Services Department due to fewer calls for schedule information

UTA's Phase I experience has shown that neither of the first two potential benefits can be expected in Salt Lake City. As discussed in Chapters 3 and 4, no increases in passenger revenue could be attributed to the Phase I operation of the CRIS system. Furthermore, the ridership decreases which occurred on CRIS test routes relative to control routes make it unrealistic to assume that the full CRIS system would cause any measurable ridership increases for UTA as a whole. Thus for the base case, the value of continuing benefits due to increased passenger revenues is estimated to be zero in all years of system operation.

The UTA Board's decision to proceed to Phases II and III following the negative ridership results of Phase I was based partially on their expectation that they would also be gaining additional computer capabilities which could be used to support non-CRIS planning and operations activity at UTA. Discussions held with the UTA data processing staff as preparations were continuing to begin Phase II of the CRIS project, however, indicate that there is no significant value which can be assigned to these additional capabilities. The CRIS system requires a schedule data base, but this file contains fewer data items than those included in the data bases used by UTA for bus schedule development and driver run cutting. The system provides the possibility of accessing this data base in an interactive mode, which can aid the Customer Service telephone operators, but the UTA-Teleride agreement does not provide the number of on-line terminals required for this additional use of the system. Furthermore, the CRIS system's real-time computing requirements severely limit the computer's capacity to carry out unrelated data processing activities while the CRIS system is operating. These factors all suggest that there is no positive value to be assigned to the additional computing capabilities provided by the CRIS system. This assumption is reflected in the economic evaluation's base case.

The final potential benefit is due to cost savings in UTA's Customer Services Department, as bus users obtain schedule information by calling the CRIS system rather than by calling the Customer Services Department. During Phase I, a 33 percent reduction in Customer Service calls was observed for the CRIS test routes. This rate of reduction has been assumed to hold for the entire system after the completion of Phase III, and to allow for a corresponding reduction in the costs of providing telephone information by UTA's Customer Services Department. These costs, which include telephone equipment rental and operator wages, were $502,000 in 1983. The 33 percent reduction implies a benefit of $167,333, expressed in 1983 dollars. For the base case, these savings are assumed to remain at a fixed value in constant-dollar terms. Sensitivity analyses were used to explore rates of UTA cost inflation greater than those for prices in general. These savings are not expected to be fully realized until 1990; they are expected to increase linearly from zero in 1985 to the 1990 value.

5.3 NET PRESENT VALUES

The time stream of the costs and benefits shown in Tables 5.1 and 5.2 can be represented as a single Net Present Value (NPV) for any specified discount or interest rate. When the OMB-recommended rate of 10 percent is used, an NPV in 1983 dollars of -$891,000 is estimated, where the negative sign signifies a net <u>cost</u> rather than a net benefit.

Economically speaking, the complete UTA CRIS system is expected to be a poor investment, based on the experience observed in the system's first phase. The large negative value of the NPV indicates that only very significant changes in the various factors affecting estimated costs and benefits would reverse this conclusion. The magnitudes of some of the changes which would be required for the net present value to be positive are the following:

- If the CRIS system for all UTA routes would cause systemwide ridership to increase by 492,000 annual passengers (+3.2 percent). This level of ridership increase cannot be ruled out using the results of Phase I on a statistical basis, but would be a reversal of the observed trends in Phase I.

- If the benefits of using the CRIS computer for non-CRIS data processing were $266,000 per year rather than zero, as predicted. Some benefits of CRIS computer usage are quite likely, but this high level of annual benefits from equipment costing just $232,000 and continually used to support the CRIS system is essentially impossible.

- If the cost savings in the Customer Service Department in 1990 would be $433,000 rather than $167,000, as predicted. This increased savings would require an 86 percent reduction in information calls to Customer Service, not the 33 percent observed in Phase I.

Four additional changes from the base estimates discussed in the previous section would result in reduced net present costs, but could not reverse the outcome to provide a positive net present value.:

- If the CRIS system could be used indefinitely by UTA, the NPV would increase by $50,000, but would remain significantly negative: -$841,000.

- If all annual telephone rental and system maintenance costs were eliminated, the project's NPV would remain negative: -$435,000.

- If UTA's future costs per employee, over and above inflation, would increase by 5 percent annually, rather than remaining constant as they did over the 1978-1983 period, then the NPV would increase only moderately, to -$799,000.

- If the cost savings in the Customer Service Department would reach their maximum value in 1987 rather than in 1990, then the NPV would increase to -$724,000.

Finally, the conclusions of the base case evaluation are not sensitive to the discount rate chosen. Since the initial costs are very high in comparison with the continuing net benefits, the NPV will be negative for all discount rates.

These sensitivity explorations indicate that a complete CRIS system will only be economically viable if a number of significant changes in the estimated costs and benefits occur, and if the net effect of all such changes occurs in the direction of greater advantage to UTA.

6. Conclusions and Implications

6.1 MAJOR CONCLUSIONS OF THE EVALUATION

This section draws together a number of major conclusions concerning the effectiveness of the UTA Computerized Rider Information System, based on the observed system impacts discussed in Chapters 3 through 5. These conclusions are presented in the order of the presentation of impacts in the previous chapters.

6.1.1 Conclusions Based on Ridership Impacts

Total Ridership Trends--The available counts of bus passengers on the CRIS test and control routes do not show what was hoped to be the CRIS system's most important impact, an effectiveness in increasing ridership levels. In total, ridership apparently declined more on the set of six test routes than on the control routes. These results, however, are based on just three daily counts per route during each of the 16 months of the Phase I evaluation period. Due to the normal large day-to-day variation in bus passenger levels, this observed result is not significantly different from either zero or from the target relative increase of three percent. Thus the possibility exists (with an expected chance of less than one in ten) that ridership did increase at the desired level on the CRIS test routes. Conversely, there are nearly nine chances in ten that the system did not meet its goals, and three chances in four that the actual ridership level on the test routes decreased more than on the control routes.

Time of Day Variations--During Phase I of the CRIS project, measured test route ridership levels on Saturdays increased relative to the control route levels. These results suggest that the CRIS system is most effective in promoting increased bus usage when the level of transit service is low and people can reduce their expected wait time most by ascertaining the arrival time of the next bus, and when people are more likely to make non-habitual transit trips. CRIS apparently had a reduced value for weekday peak period bus riders, who can catch a bus in a matter of a few minutes even if the exact arrival time of the next bus is not known, and who are much more likely to know the basics of the schedules for bus routes frequently used.

Determinants of Ridership Levels--In the first three months of UTA's CRIS project, relative ridership increases occurred on the test routes during each time period for which information was collected: weekday peak, weekday off-peak, and Saturday. These initial positive changes, negated in later months of the project, were apparently caused by the marketing efforts which accompanied the start-up of the system rather than by the system itself. Tests of a variety of potential explanatory variables for bus passenger levels by route indicated that neither the CRIS system nor the CRIS marketing activities were as important as other factors which affect ridership levels. The factors having larger impacts on ridership include unemployment rates (reflecting economic conditions), temperature (reflecting seasonality), and fare levels.

6.1.2 Conclusions Based on CRIS System Usage

Route Type and Time of Day Variations--The conclusions based on determinants of ridership levels are borne out by the information on CRIS call rates by route. These rates are generally highest for routes with the lowest service levels. As headways and expected wait time are increased, riders tend to find it more useful to call CRIS for schedule information. This also initially held true for off-peak periods, although the off-peak call rate was nearly equal to the peak period rate by the end of Phase I.

Weather Variations--Colder weather was found to have a significant impact on increasing the number of CRIS calls. This indicates that the perceived usefulness of the system is greater when wait time is most onerous. Although winters in Salt Lake City are not severe, monthly average temperatures in the 30s (degrees Fahrenheit) were low enough to have a sizeable impact on CRIS call rates.

Trends over Time--The rate of CRIS calls per passenger exhibited a general trend toward lower values as Phase I continued. Apparently, this reflects an increasing level of knowledge about the CRIS test routes by their riders and thus a reduced need for current information. It also is consistent with a lack of ridership growth and thus with few new riders who would find the CRIS system useful in increasing their knowledge about the available service.

Impacts of Marketing--Marketing activities were significant factors in increasing CRIS calls, but these increases generally did not last long. The relative magnitude of the marketing impacts were generally in proportion to the levels of effort of each of the three marketing activities. The results are not sufficiently detailed to indicate the relative cost-effectiveness of the alternative marketing methods used: direct mail or personal distribution.

CRIS Versus Customer Service Call Rates--A comparative analysis of the CRIS call rate and the Customer Service inquiry rate for all CRIS routes indicates that people's familiarity with the CRIS system increased as time went on. Although the CRIS call rates did not increase over time and thus continued to be low compared to Customer Service schedule inquiry rates for all Salt Lake City routes, riders on CRIS routes found it less and less necessary over time to call Customer Service for schedule updates. Customer Service rates were one-third less for CRIS test routes than for control routes of the end of Phase I.

6.1.3 Conclusions Based on Bus Riders' Awareness of CRIS

Non-Workers Versus Workers--An on-board survey conducted on the CRIS test routes early in Phase I indicated increased awareness and usage rates among non-working riders. These results indicate the enhanced value of the system for non-work travel.

Variations by Age Level--The survey results also show that system usage decreases as riders' ages increase. This suggests that the young more readily accept the use of a computerized system and are more likely to experiment with a system involving new and different features.

Marketing Impacts--The survey, conducted early in Phase I, revealed that the initial mail-out marketing used to inform users near the test routes of the CRIS system was not as effective as desired. Subsequently, Teleride switched to the direct distribution of marketing materials to residences. Although both CRIS call rates and route ridership levels increased temporarily following each marketing activity, it was not possible to determine the relative effectiveness of the alternative distribution methods and marketing messages.

6.1.4 Conclusions Based on Customer Service Usage

Total Impact of CRIS--The existence of the CRIS system did not eliminate the need for telephone opeators providing schedule information from UTA's Customer Service Department. By the end of Phase I, however, the system did result in a reduction one-third in calls to Customer Service for information on CRIS test routes.

Bus Users' Information Needs--During Phase I, the rates of calls by route both to Customer Service and to the CRIS system were found to be higher for routes with longer headways and longer route lengths, and for those without peak-period express services. These results indicate that both sources of bus service information are serving similar types of information needs and that users' preferences (human response vs. computer--generated voice) and prior information levels (one general telephone number versus bus stop-specific numbers) tend to favor calls to Customer Service. By providing both services, UTA was able to increase the variety of means of providing bus service information. The net result was a very small increase in the total rate of calls per passenger (CRIS plus Customer Service) on the CRIS test routes.

6.1.5 Conclusions Based on the Economic Analysis of the System

Expected Net Present Value--Following its extension to all UTA bus routes, the CRIS system is not expected to be economically justified. In net present value terms, the system's total initial and continuing cost will exceed total estimated benefits by nearly 900,000 dollars. Only with a number of significant changes from the assumed levels of wage inflation rates, additional computer benefits, and/or additional labor savings; or with ridership results very different than those observed in Phase I; will the complete system be able to demonstrate net economic benefits.

The Board's Decision to Proceed to a Full CRIS System--Although economic analysis does not support the UTA Board's decision to proceed to Phases II and III of the CRIS system, this does not necessarily mean that the Board made a mistake. This analysis was made on the basis of total costs and benefits, to the extent that these can be quantified in dollars and cents. The Board also considered additional non-quantifiable factors, such as the authority's image, which they felt would be enhanced by continuing to take advantage of the latest technological innovations available to transit agencies. Furthermore, the Board probably tended to see only that portion of the system's costs which were locally funded. They had little incentive to recognize the 80 percent system costs contributed by the Federal Government as an important factor in whether or not the system should be extended to all UTA bus routes. Since they could have chosen to request UMTA to reallocate its grant monies to other UTA projects, the Board's decision suggests that they did not perceive the level of net costs estimated in this evaluation and/or that they failed to identify a preferable alternative use of the funds.

6.2 IMPLICATIONS FOR OTHER TRANSIT AGENCIES

This evaluation of the initial test version of the Buzz-a-Bus system in Salt Lake City has identified a number of impacts and factors which provide valuable information for other areas considering such systems. All regions are different, and thus the Salt Lake City results cannot be used to predict what will happen elsewhere with certainty. The results do, however, provide a number of valuable insights and cautions which can be expected to apply to any proposed CRIS system. These insights are summarized here as responses to the kinds of questions other transit agencies considering CRIS systems are likely to ask.

6.2.1 Should We Implement a CRIS System?

The experience in Salt Lake city to date does not provide a clear, unambiguous answer to this question. Ridership levels increased less (or decreased more) on test routes than on control routes. These results, however, have limited statistical significance and there is no basis for saying that the CRIS system caused this negative performance. The ridership results do, however, suggest that alternatives to CRIS systems should also be carefully evaluated. Such alternatives include various manual and partially automated systems which have been implemented recently in

Nashville, Washington, DC, Minneapolis-St. Paul, and other US and foreign cities.[1]

In terms of the net present value of a stream of expected future costs and benefits, Salt Lake City's initial experience with its CRIS system leads to the conclusion that such systems are not a prudent expenditure for public transit agencies. After considering all quantifiable costs and benefits expected in Salt Lake City, its CRIS system's net value in 1983 dollars is a negative amount greater than one million dollars.

The limitations of these findings, based as they are on UTA's experience to date with Buzz-a-Bus, must be recognized. On the positive side, there is every reason to expect that the final system, serving all of UTA's bus routes, will have a number of advantages over the limited test system. User information will be easier to disseminate because region-wide media--newspapers, radio, TV--will be usable more cost-effectively. Also, word-of-mouth "free" marketing will also become more prevalent. Thus, system usage could feasibly increase and the hoped-for increased ridership could result. On the negative side, both the initial and operating costs of a full system will be significant, and may only demonstrate their effectiveness if accompanied by a high level of system-specific marketing on a continued basis.

To sum up, other transit agencies should not base their decision on whether or not to implement a CRIS system solely on the Salt Lake City experience to date. Nor should they attempt to justify a system solely on

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[1] N.D. Lea, "Assessment of Transit Passenger Information Systems", Report No. UMTA-IT-06-0248-83-1, Washington, June 1983.

the basis of expected ridership increases, unless factors can be identified which point to different ridership impacts than those experienced in Salt Lake City. In any case, they should carefully consider alternative means of improving their information services and transit marketing, as well as programs which will improve the on-time reliability of their buses. If the decision is made to explore this possibility further, however, the answers to the remaining questions should be used to guide this exploration.

6.2.2 How Should a CRIS Implementation Project Be Structured?

Using the benefits of both hindsight and the viewpoint of observers not directly involved, a number of guidelines can be recommended to other transit agencies concerning the features to be sought in CRIS implementation projects. The difficulties and disagreements which occurred in Salt Lake City between UTA and its contractor provide the following factors which should be considered by other agencies:

- By accepting a more limited computer on loan at the beginning of the project, UTA apparently forfeited its ability to obtain the specified computer as originally scheduled. (See Section 1.5.4) This situation had no adverse impacts on the CRIS project, but did deprive UTA of additional computing power potentially usable in other aspects of transit operations and planning during the early portion of Phase I, prior to the operation of the full CRIS system.

- Conflicts occurred because UTA retained the right to provide final approval of the CRIS marketing program while the contractor's level of payment depended on the effectiveness of these marketing efforts. In the Salt Lake City case, these conflicts were resolved by giving the contractor a free hand with respect to the marketing program. Although no major problems occurred, this resolution was very risky: unequal emphasis on test and control routes and an inappropriate agency image are two potential dangers over which UTA lost its right of review.

- Perhaps because of the many complexities and contingencies in the CRIS contract, UTA was faced with requests from the contractor following the initial test period to renegotiate its terms. This further complicated UTA's internal evaluation of the system and caused additional delays in making the decisions required of it at various points during Phase I.

Other, more basic, aspects of the Salt Lake City CRIS project suggest revised structures for other agencies. To the extent that major decisions must be made at the highest level of transit management and at the transit board level (as, for example, on system acceptance or rejection at the conclusion of a Phase I test period), the required amount of time should be provided in the project plan and in the supplier's contract. The time schedule of the UTA/Teleride agreement assumes that these decisions would be made instantly; when instead they took about three months after the first test period, the entire agreement was placed in some degree of jeopardy due to the lack of timely performance.

The Salt Lake City experience also calls into question the value of an extended test period to determine the final system price at the beginning of a CRIS implementation. In spite of the 16 months devoted to this activity, the Buzz-a-Bus results were termed inconclusive by the UTA Board, and indeed were not statistically significant. The outcome has been the acquisition of a system at a relatively low initial dollar cost to the local area, but a number of other costs or disbenefits have resulted. Two of these are:

- Implementation of the full system has been delayed by at least two years over what could have been accomplished without a test period.

- Marketing for the CRIS system was made costly (on a unit basis) and difficult by the need to be narrowly focused on a few routes.

On the other hand, the statistical results suggest that if a conclusive test period is to be included in future CRIS projects, more data must be collected. This could be accomplished in a number of ways:

- Providing for a longer test period: this probably should be avoided for the reasons cited above.
- Including more routes in the test and control groups: this may be desirable also as a way to make the associated marketing effort more cost-effective; perhaps by including all routes in a selected sector of the city.
- Performing more frequent counts of bus ridership: since many agencies do already count passengers more frequently than the three times per month done by UTA on test and control routes, this alternative will often be a viable one.

A final point with respect to test periods for performance costing is that CRIS system suppliers may be increasingly reluctant to agree to such contracts in the future, in the light of the Salt Lake City experience. This is especially true with respect to the loan feature of the UTA agreement, but agreements to base payment schedules on ridership changes will probably continue to be negotiable.

6.2.3 What Implementation Strategy Should Be Adopted?

Proceeding under the assumption that implementation of a CRIS system is planned and that a test period for performance pricing is incorporated in the project, the Salt Lake City experience suggests that test and control routes should be selected with great care. The CRIS contractor claimed that this was not done in Salt Lake City, with the result that the two selected groups of routes did not represent a fair comparison. The contractor's subsequent analysis of past trends on these routes revealed variations in ridership changes over time rather than a desired long history of stable patterns. The contractor's desires may not have been realistic in the light of the long-range trends which can be expected on any set of urban transit routes, but these disagreements point to the need for both parties to study carefully, and then finally agree on, the test and control routes. The primary concerns of the transit agency should be to select representative sets of routes (keeping in mind the variations in potential advantages of a CRIS system on routes of varying lengths, headways, and types of service as discussed in Chapter 4) with the greatest possible degree of similarity between the routes in the test and control groups.

The selection of the agency's bus routes in particular sectors of the service area should be considered when test and control routes are chosen. This approach will simplify the marketing process and make it easier to provide information on the availability and use of the system on an areawide basis.

If a test period is oriented mainly to operational concerns rather than to determining ridership impacts, then routes should be selected for which a CRIS system is most likely to be effective. Ideal candidate routes in this case will be those which are:

- longer than average,
- lower frequency than average,
- relatively high emphasis on off-peak and/or weekend service, and
- not express only.

By selecting these types of routes, transit agencies will ensure that the early system operational tests will demonstrate the most effective use of this innovative transit technology.

6.2.4 <u>What Are the Implications for Transit Marketing?</u>

Whether or not transit marketing efforts are oriented primarily to a CRIS system, the Salt Lake City CRIS-related experience provides a number of guidelines for other transit operators. This experience demonstrates that transit marketing efforts with a sharp geographic focus represent major difficulties in reaching the intended audience and in getting the desired messages to this audience economically and effectively. For the CRIS project, these difficulties became evident following the initial attempt to use the mail system for distribution of materials to residences. Subsequent surveys and system results indicated that this attempt was not successful: CRIS system usage levels were low, many bus passengers were not aware of the system, and those that were usually credited on-bus advertising rather than direct-mail materials as the source of their information.

Subsequent marketing efforts using door-to-door distributions were found to be more effective. As the results in Section 4.2 show, the focused marketing efforts did have a measurable impact on CRIS system usage and test route ridership. This impact was costly and short-lived, however, and appears to have been stronger on the control routes than on the test routes. These results suggest that other operators should consider the strategy of directly-distributed route-specific marketing on a regular basis as a means of attracting riders, if the costs of these efforts can be reduced significantly. The apparently short-term nature of the impacts of this marketing strategy suggest that individuals are not changing their basic habitual travel patterns, but that for a few weeks they are deciding to use transit more often for infrequently-made trips.

By tying localized distributions with the marketing for typical destinations of non-work trips (shopping and amusement facilities, for example) transit agencies can further promote these types of ridership increases, and also have "excuses" for repeated distributions to the same residential areas while minimizing the likelihood that successive distributions will have diminished impacts.

Appendix A. Examples of CRIS Marketing Materials

Figures A-1 through A-4 contain copies of a number of the printed materials used in the three marketing efforts (January and May 1983, and January 1984). Figure A-5 is a reproduction of the reflectorized panel added to all existing bus stop signs on the CRIS test routes. At each bus stop, the last four digits of the stop-specific telephone number was added following the "264-".

GIVE US A BUZZ!

BUZZ UTA BUS at 264-____

If you find that the inconvenience of trying to figure out schedules, waiting for buses (and wondering whether you've just missed one) makes taking the bus too much of a problem—UTA has the solution for you. It's called BUZZ-A-BUS.

Your bus stop sign will tell you more....

- *a quick phone call to your BUZZ-A-BUS number*
- *located on your bus stop sign*
- *will tell you when the next two buses arrive at your bus stop*
- *there is no charge for this service*
- *call as often as you like!*

Now, in your neighborhood! Bus travel with ease! UTA's BUZZ-A-BUS system is being introduced on a special test basis.

People in your area are getting to try it first!

However, the system has been tried and proven all over North America. People who use it find it saves them a lot of time and bother. They're leaving their cars at home more often because taking the bus is more convenient.

Your bus stop has a phone number. It begins with 264-

Check the map of your route that we've included. Beside every stop there's a phone number. Dial that number and a friendly computer answers within 10 seconds. (There's never a busy signal).

It will say something like "NEXT BUS IN 14 MINUTES. FOLLOWING BUS IN 44 MINUTES."

That means the bus will arrive at the stop you've dialed in 14 minutes and there'll be another along in 44 minutes if you want to relax and have a chat with the family.

Your three easy steps to convenient bus travel.

__ONE__ Enclosed are special stickers. Jot down the number of your outbound (going away from downtown) and inbound (going towards downtown) bus stop numbers.

__TWO__ Put the stickers by your phones. (It's a good idea to keep this map handy too—in case you want to call stops near your shopping center, or whatever.)

__THREE__ Next time you're taking the bus, give your stop number a buzz—and enjoy convenient, problem-free travel.

WIN!! $600.00 worth of UTA bus passes.

No entry required.

Just fill out the enclosed stickers and put them on your phones.

During the next few weeks, UTA information operators will call households in this area at random.

If you can tell the operator your bus stop's BUZZ-A-BUS number, you could win.

FIGURE A-1. Portion of Mailing to Residences along CRIS Routes, January 1983

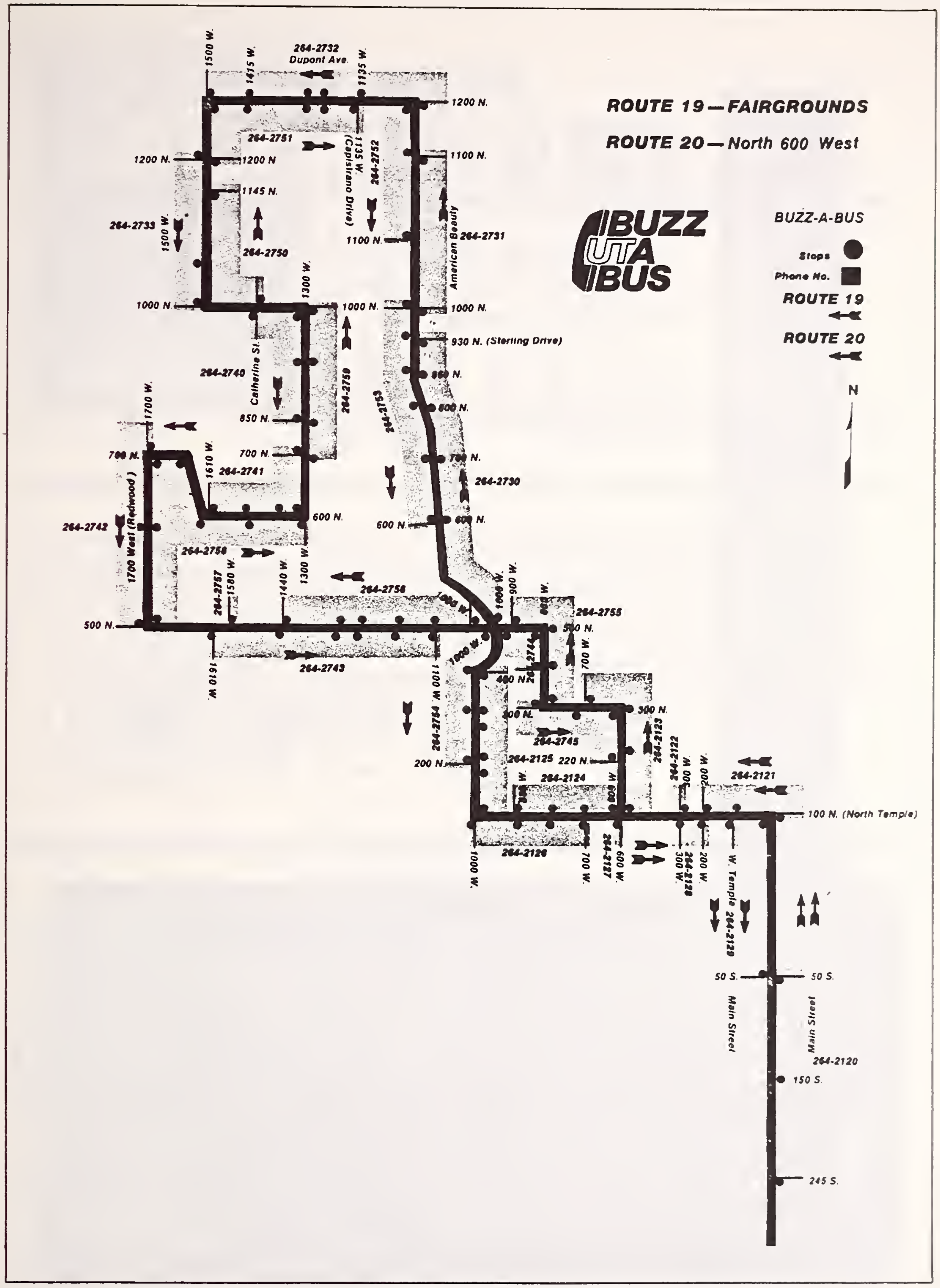


FIGURE A-2: Map Mailed/Distributed to Residences along CRIS Routes, January and May 1983

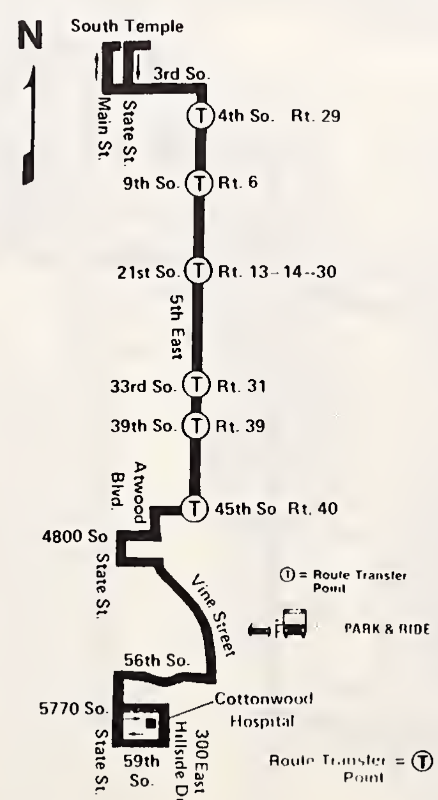
There's never been a better time for riding the bus! With more routes and more buses, UTA is making bus travel more pleasant and more convenient than ever before.

To make riding the bus even easier, we have printed the bus route for your area in this brochure. Then all you do is catch the bus that is most convenient for you! Be sure to check the fare schedule in this brochure so you can have the exact fare ready when you board the bus. Then just sit back and relax while UTA gets you right where you want to go.

If you have any questions about bus routes, fares and schedules, give UTA a call. Our information office can be reached by calling 263-3737. Monday-Saturday from 6 a.m. to 7 p.m. In Ogden, call 621-5862.

UTA Route

10



UTA Fare Schedule.

Cash Fares. Fare Category	**Off-Peak Hours***	**Peak Hours****
Standard	.40	.50
Senior Citizen/Handicapped	.20	.25
Children 5 Years and Younger	FREE	FREE
Subscription/Commuter/Express	—	.60
Transfers	FREE	FREE
Each Additional Zone (after first two):		
Standard	.40	.50
Senior Citizen/Handicapped	.20	.25
Subscription	—	.50

Monthly Passes: Fare Catergory	**Two Zones**	**Three Zones**	**Four Zones**
Standard	$18	$36	$54
Student	$13	$26	$39
Senior Citizen /Handicapped	$ 9	$18	$27
Subscription /Commuter/Express	$22	$40	—

*Non-Peak Hours: Monday-Friday, 8:30 a.m. to 3:30 p.m. and after 5:30 p.m.; all day Saturday; all day Sunday (airport bus service only)

**Peak Hours: Monday-Friday, before 8:30 a.m. and 3:30-5:30 p.m.

FIGURE A-3: Flier Distributed to Residences along Control Routes, January and May 1983

GIVE US A BUZZ!

BUZZ UTA BUS at 264-____

UTA's new BUZZ-A-BUS service makes riding the bus as easy as picking up the phone!

ROUTE 19/20 FAIRGROUNDS

The BUZZ-A-BUS System.

BUZZ-A-BUS is a computer-updated telephone service that puts current information about your UTA bus route at your fingertips.

Here's how BUZZ-A-BUS works:

1. *Look at the BUZZ-A-BUS phone number list below and find your bus stop.*
2. *Add the four-digit number listed by your stop to the BUZZ-A-BUS phone prefix, 264-____.*
3. *Write down your BUZZ-A-BUS number and keep it by your phone (use the space provided on the front of this brochure).*
4. *Now just pick up the phone and dial your BUZZ-A-BUS number!*

The BUZZ-A-BUS Service.

When you call your BUZZ-A-BUS number, the computerized system will answer your call quickly and tell you when the next two buses are due to arrive at your stop. It will say something like, "Next bus in 14 minutes. Following bus in 44 minutes."

With BUZZ-A-BUS, there's no more wondering about bus arrival times. No more unnecessary waiting at bus stops. And the service is free, so you can call as often as you like!

ROUTE 19 FAIRGROUNDS

Stops From Downtown	Phone No.
245 S./Main Street to 150 S./Main Street to 50 S./Main Street to	264-2120
100 N. (North Temple)/Main Street to 100 N./West Temple to 100 N./200 W. to	264-2121
100 N./300 W. to	264-2122
100 N./600 W. to 100 N./800 W. to 100 N./880 W. to	264-2124
100 N./1000 W. to 200 N./1000 W. to 300 N./1000 W. to 400 N./1000 W. to	264-2125
500 N./100t W. to 600 N./1000 W. to 700 N. (Signore Drive)/1000 W. to 800 N./1000 W. to 860 N. (Pinnocchio Drive)/1000 W. to 930 N. (Sterling Drive)/1000 W. to	264-2730
1000 N./1000 W. to 1100 N./1000 W. to 1200 N./1000 W. to	264-2731
Dupont Ave./American Beauty to Dupont Ave./1135 W. (Capistreno Drive) to Dupont Ave./1200 West to Dupont Ave./1285 W. (Sonete St.) to Dupont Ave./1335 W. (Colorado St.) to Dupont Ave./1415 W. to Dupont Ave./1500 W. to	264-2732
1500 W./1200 N. to 1500 W./1145 N. (Goodwin Ave.) to 1500 W./1000 N. to	264-2733

Stops To Downtown	Phone No.
1000 N./Catherine St. to 1300 W./1000 N. to 1300 W./900 N. to 1300 W./850 N. to	264-2740
1300 W./700 N. to 1300 W./600 N. to 1610 W./600 N. to	264-2741
700 N./1700 W. (Redwood Road) to 610 N. (Northwood Ave.)/1700 W. to 500 N./1700 W. to	264-2742
500 N./1580 W. (Montgomery Street) to 500 N./1440 W. to 500 N./1340 W. (Colorado Street) to 500 N./1300 W. to 500 N./1100 W. to	264-2743
500 N./1000 W. to 500 N./900 W. to 400 N./800 W. to	264-2744
800 W./300 N. to 600 W./300 N. to 600 W./200 N. to	264-2745
100 N./600 W. to	264-2127
100 N./300 W. to 100 N./200 W. to	264-2128
100 N. (North Temple)/to W. Temple to	264-2129

ROUTE 20 North 600 West

Stops From Downtown	Phone No.
245 S./Main Street to 50 S./Main Street to	264-2120
100 N. (North Temple)/Main Street to N. Temple/W. Temple to 200 W./N. Temple to	264-2121
300 W./N. Temple to	264-2122
N. Temple/600 W. to 220 N./600 W. to 300 N./700 W. to	264-2123
800 W./300 N. to 900 W./500 N. to	264-2755
500 N./1000 W. to 500 N./1440 W. to	264-2756
500 N./1500 W. to	264-2757
500 N./1700 West (Redwood Street) to 610 N. (Northwood Avenue)/1700 W. to 700 N./1700 W. (Redwood Street) to 700 N./1610 W. to	264-2758
600 N./1590 W. to 600 N./1440 W. (Catherine Street) to 600 N./1340 W. (Colorado Street) to 600 N./1300 W. to	264-2758
700 N. (Lafayette Street)/1300 W. to 850 N./1300 W. to 900 N./1300 W. to 1000 N./1300 W. to	264-2759

Stops To Downtown	Phone No.
1000 N./Catherine Street to 1500 W./1145 N. to	264-2750
1500 W./1200 North to 1135 W./(Capistreno Drive)/Dupont Avenue to	264-2751
Dupont Avenue/American Beauty to 1200 N./American Beauty to 1100 N./American Beauty to	264-2752
1000 W./1000 N. to 1000 W./600 N. to	264-2753
500 N./1000 W. to 200 N./1000 W. to	264-2754
100 N. (North Temple)/1000 W. to 100 N./900 W. to 100 N./800 W. to 100 N./700 W. to	264-2126
100 N./600 W. to	264-2127
100 N./300 W. to 100 N./200 W. to	264-2128
100 N. (North Temple /100 W. (West Temple) to	264-2129

FIGURE A-4: Portion of Material Distributed to Residences along CRIS Routes, January 1984

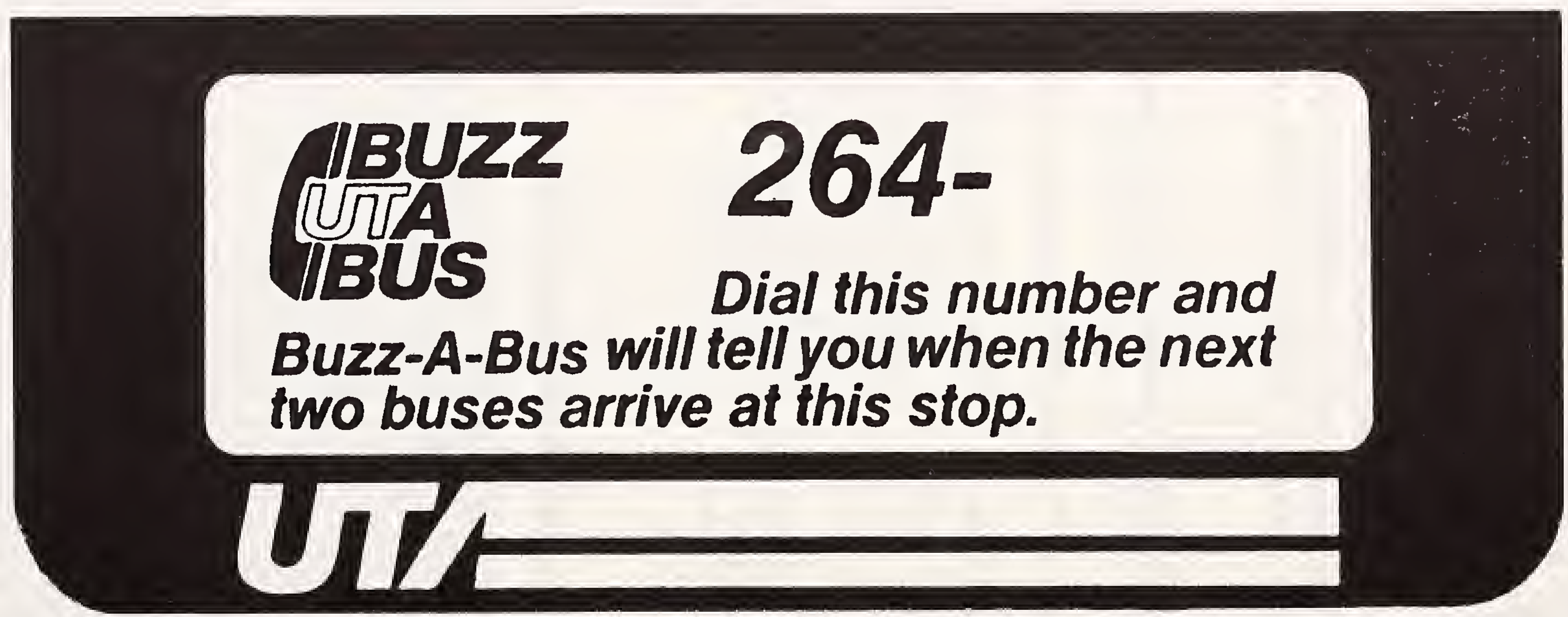


FIGURE A-5: Reflectorized Panel Added to Existing Bus Stop Signs

Appendix B. Statistical Significance of Transit Ridership Measurements

To quantify the variability of UTA's ridership data while at the same time recognizing seasonal trends as non-random components of this variability, the standard deviation of annual fractional changes in observed pseudo-week ridership at the route level was used. The value of this standard deviation (S) was estimated using data representing annual changes by month for all of UTA's non-CRIS test and control routes for the months of February through July, 1983; this value was 0.273. This value can be used to infer a value for variability of the basic daily counts, where variability (V) is defined as the ratio of these counts' standard deviation to their mean value. The derivation of this variability as a function of S follows.

First, annual fractional changes can be defined in terms of bus route counts as these are performed by UTA:

$$F = \frac{TB - TA}{TB} \qquad (1)$$

where:

F is an annual fractional change in observed pseudo-week ridership on a particular bus route for a particular month

TB is the pseudo-week ridership on the bus route for the month in the previous year

TA is the pseudo-week ridership on the bus route for the month in the current year

Further;

$$TB = 2.5\ (TBW1 + TBW2) + TBS \qquad (2)$$

$$TA = 2.5\ (TAW1 + TAW2) + TAS$$

where:

TBW1, TBW2, TAW1, and TAW2 are weekday counts in a particular month

TBS and TAS are Saturday counts in a particular month

The variance of F (S^2) can be expressed as a function of the daily counts and their variances based on the following general formula:

$$S^2 = \left\{\frac{\partial F}{\partial TBW1} \cdot S_{TBW1}\right\}^2 + \left\{\frac{\partial F}{\partial TBW2} \cdot S_{TBW2}\right\}^2 + \left\{\frac{\partial F}{\partial TBS} \cdot S_{TBS}\right\}^2 + \left\{\frac{\partial F}{\partial TAW1} \cdot S_{TAW1}\right\}^2 + \left\{\frac{\partial F}{\partial TAW2} \cdot S_{TAW2}\right\}^2 + \left\{\frac{\partial F}{\partial TAS} \cdot S_{TAS}\right\}^2 \quad (3)$$

If we assume the following:

$$V = \frac{S_{TBW1}}{M_{TBW1}} = \frac{S_{TBW2}}{M_{TBW2}} = \frac{S_{TBS}}{M_{TBS}} = \frac{S_{TAW1}}{M_{TAW1}} = \frac{S_{TAW2}}{M_{TAW2}} = \frac{S_{TAS}}{M_{TAS}} \quad (4)$$

$$M_W = M_{TBW1} = M_{TBW2} = M_{TAW1} = M_{TAW2} \quad (5)$$

$$M_S = \frac{1}{3} M_W = M_{TBS} = M_{TAS} \quad (6)$$

where:

M_X is the mean value of variable x

M_W is the mean value of a weekday count

M_S is the mean value of a Saturday count

Then Equation 3 can be simplified to the following equation:

$$S^2 = 0.887\ V^2\ (1 - F)^2 \quad (7)$$

When the value for S from above (0.273) and the average value for F during the second test period (-0.0463) are substituted in Equation 7, V is estimated to be 0.277.

The standard deviations of other fractional changes and of increase factors can in turn be expressed in terms of V, the variability of individual daily counts, using the same means of derivation shown in Equations 1 through 7. The results are:

$$V_{F_{MR}} = \frac{0.941\ (1-F_{MR})\ \ V}{\sqrt{MR}} \tag{8}$$

$$V_{IF_{MR}} = 0.941 \sqrt{\frac{(1 - F_T)^2 + (1 - F_C)^2}{MR}} \cdot V \tag{9}$$

where:

$V_{F_{MR}}$ is the variability of a fractional change, F_{MR}, measured over M months and R routes

$V_{IF_{MR}}$ is the variability of an Increase Factor measured over M months, R test routes, and R control routes.

F_T and F_C are the fractional changes measured on the test and control routes

Equations 8 and 9 can be approximated quite accurately for small fractional changes by assuming that F_{MR}, F_T, and F_C all equal zero. Then, after substituting the value found for V (0.277), the following expressions are obtained:

$$V_{F_{MR}} \quad \frac{0.261}{\sqrt{MR}} \tag{10}$$

$$V_{IF_{MR}} \quad \frac{0.368}{\sqrt{MR}} \tag{11}$$

These approximate expressions for variability imply the standard deviations shown in Table B-1 for a number of the measures of percentage changes and Increase Factors which are relevant in this evaluation. Throughout Chapter 4, the values shown in Table B-1 can be used to measure the statistical significance of percentage changes and Increase Factors. If the calculated values of these measures are greater than two times their standard deviations, there is a 95 percent probability that the measures are significant. This criterion has been applied throughout Chapter 4: percentage changes and Increase Factors are termed <u>statistically</u> <u>significant</u> if their values exceed twice the approximate standard deviations shown in Table B-1.

TABLE B-1: Approximate Standard Deviations for Bus Ridership Measures

Number of Routes	Number of Months	Standard Deviations: Percentage Changes	Standard Deviations: Increase Factors
1	1	± 26.1	± .368
1	6	± 10.7	± .150
1	16	± 6.5	± .092
5	1	± 11.7	± .165
5	6	± 4.8	± .067
5	16	± 2.9	± .041
72	1	± 3.1	-
72	6	± 1.3	-
72	12	± 0.9	-

Appendix C. On-Board Survey Questionnaire

The questionnaire used in the on-board survey discussed in Section 3.3 is reproduced in Figure C-1.

In order to provide better transit to you the rider we would appreciate your time for filling out this questionnaire. Please indicate an x beside the correct answer and return this questionnaire to the driver

OFFICE USE ONLY

Bus Route No ________ (1-2)

Present Time ________ (3-4)

1. How many bus ridas do you take on average in e week? (5-6)

(round trip = 2 rides, trip with transfer = 1 ride)

2. During the last tour weeks, have you taken the bus during the following time periods? (7)

- ☐ 1 RUSH HOUR - MORNING (7:00 a.m. to 8:30 a.m.)
- ☐ 2 - AFTERNOON (3:30 p.m. to 5:30 p.m.)
- ☐ 3 OTHER

3. What method of fere payment do you use? (8)

- ☐ 1 TOKENS
- ☐ 2 CASH
- ☐ 3 PASS

4. Your ege catagory is: (9)

- ☐ 1 12 TO 17
- ☐ 2 18 TO 24
- ☐ 3 25 TO 44
- ☐ 4 44 TO 65
- ☐ 5 OVER 65

5. Your current occupation is: (10)

- ☐ 1 WHITE COLLAR
- ☐ 2 BLUE COLLAR
- ☐ 3 HOMEMAKER
- ☐ 4 STUDENT
- ☐ 5 RETIRED
- ☐ 6 UNEMPLOYED

6. Heve you heard about the "BUZZ-A-BUS" telephone information service? (11)

- ☐ 1 YES
- ☐ 2 NO (If NO, stop here)

7. How did you first heer about tha "BUZZ-A-BUS" system? (12)

- ☐ 1 FLYER IN THE MAIL
- ☐ 2 MEDIA ADVERTISING
- ☐ 3 UTA CUSTOMER SERVICE
- ☐ 4 BUS ADVERTISING
- ☐ 5 WORD OF MOUTH
- ☐ 6 BUS STOP DECAL

8. Do you have e sticker with your "BUZZ-A-BUS" stop number on it, on or naer your phone? (13)

- ☐ 1 YES
- ☐ 2 NO

9. Do you know how to use the "BUZZ-A-BUS" system? (14)

- ☐ 1 YES
- ☐ 2 NO (If NO, stop here)

10. Do you know the "BUZZ-A-BUS" stop number naar your homa? (15)

- ☐ 1 YES
- ☐ 2 NO

11. Have you ever usad tha "BUZZ-A-BUS" system? If YES, how often? (16)

- ☐ 1 AT LEAST ONCE A DAY
- ☐ 2 ALMOST EVERY DAY
- ☐ 3 SEVERAL TIMES
- ☐ 4 ONLY ONCE
- ☐ 5 NEVER/NO (If NO, stop here)

12. Did you call "BUZZ-A-BUS" before starting your lest bus trip? (17)

- ☐ 1 YES
- ☐ 2 NO

13. What was the main purpose of the trips for which you used "BUZZ-A-BUS"? (18)

- ☐ 1 WORK
- ☐ 2 SCHOOL
- ☐ 3 SHOPPING
- ☐ 4 SOCIAL/RECREATIONAL
- ☐ 5 OTHER (Specify ________)

14. Do you understend tha "BUZZ-A-BUS" talephona message? (19)

- ☐ 1 YES
- ☐ 2 NO
- ☐ 3 NO I USUALLY CALL BACK TO TRY AND UNDERSTAND AGAIN

15. Do you have any comments or suggestions concerning "BUZZ-A-BUS"? (20) (21) (22)

____

____

16. Dete ot Survey? ☐☐☐☐ (23-26)

M M U U

THANK YOU FOR FILLING OUT THIS QUESTIONNAIRE. YOUR HELP HAS BEEN MOST APPRECIATED.

FIGURE C-1: Questionnaire Used for Test Route On-Board Survey

Appendix D. UTA Ridership Models

In this appendix, a structural model is described which explains ridership levels for CRIS routes, control routes, and for the entire UTA system. Its purpose is to determine the impact of CRIS and the volume of CRIS calls on ridership levels, taking into account plausible explanatory variables.

Ordinary least squares regressions were run on monthly time-series data from January 1980 to May 1984 with the ridership levels of two groups of routes as dependent variables (see Figure D-1):

- PAXCRISA: Weekday count of total CRIS test route ridership
- PAXCNTLA: Weekday count of total control route ridership

The following independent variables were available for use either directly or following transformation (see Figures D-2 to D-5 and Figure 3-7):

- UERATE Average monthly unemployment rate in the Salt Lake City-Ogden Labor Market Area (LMA), as recorded by the Utah Department of Employment Security
- TEMP: Average monthly temperature in degrees Fahrenheit, as recorded at the Salt Lake City Airport by the National Oceanic and Atmospheric Administration
- PFAREA: Average UTA cash fare for a one-way bus trip in constant 1967 dollars[1]
- PGASA: Average retail full-service price for one gallon of unleaded gasoline in the Salt Lake City area as reported by the American Automobile Association, in constant 1967 dollars[1]
- CRIS: Computerized Rider Information System availability for th initial test routes (1 for all months since February, 1983; 0 otherwise)
- VOLCRIS: Monthly volume of CRIS calls increasing one unit per month thereafter
- SPRING: Dummy variable with a value of 1 for the months March, April, and May; 0 otherwise

---

[1] Converted to 1967 dollars using the Consumers Price Index for all Urban Consumers (CPI-U).

Several sets of regressions were run on the two weekday count dependent variables. The most significant results are presented in Table D-1. These results are discussed in Section 4.1.

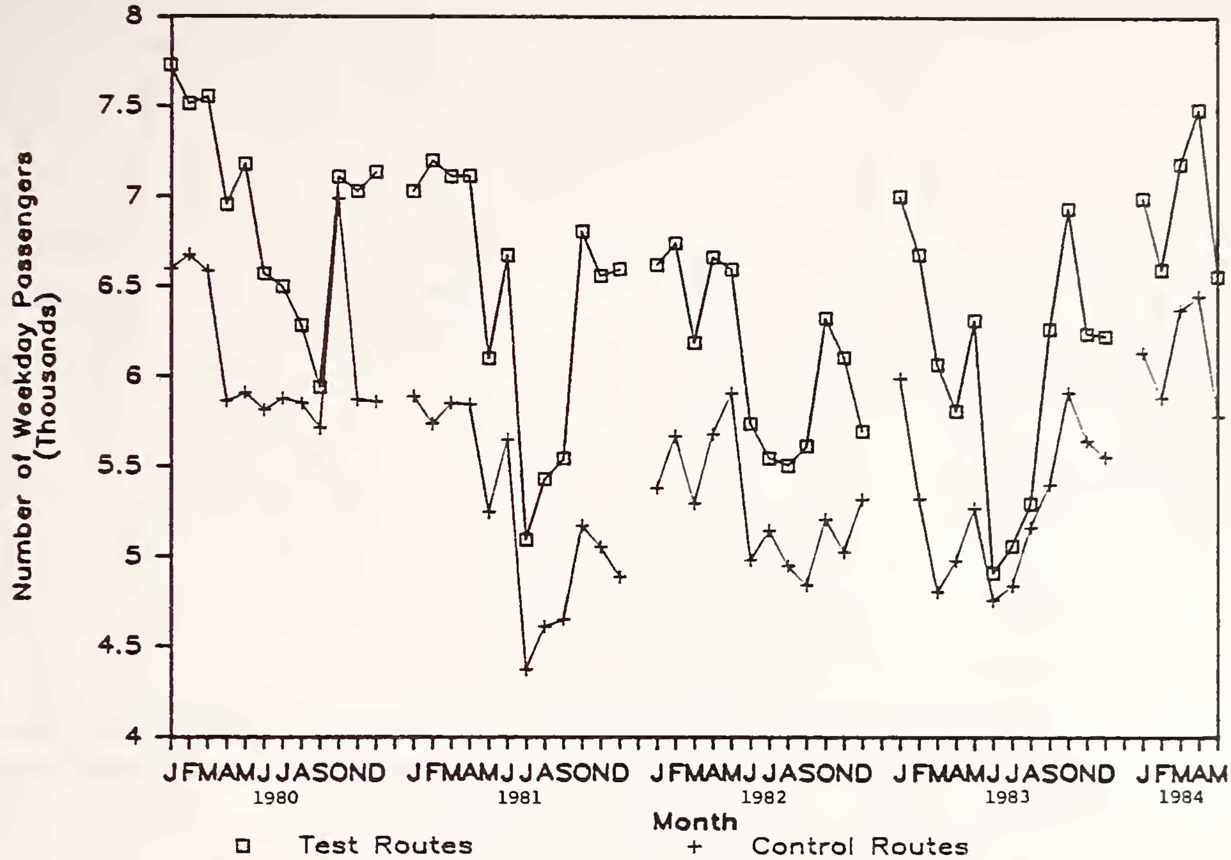


FIGURE D-1: CRIS Route Weekday Ridership by Month

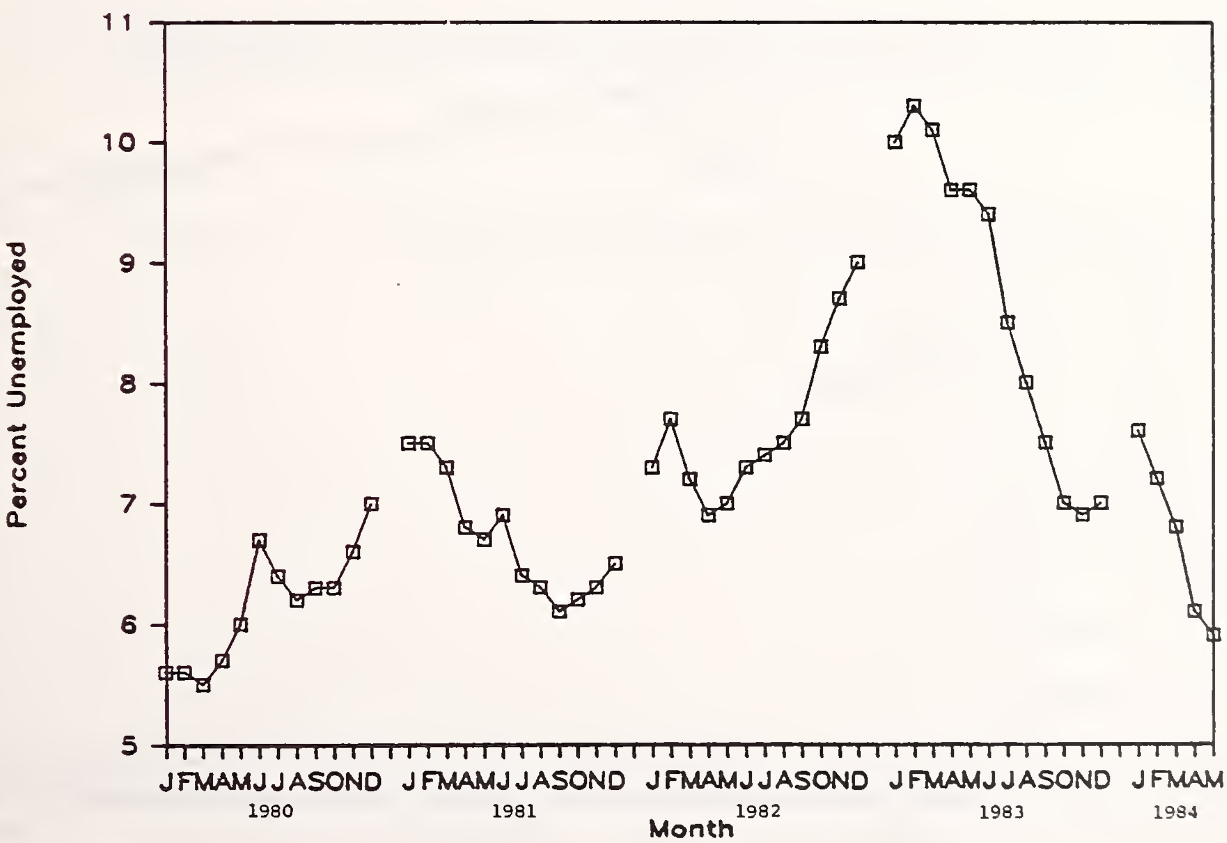


FIGURE D-2: Salt Lake City Area Unemployment Rates by Month

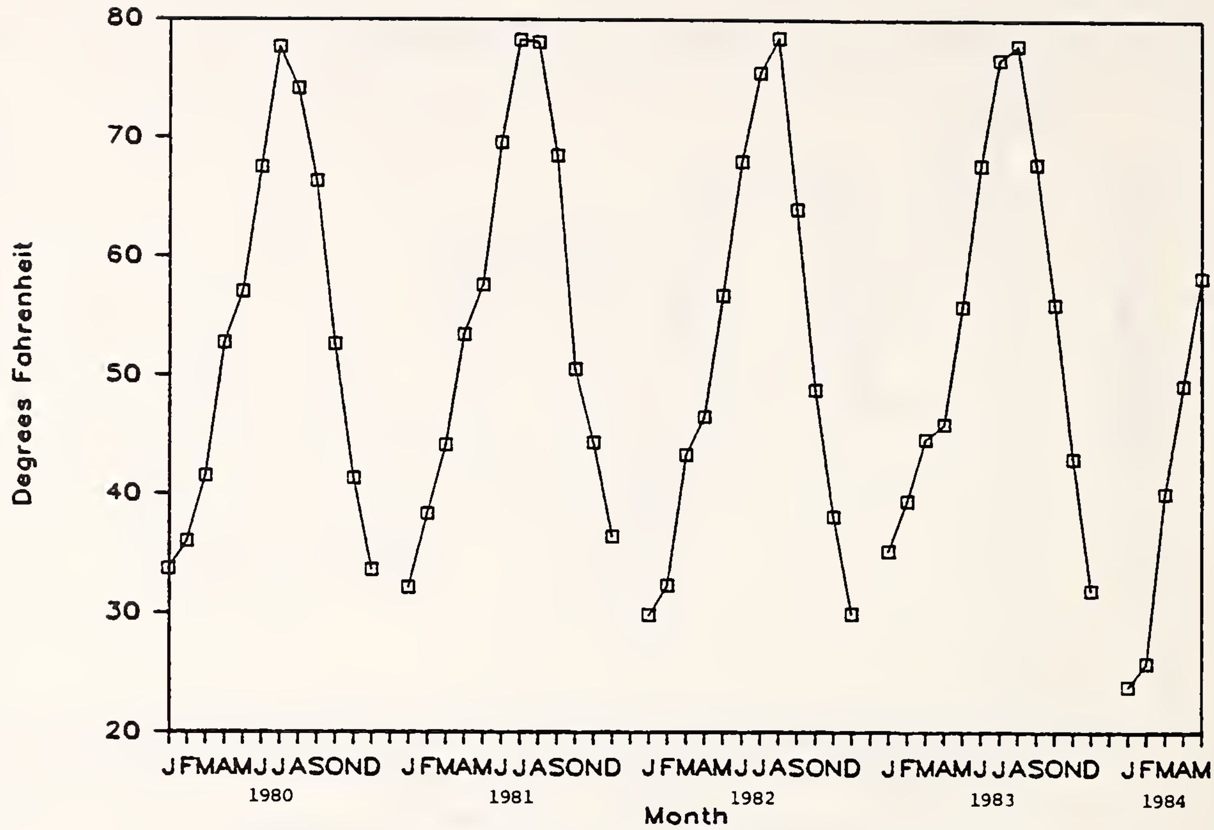


FIGURE D-3: Salt Lake City Average Temperatures by Month

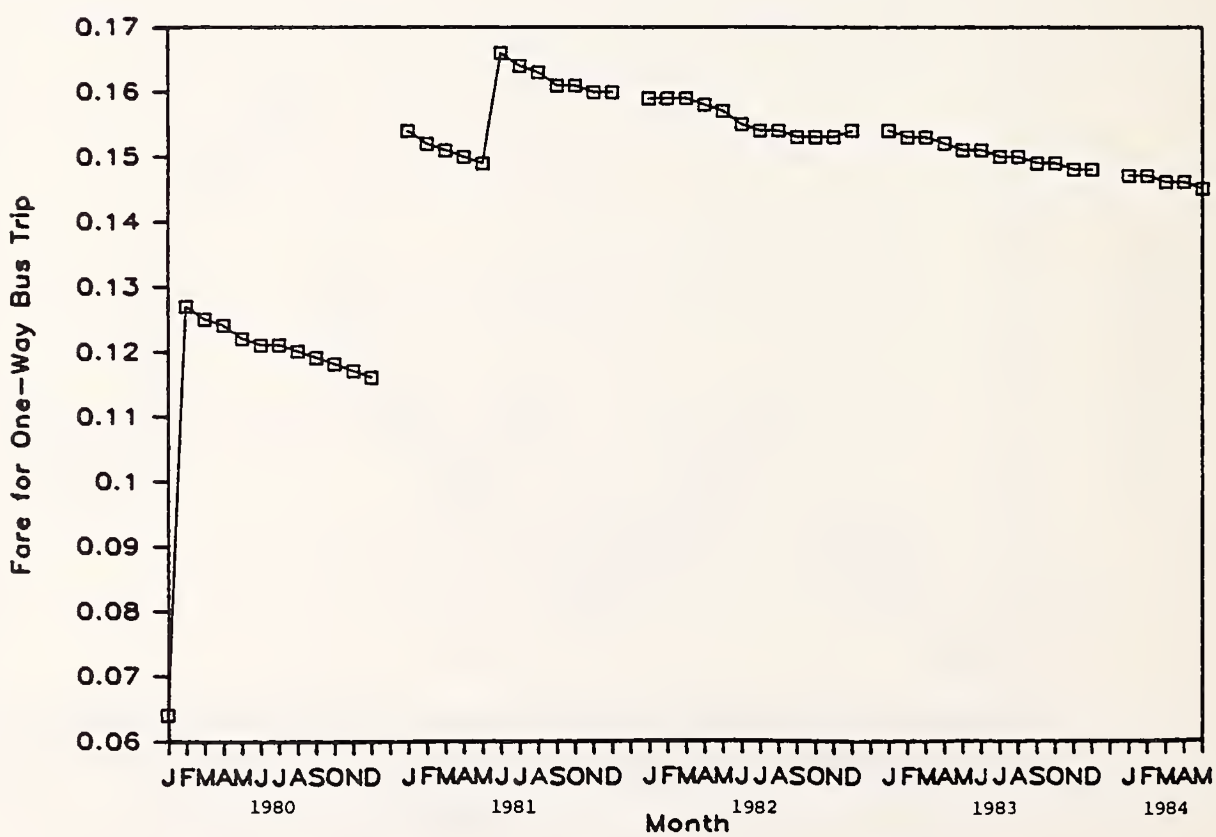


FIGURE D-4: UTA Fare Price in 1967 Dollars by Month

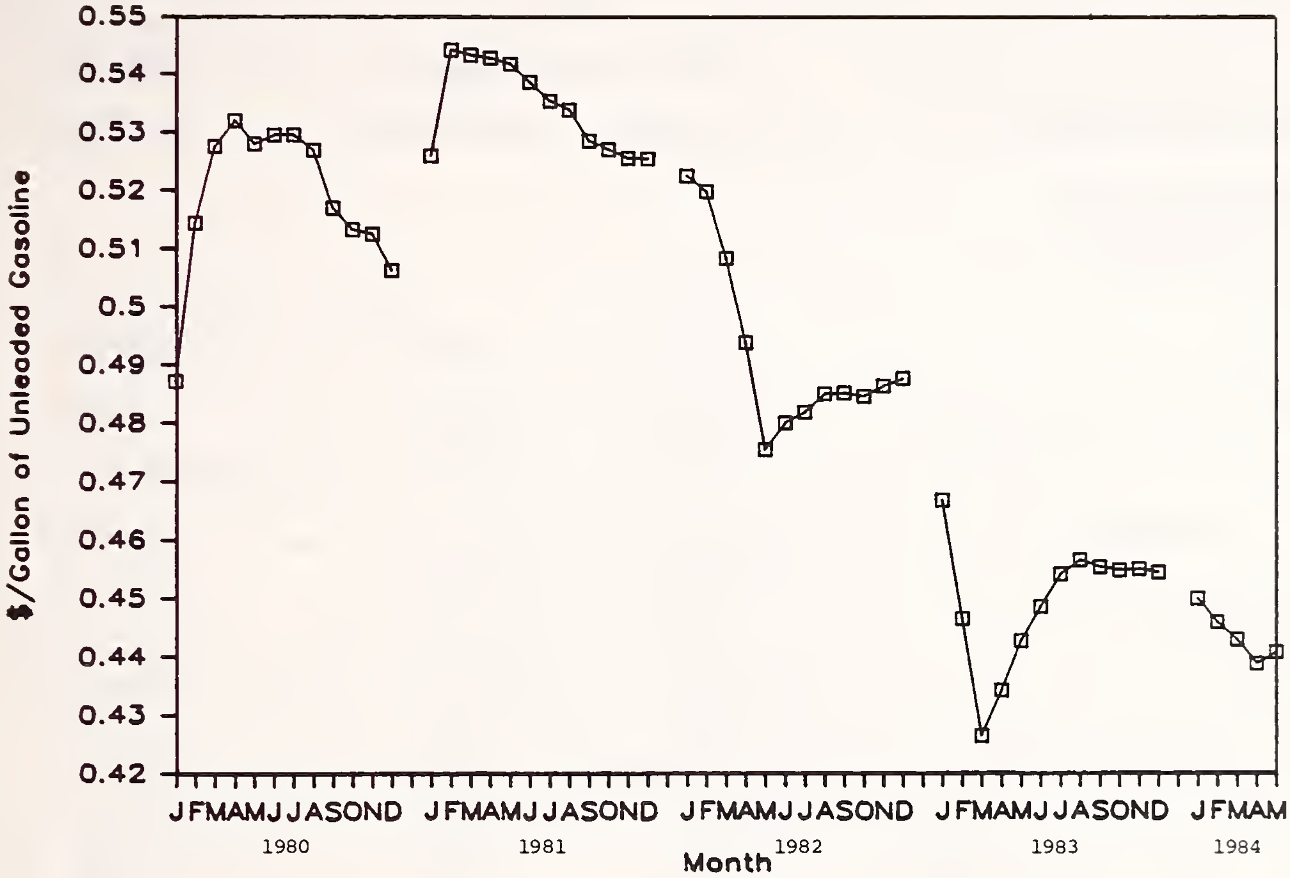


FIGURE D-5: Unleaded Gasoline Prices in 1967 Dollars by Month

TABLE D-1: Structural Ridership Equations

		CRIS Test Routes		Control Routes
Dependent Variables:		PAXCRISA	PAXCRISA	PAXCNTLA
Coefficient Values with t-statistics (in parenthesis):				
Constant		8210	8551	10090
UERATE	Unemployment Rate	-149* (-2.4)	-142* (-2.2)	-152* (-2.5)
TEMP	Temperature	-25.5* (-6.9)	-26.4* (-7.2)	-14.0* (-4.1)
PFAREA	Bus Fare	-11420* (-3.2)	-11386* (-3.2)	-15124* (-4.6)
PGASA	Gasoline Price	4327 (1.6)	3666 (1.1)	-1191 (-0.4)
CRIS	CRIS System Dummy	____	139 (0.6)	65 (0.3)
VOLCRIS	Volume of CRIS Calls	0.0716 (1.1)	____	____
SPRING	Season Dummy	315* (2.4)	323* (2.5)	180 (1.5)
Point Elasticity with respect to:				
fare		-0.26	-0.26	-0.40
gas price		+0.33	____	____
volume of CRIS calls		+0.01	____	____
R^2:		0.69	0.68	0.61
Standard Errors of Estimate:		412	416	385
F-Statistics:		16.8	16.3	11.8

* Signifies statistical significance at the 95 percent confidence level.

Appendix E. CRIS Usage Models

Ordinary least squares regressions were run on a data set containing daily information from February 1983-March 1984 on number of CRIS calls, weather, marketing, and base/trend variables. The dependent variable was the number of CRIS calls per day. The independent variables are described below.

E.1 BASE/TREND VARIABLES

In addition to the constant, three other base/trend variables were specified as independent variables: SUNDAY, HOLIDAY and TREND. SUNDAY and HOLIDAY refer to the data point being a Sunday or holiday, respectively. TREND is a trend variable, taking a value of one for the first observation (first day of CRIS implementation) and increasing by one for each subsequent day. One more potential base variable, SUMMER (one for all days in June, July, or August; zero otherwise), was tried but found not to be significant.

Calls to the CRIS system were expected to be less frequent on Sundays and holidays, days on which UTA does not provide service. Also, as seen in Figure 3-8 (see main text, Section 3.2), there appears to be a negative trend from CRIS implementation up to the period of the third marketing activity, which took place in January 1984.

E.2 WEATHER

Two weather variables were specified: AVGTEMP and PRECIP. AVGTEMP is the average daily temperature in degrees Fahrenheit. PRECIP is the daily amount of precipitation in inches. Both of these measures were obtained from National Climatic Data Center observations at the Salt Lake City airport weather station.

It is hypothesized that passengers will call more often in bad weather, because they perceive bus reliability to be poorer and they find it unpleasant to wait for buses on days which are cold and/or rainy.

E.3 MARKETING ACTIVITIES

Three major marketing activities have taken place. On January 28, 1983, initial major marketing was implemented with direct mail going to 48,000 households, half of which were along CRIS routes. At the end of May 1983, test marketing was done in the area served by two routes (19 and 20) using direct distribution. During the third week of January 1984, there were door-to-door handouts on all test and control routes.

As seen in Figure 3-8, there appears to be a strong correlation between marketing activities and the CRIS call rate. However, marketing impacts appear to diminish significantly after a month has elapsed following completion of the marketing activity. These diminishing impacts of marketing activities can be tested in the regression analysis. For each of the marketing activities, a maximum of two periods of impact will be specified. The first of these periods is the actual period in which the marketing activity occurred. The second period is generally a three to four-week period subsequent to the actual marketing activity. The second impact period, in turn, is split up into the first, second, third, and fourth weeks after the marketing activity where appropriate.

The first marketing effort differs from the later efforts in two significant ways related to its timing just prior to the startup of the CRIS system. First of all, this timing means that the "during marketing" impact period did not exist for this marketing effort. Secondly, CRIS usage was abnormally high in its first month of operation, at least partially due to the curiosity factor which resulted in many CRIS calls being made for testing or trial purposes rather than information gathering purposes. Since the novelty period and the first "after marketing" period coincided, the regression results can only measure their combined impacts on CRIS calls.

Variables for the two impact periods (during and after marketing) are labeled MRKTGm and MRKTGmWn, respectively, with m indicating the first to third activities and n indicating the first to fourth weeks subsequent to activity m.

E.4 MULTIVARIATE ANALYSIS RESULTS

More than two-thirds of the variation in the number of CRIS calls was explained by the base/trend, weather, and marketing variables (see Table E-1). Most of the hypothesized impacts proved to be statistically significant. The model and its implications for this evaluation are discussed in Section 4.2.

TABLE E-1: Regression Results: Daily CRIS Calls Versus Weather and Marketing Factors

Independent Variable	Coefficients	t-Statistics
CONSTANT	166	
SUNDAY	-96.0*	-15.05
HOLIDAY	-35.0*	-2.57
TREND	-.044	-1.86
AVGTEMP	-.943*	-6.33
PRECIP	-17.1	-1.07
MRKTG1W1	274*	11.87
MRKTG1W2	161*	9.06
MRKTG1W3	145*	8.16
MRKTG1W4	71.6*	4.34
MRKTG2	50.1*	1.96
MRKTG2W1	62.8*	3.70
MRKTG2W2	31.5	1.42
MRKTG2W3	-11.3	-0.67
MRKTG3	102*	6.13
MRKTG3W1	62.2*	3.62
MRKTG3W2	34.2*	1.96
MRKTG3W3	54.7*	2.95
MRKTG3W4	84.8*	4.90
R^2	.674	
$\bar{R}^2$	.642	
Standard Error of Equation (CRIS calls per day)	43.8	
Mean value of Dependent Variable (CRIS calls per day)	111.	

* Signifies statistical significance at the 95 percent confidence level.

Appendix F. Customer Service Models

F.1 MODEL VARIABLES

Ordinary least squares regressions were run on data sets containing one observation per UTA bus route. For each route, the following variables were available for use either directly or following transformation:

- TINQPP: total Customer Service inquiries per 1000 passengers
- SINQPP: Customer Service schedule inquiries per 1000 passengers
- EXPRESS: equals 1 if the route operates as a peak period-only express service; 0 otherwise
- NEXPTP: the number of one-way non-express or regular trips per day
- CRIS: equals 1 for CRIS test routes; 0 otherwise
- LENGTH: length of route in miles

Two sets of regressions were run, one based on the data collected in 1983 and one on the 1984 data.

F.2 MODEL SPECIFICATIONS

Two regressions were run on each of the data sets. In the first regression, total Customer Service inquiries per 1000 passengers (TINQPP) was selected as the dependent variable. Customer Service schedule inquiries per 1000 passengers (SINQPP) was the dependent variable in the second regression. The following independent variables were selected for both models: EXPRESS, NEXPTP, CRIS and LENGTH. EXPRESS is a binary variable having a value of 1 for each of the 29 express routes operated by UTA to some of the larger firms and industrial parks within the Salt Lake City area. All express routes have nine or fewer bus trips per day. Since nearly all of the riders of the express routes are regular bus users, and hence are quite familiar with the schedule, lower inquiry rates were expected on these routes. NEXPTP denotes the daily number of non-express or regular route trips.

Inquiry rates were expected to decline as level of bus service or number of bus trips increased. Besides route type (CRIS versus all others), another route characteristic that is included as an independent variable is route length (LENGTH). Inquiry rates are expected to be larger for longer routes, since estimating the time of arrival of buses is less precise for these routes, providing a greater incentive for users to call the Customer Service Department for schedule information.

F.3 MODEL RESULTS

Tables F-1 and F-2 present descriptions of the estimated models of Customer Service inquiries. These results are discussed in Section 4.3.

TABLE F-1: Customer Service Regression Results for the First Test Period

Independent Variable	Coefficients and t-Statistics: Total Inquiries Per 1000 Passengers (TINQPP) as Dependent Variable	Schedule Inquiries Per 1000 Passengers (SINQPP) as Dependent Variable
Constant	111	106
CRIS	6.70 (0.48)	2.75 (0.21)
LENGTH	0.981 (1.75)	0.918 (1.71)
EXPRESS	-112* (-6.56)	-107* (-6.54)
NEXPTP	-1.112* (-3.13)	-1.04* (-3.24)
Number of Observations	70	70
R^2	0.485	0.487
F	16.25	14.41
Standard Error of Equation	31.5	30.1
Mean value of dependent variable (unweighted average)	56.2	53.1

* Signifies statistical significance at the 95 percent confidence level.

TABLE F-2: Customer Service Regression Results for the Second Test Period

Independent Variable	Coefficients and t-Statistics: Total Inquiries Per 1000 Passengers (TINQPP) as Dependent Variable	Schedule Inquiries Per 1000 Passengers (SINQPP) as Dependent Variable
Constant	74.1	67.2
CRIS	-16.8 (-0.89)	-15.6 (-0.83)
LENGTH	1.93* (2.94)	1.92* (2.90)
EXPRESS	-99.1* (-4.41)	-92.4* (-4.15)
NEXPTP	-0.952* (-2.11)	-0.856 (-1.92)
Number of Observations	74	74
R^2	0.268	0.251
F	6.32	5.78
Standard Error of Equation	43.1	42.7
Mean value of dependent variable (unweighted average)	41.5	39.7

* Signifies statistical significance at the 95 percent confidence level.

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