A REAL-TIME FREEWAY TRAVELER INFORMATION SYSTEM: EXPANSION, IMPLEMENTATION, AND EVALUATION

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Mark P. Haselkorn, Jan Spyridakis, Daniel J. Dailey, Connie Miller, Brain Goble, Margaret Garner	

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16. ABSTRACT

This report documents the third phase of efforts to develop Traffic Reporter, an advanced traveler information system for the Puget Sound Region. Traffic Reporter is a PC-based, graphical, interactive program that displays real-time traveler information.

The goal of this project was to help commuters make more efficient use of Puget Sound-area freeways by providing them with accurate information about traffic conditions. On-road surveys of Puget Sound commuters and other data provided the basis for the first Traffic Reporter design and prototype. Useability tests guided the development of a second prototype. In Phase 3, we conducted additional useability tests and developed a third version. This report describes in detail the features of the second prototype, the results of the useability tests, and the program enhancements implemented in Phase 3. We also tested two methods of delivery: TV and radio traffic reporters and a touch-screen kiosk version.

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A REAL-TIME FREEWAY TRAVELER INFORMATION SYSTEM: EXPANSION, IMPLEMENTATION, AND EVALUATION

by

Mark Haselkorn
Principal Investigator

Jan Spyridakis
Co-principal Investigator

Daniel J. Dailey
Co-principal Investigator

Connie Miller
Research Assistant

Brian Goble
Research Engineer

Margaret Garner
Information Specialist

College of Engineering
University of Washington

Washington State Transportation Center (TRAC)
University of Washington
The University Building
1107 NE 45th Street, Suite 535
Box 354802
Seattle, Washington 98105-4631

Washington State Department of Transportation
Technical Monitor
Larry Senn
ITS Engineer

Prepared for

Washington State Transportation Commission
Washington State Department
of Transportation
Olympia Washington 98504-7370

Transportation Northwest (TransNow)
135 More Hall, Box 352700
University of Washington
Seattle, Washington 98195

and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

May 1996

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TABLE OF CONTENTS

Section	Page
Executive Summary	vii
Chapter 1. Introduction	1
Background	1
User Surveys	1
Prototype Development	2
Overview of This Report	3
Chapter 2. Useability Testing	5
Subjects	6
Materials	6
Procedure	7
Findings	9
Subject Profile	9
Interaction with Touch Screen	10
Making Selections with a Finger or Pointer	12
Selecting Area Labels	12
Selecting and Using Specific Entry and Exit Ramps	12
Interaction with Touch Screen—Summary of Results	13
Interpreting the Main Screen	14
Speed Color Key	14
Directional Orientation	14
Express Lane Information	15
Map Display	16
Suggested Display Changes	16
Suggested Location Additions and Changes	17
Locations Circled from Radio Traffic Reporter Lists	18
Background Color	18
Interpreting the Main Screen—Summary of Results	18
Using and Interpreting the Trip Window	19
Locating Trip Window Information	19
Responding to Trip Window Design	21
Using Trip Window Information	22
Using and Interpreting the Trip Window—Summary of Results	24
Zoom Feature	25
Using Printed Guides	25
Ramp Selection	27
Ramps versus Area Labels	28
Freeway Lanes	28
Scroll Bars	28
Eliminate Information	28
Change Type	28

TABLE OF CONTENTS (Continued)

Section	Page
Long Term Use/Overall Impression	29
Positive Reactions	29
Most Useful Features	29
Most Liked Features	30
Negative Reactions	30
Most Confusing Features	30
Least Liked Features	30
Preferred Location	31
Useability Assessment Conclusions and Recommendations	33
Chapter 3. Expansion and Enhancement	**35**
Expanded Coverage	36
Enhancements	36
Changes to Interface Design	36
Area Labels	37
Directional Arrows	37
Data Key Window	37
Trip Information Window	39
Improved Menu Commands	39
Setup Menu	40
Stats Menu	41
Lanes Menu	41
Handling Faulty Stations	41
Faulty Data Detected by TSMC	42
Faulty Data Detected by Traffic Reporter	42
Confidence Factors	42
Improvement of Conversion and Accuracy of Sensor Data	43
Predictive Mode Investigated	43
Chapter 4. Delivery of Traffic Reporter	**45**
Delivery of Via TV and Radio	45
Delivery Via Touch Screen	45
Delivery to Other Locations	46
Problems with Delivering Traffic Reporter	46
Problems with TSMC	47
Problems with Freeway Sensors	47
Problems with Freeway Station Software	48
Final Comments	48
Appendix A Testing Traffic Reporter: Subject Profile	
Appendix B University of Washington Consent Form	
Appendix C Printed Instructions for Using Traffic Reporter	

TABLE OF CONTENTS (Continued)

Section

Appendix D Index of Areas with Ramps

Appendix E Index of Ramps with Areas

Appendix F Questions About Using Traffic Reporter

Appendix G Questions About Traffic Reporter

Appendix H Trip Information Window Displays

Appendix I Route Descriptions

Appendix J Traffic Reporter

Appendix K Landmarks Used by Radio Traffic Reporters

Appendix L Traffic Reporter: Introductory Script

Appendix M Menu Description

LIST OF TABLES

Table		Page
1.	Number of Subjects Who Use Media Sources for Traffic Information	10
2.	Number of Subjects Using Media Traffic Information in Various Ways	10
3.	Number of Subjects' Exhibiting Different Commuting Behaviors	11
4.	Number of Subjects Traveling Particular Routes	11
5.	Number of Subjects Correctly Interpreting Express Lane Displays	16
6.	Number of Subjects Ranking Express Lane Displays 1st, 2nd, or 3rd Choice	16
7.	Number of Subjects Ranking Background Colors by Ease of Reading and Preference	19
8.	Number of Subjects Ranking Route Descriptions 1st or 2nd Choice	22
9.	Number of Subjects Ranking Speed, Time and Distance Information 1st, 2nd or 3rd Choice	23
10.	Number of Subjects Choosing Routes Based on Various Characteristics	24
11.	Number of Subjects Using Instructions and Ramp Lists on Section I Questions	27
12.	Number of Subjects Ranking Ramp Lists for Usefulness	27
13.	Number of Subjects Using Traffic Reporter by Location	32
14.	Statistics on Use of TR at Demonstration Sites	47

LIST OF FIGURES

Figure		Page
1.	Main Screen Display Showing Area Labels and Data Key Window	38
2.	Freeway Map Showing Individual Ramps for a Specific Area	38
3.	Trip Information Window Displaying Multiple Routes and HOV Lanes	40

EXECUTIVE SUMMARY

This summary describes the third phase of efforts to develop *Traffic Reporter*, an advanced traveler information system for the Puget Sound area. *Traffic Reporter* is a PC-based, graphical, interactive program that displays real-time traveler information.

BACKGROUND

The goal of this research project was to help commuters make more efficient use of Puget Sound-area freeways by providing them with accurate and timely information about traffic conditions. To achieve this goal, however, we needed to first understand commuter behavior and needs. Therefore, in the first two phases of the *Traffic Reporter* project, we conducted on-road surveys of Puget Sound-area commuters. The results of the first survey identified four types of commuters, which we labeled Pre-trip Changers, Route and Time Changers, Route Changers, and Non-changers. The results of the second survey confirmed that these commuter types are relatively stable across geographical areas.

On the basis of results of the on-road surveys, and using a limited set of available data, we designed the first version of *Traffic Reporter*. We then conducted useability tests of commuters and traffic reporters to determine whether *Traffic Reporter* would meet the needs of commuters and would be easy to use. We also solicited input from traffic engineers.

The results of these useability tests guided the development of an expanded prototype of *Traffic Reporter.* This version displayed a graphical representation of a 15-mile corridor of I-5. Segments of the freeway were colored according to broad speed ranges. Freeway ramps were labeled according to well-known street designations. Users could zoom in on a particular segment and view more specific speed information for that segment. By selecting two freeway ramps, users could also view trip-specific information in the form of the current estimated speed and travel time between those two

ramps. The second version of *Traffic Reporter* also included features important to traffic engineers. These features allowed traffic engineers to view freeway volume and occupancy data, detect malfunctioning loop stations, and record and play back commute data.

In Phase 3 of the project, we conducted additional usability tests on the prototype of *Traffic Reporter*, and we developed a third version, which uses all available loop data in the Puget Sound region and provides enhanced user functionality. We delivered this version to radio traffic reporters, the Traffic Systems Management Center, and several other organizations that requested it. We also created a touch-screen kiosk version, which was demonstrated in public areas.

USEABILITY TESTING

The useability test focused on commuters' use of and reaction to the new, expanded *Traffic Reporter* design. The goal was to identify areas that needed refinement before the interface became available for public use.

Procedure

For useability test purposes, *Traffic Reporter* was run on an IBM computer with a touch screen. For the portion of the test in which subjects interacted with the screen, prerecorded data were used so that we could determine when a subject was using and interpreting *Traffic Reporter* correctly.

The 16 subjects tested between June 30 and July 23, 1992, were drawn from respondents to motorist information surveys delivered in April 1990. The subjects comprised ten men and six women, who ranged in age from 26 to 60. Eleven people characterized themselves as very comfortable with computers, while five characterized themselves as somewhat comfortable. Most of the 16 subjects commuted alone on freeways five days a week.

Subjects took the test individually and spent between one and two hours. Data were recorded in three ways: subjects' interactions with Traffic Reporter screen were

videotaped; subjects' answers to questions and their comments were audio taped; and subjects' answers and comments were recorded by a research assistant on response sheets.

Findings

Interaction with the Touch Screen

Subjects interacted with the *Traffic Reporter* touch screen while answering 14 questions. We evaluated their ability to make selections with a finger or pointer, select area labels, and select and use specific entry or exit ramps. We found that the small size of the area labels and ramp displays presented people with difficulty in physically selecting labels. The design of *Traffic Reporter*, in which specific ramps displayed in lists to the right of and slightly below the area labels, discouraged ramp use for trip information. Because 43.75 percent of the subjects indicated that they would use specific ramps regularly, we recommended that the specific ramp feature be redesigned.

Interpreting the Main Screen

We evaluated the subjects' abilities to interpret the main screen in five areas: speed color key, directional orientation, express lane information, map display, and background color. We found that the colors indicating traffic flow speeds on the main screen were intuitive and the most effective design element of *Traffic Reporter.* Arrows indicating the direction of traffic flow needed to be added to the map, either between or beside the freeway lanes. Alternative designs for the express lanes needed to be considered, including the disappearance of closed ramps. Adding SeaTac International Airport and lines indicating other major Seattle-area roadways would help users orient themselves to the *Traffic Reporter* map. We found that we should consider the possibility of changing the background to gray or a similar dark color.

Using and Interpreting the Trip Window

Subjects evaluated different trip window designs and interpreted different pieces of information from the trip window. Commuters tend to choose their routes according to how long a trip takes. However, distance, speed, and other factors also play a role,

especially if the time differences between routes is small. Thus, we found that although travel time was the most valuable piece of information *Traffic Reporter* provided in the trip window, typical times and speeds did not interest users enough to bother displaying them. They indicated that the usefulness of *Traffic Reporter* would be enhanced if it displayed the reasons for traffic slow-downs. We found that we should re-examine the trip window design to see whether travel time information could be more effectively presented, and we should explore the possibility of including incident reports where major slow-downs occur. Ideally, we could design the trip window so all the information would fit on one screen.

Zoom Feature

While the majority of subjects identified ways to use the zoom feature, none of the suggestions was particularly compelling. As designed, the zoom feature did not add a great deal to the information already available on the main screen. For the zoom feature to be useful, motorists wanted it to display specific ramp locations and/or incident reports on the zoom screen.

Using Printed Guides

To help subjects as they interacted with *Traffic Reporter*, we gave them a brief, one-page set of Instructions for Using *Traffic Reporter* and two Lists of Freeway Ramps arranged alphabetically either by area label or by freeway ramp. Our tests showed that users would need some kind of instructions (printed or on-line) to learn how to activate the trip information window, call up ramp lists, and select specific ramps. The results indicated that most people would read brief instructions before beginning to interact with the system.

Further, ramp lists organized by ramp name would have to be available when users approached the system knowing a specific ramp name but not the area in which the ramp was located. The test subjects, all area residents and regular commuters, said that locating a specific ramp would be necessary at some times. In fact, subjects indicated

that the interactive capability of *Traffic Reporter* would be most useful for non-routine trips to places where they were most likely not to know ramp locations.

Long-Term Use/Overall Impression

Overall, subjects were enthusiastic about *Traffic Reporter*. Many of them agreed to participate in the useability test because they believed that solutions to Seattle's traffic problems are desperately needed. They saw *Traffic Reporter* as an aid to negotiating these problems if not a solution.

The most useful and most popular feature of *Traffic Reporter* was the color-coded main screen that provided traffic information at a glance. The detailed information about routes available in the trip information window was also an attractive feature. Users of *Traffic Reporter* found the direction of traffic flow and the express lane display confusing, and they did not like the process of selecting specific ramps.

Subjects indicated that building lobbies and work places were the most preferred locations for using *Traffic Reporter*. Most subjects indicated that they would use *Traffic Reporter* less at home than they would in any other location. Access to *Traffic Reporter* via modem, it appeared, could deter some users, but future interactive TV could be particularly useful.

While subjects appreciated the interactive features of *Traffic Reporter*, most admitted they would seldom use them. The fact that the most popular locations for *Traffic Reporter* were all work-related indicated that subjects viewed the system as a tool to help with their commutes. However, practical factors limit the usefulness of the interactive features for commuting purposes. As it is currently designed and accessible, the interactive features of *Traffic Reporter* would be most useful to people considering non-routine trips.

The subject perceptions stated here do not necessarily mean that future versions of *Traffic Reporter* will not be useful tools for home travel planning. Usability improvements (see page 34) and people's growing experience with using the Internet

from home will likely make the system a valuable information resource for both commute and other freeway travel.

EXPANSION AND ENHANCEMENT

Guided by the results of useability tests of *Traffic Reporter's* effectiveness and usefulness, we expanded and enhanced *Traffic Reporter.*

Expanded Coverage

In Phase 3, coverage was expanded to 60 miles and includes I-5 from Swamp Creek to Southcenter, both I-90 and SR-520 from Seattle to Bellevue, and I-405 from Renton to Woodinville. *Traffic Reporter* also covers the reversible express lanes on I-5 and distinguishes HOV lanes from regular lanes.

In addition, all of the freeway systems covered by *Traffic Reporter* are now integrated, allowing commuters to quickly and easily acquire information for a trip that starts on one freeway and ends on another. This integration also allows commuters to compare multiple routes for a single trip.

Enhancements

Enhancements to *Traffic Reporter* were made to the interface design, menu commands, detection of faulty freeway stations, computation of confidence factors for each freeway station, and conversion and accuracy of sensor data.

Four major changes were made to *Traffic Reporter's* interface: area labels were added, directional arrows were added, the data key window (which shows the ranges for various types of data that appear on the screen's map) was modified, and the trip information window was modified. In addition, users can now customize many of the screen features through the new Setup Menu.

Menus and menu commands were added. In this version, new setup commands were added, and all setup commands now reside in the new Setup menu. This configuration allows *Traffic Reporter's* features to be easily customized to accommodate different types of users and different purposes. A Stats menu was also added, and the

Lanes menu was implemented. The Lanes menu has two commands: *Regular*, which displays regular lanes only; and *HOV*, which displays freeway segments that have HOV lanes.

This project encountered two types of faulty data (information that, because of insufficient source data, can only be estimated): data that were detected as faulty by the central computer at TSMC and data that were detected as faulty by *Traffic Reporter's* internal error detection algorithm. This version of Traffic *Reporter* was given ways to handle both of these situations.

To ensure that *Traffic Reporter* does not give out speed estimates that are based on too few data, *Traffic Reporter* now computes a confidence factor for all freeway sections. The confidence factor is the percentage of usable traffic data for a freeway section. Confidence factors for each freeway section can be displayed to show not only where data problems exist, but also severity of problems for individual freeway sections.

Finally, to improve the accuracy of the algorithm that *Traffic Reporter* uses to convert traffic data to travel speeds, we incorporated custom "g" factors for 33 of the stations used by *Traffic Reporter*. (A "g" factor is a constant that is used in the equation that converts the volume and occupancy data to freeway speeds.) We also incorporated a better general "g" factor for the remaining stations.

DELIVERY OF TRAFFIC REPORTER

Traffic Reporter's primary objective is to deliver real-time traveler information directly to commuters. Under this project we pursued two methods of delivery: (1) TV and radio traffic reporters and (2) a touch-screen kiosk version.

The *Traffic Reporter* prototype was installed at KIRO NewsRadio (for internal use only) in exchange for its suggestions for improving the system. In general, KIRO liked *Traffic Reporter* but was unable to use the system for on-air reports because of problems with the source data.

A touch-screen kiosk version of *Traffic Reporter* was created for use in public locations. This version has both interactive and non-interactive modes. In both modes, *Traffic Reporter* displays areas of congestion on the color-coded freeway map. In its interactive mode, *Traffic Reporter*'s information is accessed by a touch screen input device. Users simply touch their destination on *Traffic Reporter*'s screen and instantly receive trip information. When *Traffic Reporter* is not being used, it switches to non-interactive mode, in which it cycles through the most common trips. Trip cycling continues until someone touches the screen, returning the system to interactive mode. We demonstrated touch screen versions in Westlake Mall (downtown Seattle) and Bellevue Place (downtown Bellevue, east of Seattle).

Problems with Delivering Traffic Reporter

We encountered several problems with delivering *Traffic Reporter*. These problems were all related to insufficient and unreliable source data.

Traffic Reporter's source data comes from the mainframe computer at the Traffic Systems Management Center (TSMC). This computer receives raw volume and occupancy data from sensors in the freeways. During *Traffic Reporter's* development, the TSMC upgraded its computer system and moved to a new location. These activities caused a lengthy disruption, during which *Traffic Reporter* was unable to receive the source data and to test and verify the accuracy of the travel speeds that it calculated.

Once the TSMC's computer was back on-line and *Traffic Reporter* was receiving data, we discovered that *Traffic Reporter* was receiving only half of the normal data. This condition made it impossible for *Traffic Reporter* to display an accurate picture of the freeway conditions. The main reason for this problem was freeway construction projects. Another problem was with the cabling that allows the sensors to communicate with TSMC's computer. Finally, some of the loop sensors were simply broken, often

because an amplifier needed to be adjusted or replaced or because a modem needed to be replaced.

Recommendations for Delivery

The following activities address data delivery issues and would help make *Traffic Reporter* a viable ATIS for general use:

1. Institute a plan with sufficient resources to assure a reliable loop system and data availability.

2. Conduct tests of the reliability of the speeds and travel times predicted by *Traffic Reporter*.

3. Develop innovative methods for delivering and maintaining the *Traffic Reporter* software, particularly to address the issue of reliable access to the real-time data stream.

4. Incorporate other data sources and types of traveler information into the current, exclusively loop-based application.

5. Explore the use of *Traffic Reporter's* extended functionality for traffic management, as well as for traveler information.

CHAPTER 1. INTRODUCTION

This report describes the third phase of efforts to develop *Traffic Reporter*, an advanced traveler information system (ATIS) for the Puget Sound area. *Traffic Reporter* is a PC-based, graphical, interactive program that displays real-time traveler information.

BACKGROUND

The goal of this research project was to help commuters make more efficient use of Puget Sound-area freeways by providing them with accurate and timely information about traffic conditions. To achieve this goal, however, we needed to first understand commuter behavior and needs. Therefore, in the first two phases of the *Traffic Reporter* project, we conducted on-road surveys of Puget Sound-area commuters. On the basis of the survey results, and using a limited set of available data, we developed the first version of *Traffic Reporter*. Next, we conducted useability tests that guided the development of an expanded prototype of *Traffic Reporter*.

In this phase of the project, we conducted additional useability tests on the prototype of *Traffic Reporter*, and we developed a third version, which uses all available loop data in the Puget Sound region and provides enhanced user functionality. We delivered this version to radio traffic reporters, the Traffic Systems Management Center, and several other organizations that requested it. We also created a touch-screen kiosk version, which was demonstrated in Westlake Mall.

Additional background on work conducted during the first two phases of this project is summarized in the next two sections. An overview of this report concludes this introduction.

User Surveys

In the first two phases of this project, we conducted two extensive on-road surveys: one of commuters traveling south on I-5 into downtown Seattle and one of

commuters traveling north on I-5 into downtown Seattle. In addition, we extracted data from these surveys on respondents traveling east and west on the Lake Washington bridges into downtown Seattle. The results of the first survey identified four types of commuters, which we labeled Pre-trip Changers, Route and Time Changers, Route Changers, and Non-changers. The results of the second survey confirmed that these commuter types are relatively stable across geographical areas. (See *Improving Motorist Information Systems: Towards a User-Based Motorist Information System for the Puget Sound Area*, Washington State Department of Transportation Final Technical Report WA-RD 187.1, April 1990; and *Real-Time Motorist Information for Reducing Freeway Congestion: Commuter Behavior, Data Conversion and Display, and Transportation Policy,* Washington State Department of Transportation Final Technical Report WA-RD 240.1, April 1992.)

Prototype Development

On the basis of the results of the on-road surveys, we designed the first version of *Traffic Reporter.* We then conducted useability tests of commuters and traffic reporters to determine whether *Traffic Reporter* would meet the needs of commuters and would be easy to use. We also solicited input from traffic engineers.

Guided by the results of these useability tests, we developed the second version of *Traffic Reporter.* This version displayed a graphical representation of a 15-mile corridor of I-5. Segments of the freeway were colored according to broad speed ranges. Freeway ramps were labeled according to well-known street designations. Users could zoom in on a particular segment and view more specific speed information for that segment. By selecting two freeway ramps, users could also view trip specific information in the form of the current estimated speed and travel time between those two ramps.

The second version of *Traffic Reporter* also included features important to traffic engineers. These features allowed traffic engineers to view freeway volume and

occupancy data, detect malfunctioning loop stations, and record and play back commute data. Further useability tests were conducted on the second version of *Traffic Reporter*.

OVERVIEW OF THIS REPORT

This report describes the work done in the third phase of the *Traffic Reporter* project. The major objectives of this phase were as follows:

(1) Conduct useability tests on the second version of *Traffic Reporter* to evaluate its interface and its ability to provide commuters with effective and timely information.

(2) Create a third and final version that expands and enhances *Traffic Reporter* by extending its coverage, allowing interaction among freeways, distinguishing regular lanes from HOV lanes, improving the accuracy of sensor data, detecting faulty stations, computing confidence factors, investigating a predictive mode, and developing a touch-screen version.

(3) Provide traffic information to commuters by delivering *Traffic Reporter* to TV and radio stations and directly via a touch-screen kiosk; explore the integration of *Traffic Reporter* with other methods of delivery; and provide *Traffic Reporter* as a tool for personnel at the Traffic Systems Management Center.

Chapter 2 presents the results of the useability testing of the second version of *Traffic Reporter*. Chapter 3 describes the expansion of and enhancements to *Traffic Reporter*. Chapter 4 describes how *Traffic Reporter* is currently being delivered to commuters. Problems currently affecting the effectiveness of the system are also discussed.

CHAPTER 2. USEABILITY TESTING

This chapter describes the useability tests conducted on the second version of the *Traffic Reporter* prototype. Earlier useability tests (conducted in 1990) established the viability of the first prototype as a mechanism for delivering Puget Sound-area traffic information and identified areas in need of redesign. On the basis of these useability tests and expanded design requirements, the first version of the *Traffic Reporter* screen was redesigned. The display, which originally showed only I-5 between Swamp Creek and downtown, was expanded to include I-5 between Swamp Creek and Southcenter; I-405 between Woodinville and Renton; I-90 between I-5 and Factoria; and SR-520 between I-5 and Bellevue. The original four-color scheme for representing traffic speeds (green, yellow, purple, and red) was replaced by three colors (green, yellow, red) and flashing red to indicate stop-and-go-traffic. The trip information window was restructured so that the on- and off-ramps, which appeared on the main screen in the initial version, were accessed through area-label pull-down menus. Further area labels, as well as ramp labels, could be pressed to activate trip information windows.

The current useability test focused on commuters' use of and reaction to the new, expanded *Traffic Reporter* design. The goal was to identify areas that needed refinement before the interface became available for public use. This chapter describes the research approach to this useability test and discusses conclusions and recommendations.

For useability test purposes, *Traffic Reporter* was run on an IBM computer with a touch screen. For the portion of the test in which subjects interacted with the screen, prerecorded data from 5:36 p.m. on February 7, 1992, were used. The use of prerecorded data allowed us to determine when a subject was using and interpreting *Traffic Reporter* correctly.

SUBJECTS

All subjects in the useability test were drawn from respondents to motorist information surveys delivered in April 1990 to commuters traveling north on I-5 into downtown Seattle. Approximately two months before the testing, we called respondents who had indicated that they would be willing to come to the University of Washington and be interviewed about their use of traffic information. A surprisingly large number of the survey respondents could still be contacted through the phone numbers they had provided in 1990. We developed a pool of approximately 30 subjects interested in participating in the useability tests of *Traffic Reporter*. About two weeks before testing was scheduled to begin, we called each of the 30 people to identify a specific time when they could come to the University to spend about 1.5 hours using *Traffic Reporter*. Twenty of the 30 people scheduled an appointment. Because of three cancellations and one no-show, 16 subjects were tested between June 30 and July 23, 1992.

MATERIALS

The useability test involved the following materials.

- *Subject Profile*. To ensure that subjects met participation criteria and to help us understand their commuting behavior, all subjects completed a subject profile (see Appendix A).

- *University of Washington Consent Form.* Subjects signed a consent form to indicate that they agreed to be video- and audio-taped while they interacted with *Traffic Reporter* (see Appendix B). The form told subjects they could withdraw from the study at any time.

- *Printed Instructions for Using Traffic Reporter.* Subjects were given a one-page set of instructions for using *Traffic Reporter* before they began Section I of the useability test, and they were encouraged to read it or refer to it whenever desired (see Appendix C). The goal was to assess whether minimal instructions (170 words) would sufficiently introduce participants to the interactive features of the system.

- *Ramp Lists*. Subjects were given two lists of ramps before they began Section I of the useability test. Lists were organized alphabetically either by ramp labels or by area labels (with ramps subordinate to areas) (see Appendices D and E). Subjects were encouraged to refer to the lists as often as necessary. We wanted to determine whether such lists were an essential part of the *Traffic Reporter* interface.

- *Useability Test Content.* Section I of the useability test consisted of 14 questions about speed, travel time, express and HOV lane information, and route choice that

subjects could answer only by interacting with *Traffic Reporter* (see Appendix F). The questions aimed at simulating real-life information needs with which a commuter might approach the system.

Section II of the useability text consisted of 13 multipart questions that explored subjects' reactions to the design and functioning of *Traffic Reporter* (see Appendix G). For example, Question 1 asked what information subjects would add or eliminate from the *Instructions,* and Question 9 explored their reactions to and use of information in the trip window.

- *Alternative Express Lane Designs.* To determine the best way of showing closed ramps and the direction of express lanes, subjects viewed five alternative displays of express lane information and indicated which they found easiest to understand. The displays differed in how they showed the direction of traffic flow (color in closed ramps versus an arrow indicating the direction of flow) or how they indicated express lanes closure (e.g., color versus Xs).

- *Trip Information Window Designs.* To determine the best method for displaying information in the trip information window, subjects interpreted speed, time, and distance information in four different trip window displays and indicated which design they preferred (see Appendix H). Two of the designs were in chart format and two were in graph format. One of the charts displayed HOV information underneath regular lane information with the statement "Save x minutes on HOV." The other chart displayed HOV information in a separate column. The graphs displayed information either horizontally or vertically.

- *Route Descriptions.* To identify the clearest way to phrase and lay out route information in the trip window, subjects judged five route statements (see Appendix I). The five statements varied either in wording order or in spacing.

- *Background Colors.* To determine whether the *Traffic Reporter* screen would be easier and more pleasant to read with a colored as opposed to a white background, subjects viewed three *Traffic Reporter* main screens, each with a different background color; they ranked the displays according to which was easiest to read and which they preferred.

- *Printed Version of the Traffic Reporter Screen.* To determine whether additional locations should be added to the *Traffic Reporter* main screen, subjects marked any landmarks they felt would help orient themselves better on a black and white printed map of the main *Traffic Reporter* screen (see Appendix J).

- *Location Labels.* To determine whether additional locations should be labeled on the *Traffic Reporter* main screen, subjects read a list of the locations routinely mentioned by radio traffic reporters (provided by KIRO radio station) and circled any locations they thought should be added to the *Traffic Reporter* main screen (see Appendix K).

PROCEDURE

The *Traffic Reporter* useability tests were conducted in the Technical Communication Department's Laboratory for Useability Testing (LUTE), Loew Hall, University of Washington. Before we began testing *Traffic Reporter* with our 16 subjects, we pretested the

materials with two people who had no prior experience with the software. These pretests helped us refine the materials so virtually no problems arose during the actual test sessions themselves. However, after testing the first two subjects, we added two survey questions (Questions 11 and 12d, Section II; see Appendix G). We made no other changes to the test materials.

Subjects took the test individually and spent between one and two hours, depending upon the detail with which they answered the questions. When subjects arrived at Loew Hall, a researcher met them and escorted them to the useability laboratory where *Traffic Reporter* was running on an IBM computer with a touch screen. The researcher introduced them to the research assistant, who would be recording data during the test, and then asked them to fill out the Subject Profile and the University of Washington Consent Form. The researcher then read each subject a brief introduction that described *Traffic Reporter* and explained the test (see Appendix L). She explained that subjects would do "think-aloud protocols," saying out loud not only their answers to questions but also their thought processes as they interacted with *Traffic Reporter* and answered the questions. Because talking aloud while performing an activity is not a natural process, the researcher then asked each subject to practice a think-aloud protocol while loading staples into a stapler.

The researcher then explained that subjects would be using a touch screen to interact with *Traffic Reporter*. She gave them the option of using their finger or a pointer to touch the screen. When they were ready to begin Section I of the test, the researcher presented them with the "Instructions for Using *Traffic Reporter*" and the two "Ramp Lists" and told them to refer to the three handouts as often as they wished. She then gave them a two-page handout of 14 questions they were to answer by using *Traffic Reporter*. She asked them to read each question aloud before answering it. After subjects had completed Section I, the researcher asked them the 13 questions in Section II. Upon completion of the test, the researcher and the research assistant thanked subjects and accompanied them out of the laboratory.

Data were recorded in three ways: (1) subjects' interactions with the *Traffic Reporter* screen were videotaped, (2) subjects' answers to questions and their comments were audio taped, and (3) subjects' answers and comments were recorded by the research assistant on response sheets keyed to match the questions.

FINDINGS

The findings of the useability test are grouped into seven sections: (1) Subject Profile, (2) Interaction With the Touch Screen, (3) Interpreting the Main Screen, (4) Using and Interpreting the Trip Window, (5) the Zoom Feature, (6) Using the Printed Guides, and (7) Long Term Use/Overall Impressions.

Subject Profile

An analysis of the Subject Profile indicates that the ten male and six female subjects ranged in age from 26 to 60, with an average age of 38.4 years (Standard deviation = 8.05; Median age = 36.5). Eleven subjects (68.75 percent) characterized themselves as very comfortable with computers while five (31.25 percent) characterized themselves as somewhat comfortable. Twelve subjects (75 percent) used media sources frequently to check freeway traffic conditions and only one (6.25 percent) never used media sources to obtain traffic information (see Table 1 below).

When asked what behaviors were affected because of the traffic information they obtained from media, 11 subjects (73.33 percent) said they changed their route, seven (46.67 percent) said they changed their time of departure, and none said they changed their mode of transportation. Ten subjects (66.67 percent) used media-supplied traffic information simply to anticipate traffic conditions they might encounter (see Table 2 below).

Most of the 16 subjects commuted alone on freeways five days a week and drove their own cars five days per week (note the 5-day-per-week column of Table 3).

As expected, the most commonly traveled freeway was I-5 between Downtown and Southcenter (subjects had been selected from the participants in an earlier survey of that

freeway location). During a regular week, however, subjects spent at least some time on all Seattle-area freeways (see Table 4).

Interaction With the Touch Screen

Subjects interacted with the *Traffic Reporter* touch screen while answering 14 questions about speed, travel time, express and HOV lane information, and route choice (see Appendix F). This section summarizes subjects' interaction with the touch screen in the following areas: (1) making selections with a finger or pointer, (2) selecting area labels, and (3) selecting and using specific entry or exit ramps.

Table 1. Number of Subjects Who Use Media Sources for Traffic Information

Frequently	Sometimes	Seldom	Never
12	2	1	1

Table 2. Number of Subjects Using Media traffic Information in Various Ways

Change Route	Change Departure Time	Change Transportation Mode	Anticipate Traffic Conditions
11	7	0	10

Table 3. Number of Subjects' Exhibiting Different Commuting Behaviors

Commuting Behavior	Days/Week						
	7	6	5	4	3	2	1
Commute on Freeways	1	0	14	0	0	1	0
Commute Alone	0	1	9	0	1	0	1
Act as Driver	1	0	10	1	0	2	2
Use Own Car	1	0	11	1	0	1	2
Ride as Passenger	0	0	0	2	0	3	0
Give Ride to Others	0	0	1	2	0	2	1
Use Company Car	0	0	0	0	0	0	0

Table 4. Number of Subjects traveling Particular Routes

Route	Days/Week				
	5	4	3	2	1
I-5: Downtown/ Southcenter	8	0	0	0	2
I-5: Lynnwood/ Downtown	1	0	2	1	2
I-405: Woodinville/ Bellevue	1	0	1	0	0
I-405: Bellevue/ Coal Creek	1	0	0	0	1
I-90	3	0	0	0	2
SR 520	0	0	1	1	2

Making Selections with a Finger or Pointer

We offered subjects the option of using either a pointer or their index finger to select options on the touch screen and encouraged them to try both. No clear preference for the subjects' finger or a pointer emerged. Seven subjects (43.75 percent) elected to use their index fingers when they began their interaction with *Traffic Reporter*, while nine (56.25 percent) elected to use the pointer. By the end of Section I, eight subjects (50 percent) used primarily their index fingers, and eight used primarily the pointer. One subject started out using his index finger and switched to the pointer because his index finger was too big. One subject tried her index finger, found her nails got in the way, and switched to the pointer. Watching subjects interact with the screen and analyzing their comments led to the following conclusions.

1. Subjects with large fingers will probably have trouble selecting ramps or scrolling in the trip window.

2. Subjects with long nails will probably have trouble selecting area labels or ramps with their fingers, as the buttons on the screen respond best when touched straight on.

Selecting Area Labels

In general, subjects selected area labels successfully. Three subjects (18.75 percent) initially touched the freeway itself rather than the words of the area labels and had to be told to touch the words. Subjects frequently had to touch an area label more than once to select it, suggesting that the labels need to be larger or more sensitive.

Selecting and Using Specific Entry and Exit Ramps

Without exception, the subjects found selecting a specific ramp cumbersome and difficult. They had three main problems:

1. holding a finger or pointer on the area label to highlight the ramp list
2. hiding the ramp list with their hands while holding down the area label
3. dragging down from the area label to select a specific ramp.

Fourteen subjects (87.5 percent) said the process of selecting ramps was frustrating. Even two subjects who did not find selecting ramps frustrating commented that their hands

got in the way, the print in the ramp list was too small, and they had a tendency to highlight the wrong ramp.

Question 12 in Section I of the useability test asked subjects to choose the route they would travel between specific ramps from two different map areas. Even though all subjects had been exposed to the process of identifying ramps on an earlier question and all had access to the "Instructions for using *Traffic Reporter*," only five answered the question by selecting the specific ramps. Eleven answered the question by first identifying the appropriate area labels and then selecting these. We demonstrated to these 11 subjects how they could select specific ramps to obtain more exact trip information. When answering the last question in section I, which asked subjects to find the trip time for their usual routes between home and the office, eight still selected area labels instead of specific ramps.

Although all subjects were frustrated with the process of selecting ramps, many of them were enthusiastic about the capability. Seven of the 16 subjects said that, if they used *Traffic Reporter* on a regular basis, they would select specific ramps more frequently than area labels. This suggests that the ramp display and selection process need to be improved. For example, ramps could display automatically in the interim trip window that currently displays the selected origin and asks users to select a destination. Users could then select a specific ramp from the window or bypass the window by selecting the destination area label from the screen.

Interaction With Touch Screen—Summary of Results

Given the current small size of the area labels and ramp displays, it is likely that users will have difficulty with the physical process of selecting labels. The current design of *Traffic Reporter*, in which specific ramps display in lists to the right of and slightly below the area labels, discourages ramp use for trip information. Since 43.75 percent of the subjects indicated that they would use specific ramps regularly, the specific ramp feature should be redesigned.

Interpreting the Main Screen

Subjects had to interpret information on the main *Traffic Reporter* screen to answer many of the questions in Section I of the useability test (see Appendix F for a list of the questions). This section summarizes subjects' reactions to the main screen in five areas: (1) speed color key, (2) directional orientation, (3) express lane information, (4) map display, and (5) background color.

Speed Color Key

Subjects consistently used the colors in the freeway lanes and the color key to correctly identify traffic speeds and to make trip choices. The colors proved to be intuitive. Some subjects correctly interpreted speed information without using the "Instructions for using *Traffic Reporter*" and even without referring to the color key. While one subject said he found the flashing red irritating, several others said they thought it was effective. Twelve subjects (75 percent) said that the colored lane display was the feature they liked best about *Traffic Reporter*. Thirteen (81.25 percent) said that, if they used *Traffic Reporter* regularly, they would more frequently glance at the colors on the screen than actually touch labels or ramps to access the trip window.

Directional Orientation

The direction of traffic flow was not as intuitive to the subjects as the speed/color key. Four subjects (25 percent) needed help distinguishing northbound from southbound traffic; five (31.25 percent) needed help distinguishing eastbound from westbound. Several subjects who managed to correctly interpret traffic flow indicated that they had been guessing. Two subjects (12.5 percent) thought, at first, that southbound I-5 lanes were SR-99, another north/south Seattle highway.

Subjects suggested a number of techniques for indicating freeway direction. Fourteen (87.5 percent) believed that it would be helpful to add directional arrows to the freeway lanes. One suggested that the actual freeway data station markers (which appear on *Traffic Reporter* as gray lines dividing the freeways into sections) point in the direction of traffic

flow. Five suggested that directional information (e.g., a compass or "North to Everett") be added to the map. Another thought that the freeway icons should be placed between the two directions of each freeway.

Express Lane Information

When asked in Section I whether travel via the express lanes was possible between two areas, half of the subjects needed prompting to identify the express lanes and to distinguish northbound from southbound lanes (remember that most of the subjects commuted from the south and that the express lanes on I-5 are north of downtown). After such prompting, 15 subjects (93.75 percent) answered the express lane question correctly. These subjects noticed the gray color in the express lane entry and exit ramps and believed that, according to the color key, gray corresponded to closed.

In Section II, subjects interpreted express lane information on the basis of three alternative designs: gray color, Xs, and a combination of gray color and arrows indicating express lane direction or closure. We presented the designs, in varying order, on colored laser printouts. Most subjects correctly interpreted all displays. The "express-lanes-closed, gray-color design" was the same as the express lane design on the *Traffic Reporter* screen, which subjects used to answer a question in Section I. Previous exposure, therefore, may have made the laser printed version of this design easier to interpret. Because all subjects interpreted correctly the "Ramp-Closed, Gray plus Arrows design," this combination appears to be the easiest to understand. Table 5 shows the number of subjects that correctly interpreted each display.

Table 6 shows how subjects ranked the express lane designs for ease of understanding. Clearly, most subjects preferred the design with arrows. That preference may well have had less to do with the arrows themselves and more to do with the problem subjects had in distinguishing whether the express lanes were moving north or south. Several suggested, for example, that closed ramps on the express lanes become invisible (e.g., when

Table 5. Number of Subjects Correctly Interpreting Express Lane Displays

Express Lanes Closed		Ramps Closed		
Gray	XXX's	Gray	Gray Plus Arrow	XXX's
14	14	13	16	13

Table 6. Number of Subjects Ranking Express Lane Displays 1st, 2nd, or 3rd Choice

	Rank		
Express Lane Display	1st Choice	2nd Choice	3rd Choice
Gray color	4	6	5
XXX's	0	7	8
Arrows/color	11	2	2

the express lanes are closed northbound, hide the related entry and exit ramps). If only one direction of ramps displayed, arrows to highlight direction might prove unnecessary.

Map Display

Overall, subjects oriented rapidly and accurately to the map display, although some had problems. Two (12.5 percent) thought, at first, that the southbound I-5 lanes represented SR-99. Several, as mentioned earlier, had difficulty distinguishing northbound from southbound and eastbound from westbound. Several asked what the express lanes were.

Subjects offered numerous suggestions for improving the map display and location labels.

Suggested Display Changes

- Add arrows to indicate direction of traffic flow (14 subjects/87.5 percent).
- Add arrows or words indicating north, south, east, and west for the map as a whole (five subjects/31.25 percent).

- Change the express lane display (e.g., have closed ramps disappear as described above) (three subjects/18.75 percent).

- Add HOV lanes and park-and-ride lots (two subjects/12.5 percent).

- Point the freeway section markers in the direction of traffic flow (one subject/6.25 percent).

- Make the SR 520 sign more visible (one subject/6.25 percent).

- Place the freeway icons between the two freeway lanes (e.g., between northbound and southbound I-5 lanes) (one subject/6.25 percent).

When asked what additional locations they would like to see labeled on the map, 15 subjects (93.75 percent) added locations to a printed version of the *Traffic Reporter* map.

Suggested Location Additions and Changes

- More detail on the southern portion, including SR-167, SR-518, and SR-599, the Kent/Desmoines Road, the Southcenter hill area, etc. (seven subjects/43.75 percent).

- SR-99 (four subjects/25 percent).

- SeaTac Airport (four subjects/25 percent).

- West Seattle freeway (three subjects/18.75 percent).

- SR-522 and SR-527 in the north (two subjects/12.5 percent).

- Martin Luther King ramp from Southcenter to Boeing Field (one subject/6.25 percent).

- Change the Rainier Valley area label to Renton (three subjects/18.75 percent) and the Woodinville label to Bothell (one subject/6.25 percent).

Note that the emphasis on location additions and changes in the southern portion of the *Traffic Reporter* map reflects the fact that most of the subjects in the useability study commuted from the south.

After indicating on a map the additional locations they would like to see labeled, subjects were given a list of locations that are frequently mentioned by radio traffic reporters and were asked to circle the ones they would like to see added to the *Traffic Reporter* display. Fourteen (87.5 percent) circled locations to be added.

Locations Circled from Radio Traffic Reporter Lists

- Seattle International Airport (five subjects/31.25 percent).
- Valley Freeway Interchange (four subjects/25 percent).
- Highway 18 Interchange (four subjects/25 percent).
- King/Snohomish County Line (three subjects/18.75 percent).
- Mount Baker Tunnel (three subjects/18.75 percent).
- Ship Canal Bridge (three subjects/18.75 percent).
- Bothell/Woodinville Highway Interchange/SR-522 (three subjects/18.75 percent).
- Kennydale Hill (two subjects/12.5 percent).
- Bus Barn (N.E. 155th) (two subjects/12.5 percent).

Background color

Subjects were asked to rank three background screen colors (gray, blue, and white) according to ease of reading and preference (see Table 7). Most subjects liked gray the best and found it easiest to read and liked blue the least and found it hardest to read. Several subjects mentioned that the blue screen appeared to flicker, which may have contributed to its lack of popularity. Many of those who preferred the gray background commented that the colors and other features of the map stood out well against the darker background.

Interpreting the Main Screen—Summary of Results

The colors indicating traffic flow speeds on the main screen are intuitive and the most effective design element of *Traffic Reporter*. Arrows indicating the direction of traffic flow need to be added to the map, either between or beside the freeway lanes. Alternative designs for the express lanes need to be considered, including the disappearance of closed ramps. Adding SeaTac International Airport and lines indicating other major Seattle-area roadways (e.g., SR-99, West Seattle freeway) would help users orient themselves to the *Traffic Reporter* map. We should consider the possibility of changing the background to gray or a similar dark color.

Table 7. Number of Subjects Ranking Background Colors by Ease of Reading and Preference

	Background Color		
Rank	**White**	**Gray**	**Blue**
1st			
Read	3	8	4
Prefer	3	9	4
2nd			
Read	10	6	2
Prefer	8	6	3
3rd			
Read	3	2	10
Prefer	5	1	9

Using and Interpreting the Trip Window

Subjects used the trip information window to answer many of the questions in Section I of the useability test (Appendix F). In Section II of the test (Appendix G), subjects evaluated different trip window designs and interpreted different pieces of information from the trip window. What follows summarizes subjects' reactions to the trip information window in three areas: (1) locating information in the trip window, (2) responding to trip window design, and (3) using trip window information.

Locating Trip Window Information

Once subjects had the trip window in front of them on the screen, they had little trouble locating or understanding the information it contained. In general, they answered correctly and with little hesitation questions about travel time, speed, distance, and number of routes. Almost all subjects took longer to answer questions about the number of miles in a route than they did to answer questions about travel time or speed. One subject, in fact, did not see the distance information at all and calculated in her head comparative distances using travel times and speeds.

On Question 11 in Section I, which required subjects to locate and use scroll bars to find the number of routes between two locations, some subjects had a problem. Without

using the scroll bars, the answer appears to be four routes; however, using the scroll bars reveals an additional trip. Eight subjects (57 percent) overlooked the scroll bars and said there were four routes between the two locations; six (43 percent) used the scroll bars and said there were five routes (this question was added after the first two subjects had already completed the test, resulting in a total of 14 responses). Subjects who noticed and used the scroll bars were people who were not only comfortable with but were also experienced with computers. Even for these experienced users, the scroll bars acted temperamentally. The small arrows are hard to touch accurately, especially with a finger. In its current design, the scroll bar feature of the trip information window is useful only to adept and experienced computer users.

We asked subjects three questions to see whether their interpretations of travel time and speed coincided with *Traffic Reporter's* use of the terms. When asked whether travel speed meant constant or average speed, 15 subjects (93.75 percent) said average speed, which corresponds to *Traffic Reporter's* intended meaning. When asked whether travel time meant time on the freeways or time door to door, 15 subjects (93.75 percent) said time on the freeway, which again corresponds to *Traffic Reporter's* intended meaning. Twelve subjects (75 percent) said travel time did not include time spent on freeway ramps; 4 subjects (25 percent) said travel time did include time spent on the ramps.

The responses to these three questions indicate that most users will understand *Traffic Reporter's* use of the terms travel time and speed; however, brief on-screen definitions would ensure that all users interpreted the information correctly. Distance information, which appears to be somewhat difficult to locate in the current trip window design, should be bolded or set off separately from route descriptions. Scroll bars should be eliminated, either by fitting all trip information into one screen or by using a button that prompts the user to press it for more trips.

Responding to Trip Window Design

In Section II of the useability test, subjects answered questions about various information layouts in the trip window and expressed their preferences for four different trip information window designs (Appendix H). Two of the designs were charts, similar to the one currently displayed by *Traffic Reporter*, and two were graphs. One of the charts displayed, in a separate column, HOV time as total trip time on HOV lanes. The other chart displayed HOV time as a "Save X minutes on HOV" line below the regular lane time and speed. One of the graphs used horizontal bars to indicate time and speed, and the other used vertical bars. Twelve subjects (75 percent) preferred the chart format over the graph format. Further, 10 (62.5 percent) preferred the "Save HOV" line to the separate HOV column in the chart format. Several subjects commented that they may have preferred the chart design with the "Save HOV" line because it most closely resembled the trip window they had already used. In the less preferred graph format, 15 (93.75 percent) preferred the horizontal graph to the vertical graph.

When asked if they had noticed any order among the routes displayed in the trip information window, only five (31.25 percent) said they did. Those five correctly believed that the routes were ordered by travel time, with the least time consuming trip first. When we asked all subjects what order they would prefer for the routes, 14 (87.5 percent) said they would prefer order by travel time with least time consuming first (two had no preference).

To determine the clearest way to phrase and lay out route information in the trip window, we presented subjects with five route statements (see Appendix I). They varied either in wording order (e.g., order of direction versus freeway number: "South I-5" versus "South on I-5" versus "I-5 South") or in tab spacing:

"South on I-5"	versus	"South	on	I-5"
"East on I-90"	versus	"East	on	I-90"

We asked subjects to choose and rank as their first and second choices the two descriptions they thought were easiest to understand (see Table 8). Most subjects preferred route descriptions that listed direction first (as opposed to freeway number) and included the word "on," and most subjects preferred the nontabbed descriptions.

Test results indicate that the chart design currently displayed by *Traffic Reporter* is an effective way of presenting time, speed, and distance information. Routes should be arranged according to time, with the least time-consuming route listed first. Route descriptions should include the word "on," should list direction rather than freeway name first, and should not be spaced with tabs.

Using Trip Window Information

As mentioned above, subjects had little trouble locating or understanding the information contained in the trip window. They did feel, however, that certain pieces of information were more valuable than others. Freeway travel time was seen as the most valuable piece of information, speed as next most valuable, and distance in miles as least valuable. Table 9 below shows how subjects ranked speed, time, and distance information according to information value.

Table 8. Number of Subjects Ranking Route Descriptions 1st or 2nd Choice

	Rank	
Route Descriptions	**1st Choice**	**2nd Choice**
South on I-5 (no tabs)	9	1
South on I-5 (tabs)	3	7
I-5 South (tabs)	3	1
South I-5 (no tabs)	0	4
South I-5 (tabs)	2	2

Table 9. Number of Subjects Ranking Speed, Time, and Distance Information 1st, 2nd or 3rd Choice

	Rank		
Information	1st Choice	2nd Choice	Third Choice
Time	13	1	0
Speed	1	8	0
Distance	0	6	8

These rankings were supported by answers to four additional questions that asked subjects to choose their preferred route on the basis of information in the trip window and then to explain the reasons for their choice. Freeway travel time usually determined route choice, but most subjects also liked being told the length of each route. When asked whether it helped to know a route's distance, 10 (62.5 percent) said it did and 6 (37.5 percent) said it did not. Those who liked knowing the route distance said that distance factors into the process of choosing routes (amount of gas used, chances of an accident, etc.), especially when travel time on different routes is virtually equal. Table 10 indicates the number of times subjects indicated speed, time, distance, and other route characteristics as their first, second, or third reason for preferring a particular route.

While subjects based their route choices primarily on freeway travel time, other factors not listed in the trip information window also played a part. Half of the subjects stated that they were as likely to base their route choices on personal preference and experience as on trip window data. For example, one subject said that he tries to avoid downtown Seattle whenever possible. Others indicated that, unless the I-90 bridge is at a dead stop, they take it instead of the SR520 bridge. Another said he chooses three-lane freeways over two-lane ones whenever possible. Informal comments suggested that when time differences between routes are less than five minutes, subjects see the times as essentially equal and base their route choices on other factors.

Table 10. Number of Subjects Choosing Routes Based on Various Characteristics

	Influence on Route Choice		
Route Characteristic	1st Reason	2nd Reason	3rd Reason
Time	39	6	2
Speed	2	6	6
Distance	0	5	5
Familiarity	0	3	0
# Route changes	1	1	1

Because the times and speeds displayed by *Traffic Reporter* may differ from typical ones (e.g., normal Friday afternoons), we asked subjects whether they would be helped by comparing current data with typical travel times and speeds. Thirteen subjects (81.25 percent) said the comparison would not help them.

When asked whether there was anything they would add to or eliminate from the trip information window, subjects made the following suggestions:

- For flashing red areas, identify the nature of the problem in the trip window, e.g., accident, construction, etc. (six subjects/37.5 percent).
- Indicate, in the trip window, the number of riders (two or three) required for HOV lane use (three subjects/18.75 percent).
- Since the Freeway Time column includes the data of most interest, put it first after the Route column (two subjects/12.5 percent).
- Highlight best route (subject was not specific about what "best" meant, but time was the most important piece of information to this subject and to 81.25 percent of all subjects, as mentioned earlier) (one subject/6.25 percent).
- Present Route Distance as a separate column (one subject/6.25 percent).

Using and Interpreting the Trip Window—Summary of Results

Commuters tend to choose their routes according to how long a trip takes. However, distance, speed, and other factors also play a role, especially if the time differences between

routes is small. Therefore, although travel time is the most valuable information *Traffic Reporter* provides in the trip window, typical times and speeds do not interest users enough to bother displaying them. The usefulness of *Traffic Reporter* would be enhanced if it displayed the reasons for traffic slow-downs, particularly where the screen displays flashing red lanes. We should re-examine the trip window design to see whether travel time information could be more effectively presented, and we should explore the possibility of including incident reports where major slow-downs occur. Ideally, we could design the trip window so all the information would fit on one screen. If more than one screen is necessary for trips with many routes, we should consider replacing the scroll bars with a MORE ROUTES button.

Zoom Feature

While subjects did not use the zoom feature, we demonstrated it to them and asked whether they could think of ways they would use it. Eleven subjects (68.75 percent) said they would use it in the following ways: to break large areas of yellow or red speed colors into more specific speed blocks; to obtain exact speeds for short commutes or bridge commutes; or to decide what exit to take. Seven subjects (43.75 percent) said that the zoom feature would be useful or more useful if it displayed exit and entry ramps. One (6.25 percent) subject suggested that the cause of slow traffic (e.g., accident, construction, etc.) could display when a user zoomed in on a particular area.

While the majority of subjects identified ways to use the zoom feature, none of the suggested ways was particularly compelling. As currently designed, the zoom feature does not add a great deal to the information already available on the main screen. For the zoom feature to be useful, motorists want it to display specific ramp locations and/or incident reports on the zoom screen.

Using Printed Guides

To help subjects as they interacted with *Traffic Reporter*, we gave them a brief, one-page set of Instructions for Using *Traffic Reporter* (see Appendix C) and two Lists of

Freeway Ramps arranged alphabetically either by area label or by freeway ramp (see Appendices D and E). Twelve subjects (75 percent) read the Instructions before they started answering the questions; four (25 percent) read the Instructions only when they encountered a question they could not answer. Seven (43.75 percent) experimented with the system before they began answering the questions.

Table 11 shows that 14 subjects referred to the Instructions or the Ramp Lists while answering the questions in Section I. Eight subjects (50 percent) used the Instructions to answer Question 7, where they needed to activate and interpret the route and trip information window for the first time. Six subjects (37.5 percent) referred to the Instructions to answer Question 10, when they first identified specific freeway ramps. Recall that some of the subjects either had read the Instructions before they began using the system or had experimented with *Traffic Reporter* and thus already knew how to find the trip information window and how to identify specific ramps by the time they encountered questions on these features. To answer Questions 12 through 14, which required locating and selecting specific freeway ramps, all subjects referred to the Ramp Lists to locate at least one ramp. More subjects chose to consult the Ramp List arranged by ramp names than the list arranged by area labels (10 versus 7 for Question 12; 14 versus 2 for Question 13).

Table 12 summarizes subjects' rankings of the two ramp lists according to whether they found them useful, somewhat useful, or not useful. Most subjects (68.75 percent) found the alphabetically organized List of Ramps useful. Several subjects commented that, unless a commuter knew all the ramps in the area, such a list would be essential. However, subjects also commented that on most trips they knew where to enter and exit the freeway and would not need such a list. Overall, subjects found the list organized by area labels less useful. Those who found it useful thought it would be helpful for traveling to ramps in relatively unfamiliar areas.

Table 11. Number of Subjects Using *Instructions* and *Ramp Lists* on Section I Questions

Nature of Question	Type of Aid		
	Instructions	List by Area Label	List by Ramp Name
(#7) Activate Trip Window, First Time	8	0	0
(#10) Identify Freeway Ramps , First Time	6	0	0
(#12) Locate and Select Freeway Ramps	0	7	10
(#13) Locate and Select Freeway Ramps	0	2	14
(#14) Locate and Select Freeway Ramps	0	3	1

Table 12. Number of Subjects Ranking Ramp Lists for Usefulness

Freeway Ramp List	Rank		
	Not Useful	Somewhat Useful	Useful
Ramp Name Organization	2	3	11
Area Label Organization	5	7	4

In Section II, subjects answered questions about the usefulness of the Instructions for using *Traffic Reporter.* Seven subjects (43.75 percent) suggested information they would add to the *Instructions*; 12 (75 percent) suggested formatting or other changes. The suggested additions and changes to the *Instructions* are listed below.

Ramp Selection

- Add more information about the selecting and dragging operation (six subjects/37.5 percent).
- Highlight or otherwise emphasize information about ramp selection (four subjects/25 percent).
- Use the words "drag down" instead of "pull down" when explaining ramp selection (one subject/6.25 percent).

- Use the phrase "pull your finger down" instead of just the word "pull" (one subject).

- Use the word "light up" instead of "highlight" (one subject).

Ramps versus Area Labels

- Clarify differences between ramps and area labels (one subject).

- Use the words "specific ramps" and "general areas" (one subject).

- Call the "area labels" something else, for example, "neighborhood areas" (one subject).

Freeway Lanes

- Explain what the express lanes are and when they are closed (three subjects/18.75 percent).

- Add information about how to distinguish north from south on the regular and express lanes (one subject).

Scroll Bars

- Add instructions about the scroll bars found in the trip boxes (one subject).

Eliminate Information

- Delete the first three items listed in the *Instructions* (three subjects).

Change Type

- Reduce the type size on the information about the funding agencies (one subject).

As *Traffic Reporter* is currently designed, users will need some kind of instructions (printed or on-line) to learn how to (1) activate the trip information window, (2) call up ramp lists, and (3) select specific ramps. Our test results indicate that most people will read brief instructions before beginning to interact with the system. Although the Instructions used in the test did not adequately explain the process of ramp selection, test results indicate that the ramp selection method needs to be changed. Adopting the solution mentioned earlier of displaying ramps in the interim trip window would simplify both the process and the instructions. The express lanes and the direction of traffic flow in the freeway lanes need to be more clearly marked on the main screen and/or mentioned in the Instructions.

Further, ramp lists organized by ramp name will need to be available when users approach the system knowing a specific ramp name but not the area in which the ramp is located. The test subjects, all area residents and regular commuters, said that locating a specific ramp would be necessary at some times. In fact, subjects indicated that the interactive capability of *Traffic Reporter* would be most useful for nonroutine trips to places where they were most likely not to know ramp locations. Subjects' need to use the ramp list organized by ramp name may have resulted, in part, from the nature of the tasks we asked them to do. Nonetheless, they saw value in the list. Users who know what area a ramp is in can use the *Traffic Reporter* screen itself, which is organized on the basis of area labels. Users who know of a specific ramp but not where it is located must have access to a list arranged alphabetically by ramp name. To function effectively in all situations, *Traffic Reporter* must make such a list of ramps available.

Long Term Use/Overall Impression

Subjects answered several questions about their overall impressions of *Traffic Reporter* and their potential use of it were available to them. The following four lists summarize subjects' answers to what they found most useful about *Traffic Reporter*, liked the most, found the most confusing, and liked the least.

Positive Reactions

Most Useful Features

- Ability to obtain information by just glancing at the screen (ten subjects/62.5 percent).
- Trip information window (four subjects/25 percent).
- Exact travel time information (two subjects/12.5 percent).
- Route choices for trips (one subject/6.25 percent).
- Touch screen (one subject/6.25 percent).
- Up-to-the-minute information (one subject/6.25 percent).

Most Liked Features

- Intuitive colors indicating speed, which provide quick traffic information (11 subjects/68.75 percent).
- Trip information window (two subjects/12.5 percent).
- Bold, graphic, information-packed nature of the screen (two subjects/12.5 percent).
- Help in making route choices (two subjects/12.5 percent).
- Up-to-the-minute information (one subject/6.25 percent).
- Zoom feature (one subject/6.25 percent).
- Touch screen (one subject/6.25 percent).
- Ability to select specific ramps (one subject/6.25 percent).

Negative Reactions

Most Confusing Features

- Direction of traffic in the lanes (six subjects/37.5 percent).
- Express lane information (four subjects/25 percent).
- Ramp selection by dragging (two subjects/12.5 percent).
- Instructions for using the system (one subject/6.25 percent).
- Flashing red (one subject/6.25 percent).
- Placement of labels for highway names (one subject/6.25 percent).
- Designation of I-5 and I-405 interchanges (one subject/6.25 percent).
- More than three route choices in the trip information window (one subject/6.25 percent).

Least Liked Features

- Process of selecting and displaying ramps (five subjects/31.25 percent).
- Labels for south Seattle area (too few) (five subjects/31.25 percent).
- Touch screen (two subjects/12.5 percent).
- Square and unrealistic display (one subject/6.25 percent).
- Route descriptions in words instead of a visual representation (one subject/6.25 percent).

- Flashing red (one subject/6.25 percent).
- Indication of direction of travel in lanes (one subject/6.25 percent).
- Possibility of having to wait in line to use it (one subject/6.25 percent).
- Adjustment to its operation (one subject/6.25 percent).

In summary, the most useful and most popular feature of *Traffic Reporter* is the color-coded main screen that provides traffic information at a glance. The detailed information about routes available in the trip information window is also an attractive feature. Users of the present version of *Traffic Reporter* find the direction of traffic flow and the express lane display confusing, and they do not like the current process of selecting specific ramps.

Preferred Location

We also asked subjects to tell us what location for *Traffic Reporter* they would find most useful. Clearly, building lobbies and work places are the most preferred locations. Their answers are listed below.

- Lobbies of buildings (ten subjects/62.5 percent).
- Work place (six subjects/37.25 percent).
- Parking garages (four subjects/25 percent).
- Airport (four subjects/25 percent).
- Park-and-ride lots (three subjects/18.75 percent).
- Television (two subjects/12.5 percent).
- Cars (two subjects/12.5 percent).
- Home (two subjects/12.5 percent).
- Shopping malls (two subjects/12.5 percent).
- Above freeway entrances on large screens (one subject/6.25 percent).
- Gas stations (one subject/6.25 percent).
- On-line (one subject/6.25 percent).
- Elevators (one subject/6.25 percent).
- Drive-through espresso stands (one subject/6.25 percent).

Table 13. Number of Subjects Using Traffic Reporter by Location

	Location			
Type of Use	Lobby	Office	Home	Totals
Glance	13	7	7	27
Interact	2	9	5	16
Ignore	1	0	3	4

- Cash machines (one subject/6.25 percent).

We asked subjects to indicate how different locations would affect their use of *Traffic Reporter*. Table 13 summarizes their answers regarding locations in the lobby of the buildings where they work, in their offices, or in their homes. Regardless of location, as the "Totals" column indicates, more people would glance at *Traffic Reporter* than would interact with it. Although more subjects stated that they would interact with *Traffic Reporter* in their offices (nine subjects/56.25 percent) than simply glance at it (seven subjects/43.75 percent), this difference is not statistically significant.

Most subjects indicated that they would use *Traffic Reporter* less at home than they would in any other location. One subject, who answered the question about home use in two ways, helped clarify why. She explained that she would use *Traffic Reporter* at home if it were available to glance at on television but not if she had to dial in. Another subject also said that the need to dial in would make it too inconvenient to use from home. Access to *Traffic Reporter* via modem, it appears, could deter some users, but future interactive TV could be particularly useful.

The answers summarized in Table 13 reinforce the answers to an earlier question in which subjects stated whether they would more frequently glance at the screen or pull up a trip information window (81.25 percent of the 16 subjects said they would more frequently glance at the screen).

While subjects appreciated the interactive features of *Traffic Reporter*, most admitted they would seldom use them. The fact that the most popular locations for *Traffic Reporter* were all work-related indicates that subjects viewed the system as a tool to help with their commutes. However, practical factors limit the usefulness of the interactive features for commuting purposes. Subjects said they would not stand in line to search for route information and that they would not take the time to turn on their computers at home and dial into *Traffic Reporter* before they left for work. Had we been able to say *Traffic Reporter* was now available over cable television, home may have been a more popular location. As it is currently designed and accessible, the interactive features of *Traffic Reporter* will be most useful to people considering nonroutine trips.

The subject perceptions stated here do not necessarily mean that future versions of *Traffic Reporter* will not be useful tools for home travel planning. Usability improvements (see below) and people's growing experience with using the Internet from home will likely make the system a valuable information resource for both commute and other freeway travel.

USEABILITY ASSESSMENT CONCLUSIONS AND RECOMMENDATIONS

Overall, subjects were enthusiastic about *Traffic Reporter*. Many of them agreed to participate in the useability test because they believe that solutions to Seattle's traffic problems are desperately needed. They saw *Traffic Reporter* as an aid to negotiating those problems, if not a solution. The following summarizes the conclusions and recommendations reached as a result of the *Traffic Reporter* useability tests. These recommendations indicate changes in the user interface that can make the entire system more functional, beneficial, and easier to use. The recommendations from this list that were implemented are described in detail in the next chapter.

1. The main screen, with three colors and flashing red indicating traffic speeds, is intuitive and effective.

2. To avoid confusion and to help users orient quickly to the *Traffic Reporter* map, arrows (or some other design element) must be added inside of or beside the freeway lanes to indicate the directional flow of traffic.

3. The white background should be replaced by a gray background.

4. The express lane display, with gray color indicating direction/closed, should be redesigned. If possible, closed areas of the express lanes should disappear from the screen. If closed areas cannot disappear, then directional arrows need to be added to the color display.

5. SeaTac International Airport and some indication of other Seattle-area roadways (e.g., West Seattle Freeway, SR-99) should be added to the main *Traffic Reporter* screen.

6. To make the touch screen convenient to use, area labels should be larger, and instructions should specify that the actual labels on the screen are to be touched.

7. The process for selecting specific ramps must be redesigned.

8. Printed or on-line help must be available for those users who wish to activate trip information windows. The help must include a list of freeway ramps arranged alphabetically by specific ramp name.

9. The basic design of the trip information window is effective. Some changes that would make it more effective include

   - eliminating the need for scroll bars or replacing the scroll bar with a MORE ROUTES button
   - making the distance in miles of a route more obvious
   - making the Freeway Time column the first column after the Route column.

10. The zoom feature should be dropped or expanded to provide more information, such as the locations of specific ramps and causes of congestion.

11. Incident reports explaining the reasons for stop-and-go traffic should be added to *Traffic Reporter*, either in the trip information window or as part of an expanded zoom feature.

12. Users will seldom take advantage of *Traffic Reporter's* interactive capabilities to obtain information about their regular commutes. Users familiar with *Traffic Reporter*, however, will search for specific trip information when traveling across town in the middle of the day or when traveling less familiar routes.

13. Extensive use of *Traffic Reporter* from homes may depend upon its availability over cable television.

CHAPTER 3. EXPANSION AND ENHANCEMENT

Guided by the results of useability tests of *Traffic Reporter's* effectiveness and usefulness, we expanded and enhanced *Traffic Reporter. Traffic Reporter* now covers more of I-5 and includes HOV lanes, express lanes, and other freeway systems, all of which are now integrated with I-5. *Traffic Reporter* compares multiple routes for a single trip and even shows how much time could be saved by using an HOV lane. *Traffic Reporter's* interactive screen has been redesigned, and a touch-screen version that includes dynamic cycling has been developed.

Enhancements important to traffic engineers were also completed. These include changes to the Setup Menu, especially the record and playback options; the ability to detect more faulty stations than were possible earlier; and the addition of a mechanism to compute confidence factors. We also investigated a predictive mode and took steps towards improving data accuracy.

Finally, we took the first steps to integrate *Traffic Reporter* with other traveler information systems in Puget Sound, particularly the Advanced Public Transportation System being developed under the *Bellevue Smart Traveler* project. (See *Bellevue Smart Traveler: Reducing SOV Commuting*, Proceedings of Pacific Rim TransTech Conference/ASCE Third International Conference on Applications of Advanced Technologies in Transportation Engineering, Seattle, WA. *ASCE*, Vol. 1, pp. 286-292.)

This chapter reports on the expansion and enhancement tasks that were completed in this phase. Because of problems outside our control, we were unable to complete some enhancements. This chapter explains those problems and describes the work that we accomplished.

EXPANDED COVERAGE

By the end of Phase 2 of this project, *Traffic Reporter* covered a 15-mile section of the northbound and southbound lanes of I-5. In Phase 3, coverage was expanded to include more of I-5, as well as other freeway systems. *Traffic Reporter* now covers over 60 miles and includes I-5 from Swamp Creek to Southcenter, both I-90 and SR-520 from Seattle to Bellevue, and I-405 from Renton to Woodinville. *Traffic Reporter* also covers the reversible express lanes on I-5 and distinguishes HOV lanes from regular lanes.

In addition, all of the freeway systems covered by *Traffic Reporter* are now integrated, allowing commuters to quickly and easily acquire information for a trip that starts on one freeway and ends on another. This integration also allows commuters to compare multiple routes for a single trip.

ENHANCEMENTS

Enhancements to *Traffic Reporter* were made to the (1) interface design, (2) menu commands, (3) detection of faulty freeway stations, (4) computation of confidence factors for each freeway station, and (5) conversion and accuracy of sensor data. The following sections describe specific enhancements.

In addition to these enhancements, we investigated a predictive mode. Results of this investigation are also discussed in the following sections.

Changes to Interface Design

Four major changes were made to *Traffic Reporter's* interface: (1) area labels were added, (2) directional arrows were added, (3) the data key window (which shows the ranges for various types of data that appear on the screen's map) was modified, and (4) the trip information window was modified. In addition, users can now customize many of the screen features (e.g., change background and text colors or activate the zoom feature). Customizing *Traffic Reporter's* interface is accomplished through the new Setup Menu, which is described later in this section.

Area Labels

The previous version of *Traffic Reporter* displayed individual ramp labels. However, because of *Traffic Reporter's* expanded coverage, it was impossible to fit all ramp labels on the main screen. Therefore, one change to *Traffic Reporter's* interface was the addition of area labels to the freeway map that act as pull-down menus to display ramps. There are area labels for 16 areas—nine areas along I-5 and seven on the east/west freeway corridors. I-5 area labels include Mill Creek, Lynnwood, North Seattle, Northgate, University District, Montlake, Downtown Seattle, Boeing Field, and South Center. East-west corridor area labels include Woodinville, Totem Lake, Kirkland, Bellevue, Factoria, Coal Creek, and Renton. Figure 1 shows the main screen display with area labels. Figure 2 illustrates how individual ramps appear when area labels are selected. A list showing area labels with ramps is found in Appendices D and E.

Directional Arrows

The second change to the interface design was the addition of directional arrows. The direction of traffic flow is now represented on the freeway map by arrows pointing north, south, east, or west. In addition, a compass was added to the top of the screen showing the north-south and east-west orientation.

Data Key Window

The third change to the interface design was the modification of the data key window that displays the values for speed ranges. The previous version of *Traffic Reporter* displayed three colors, according to four speed ranges, in the data key window (green, yellow, red, and flashing red). The current version displays five colors showing six types of information: green, yellow, red, and flashing red to indicate four speed ranges; gray for closed freeway segments; and white for freeway segments with no data. (See Figure 1.)

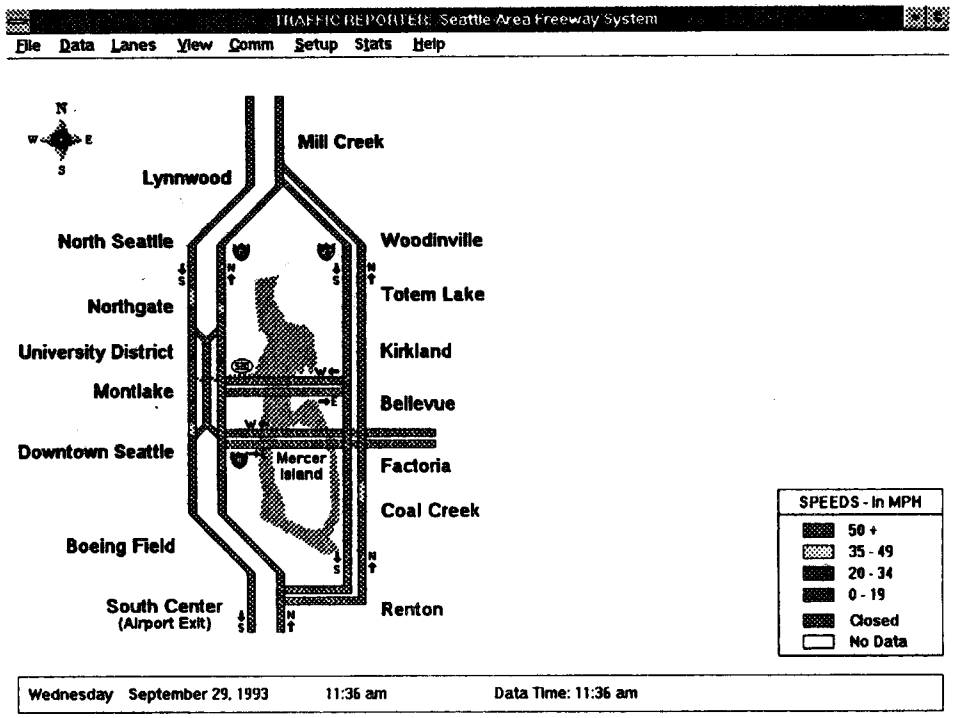


Figure 1. Main Screen Display Showing Area Labels and Data Key Window.

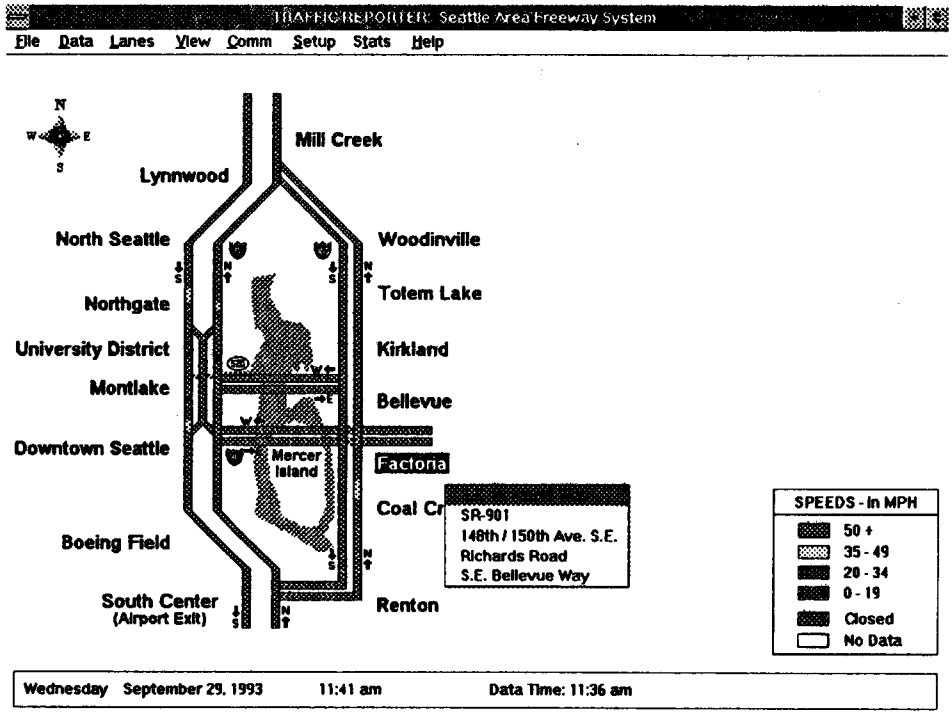


Figure 2. Freeway Map Showing Individual Ramps for a Specific Area

Trip Information Window

The fourth change to the interface design was the modification of the trip information window. In the previous version of *Traffic Reporter*, when a trip was selected, the trip information window displayed the origin and destination points, travel time, and average freeway speed. The current version displays routes along with travel times and speeds. In addition, the window displays, when relevant, time that could be saved by using an HOV lane. Finally, users may select an option that allows for comparison of the current trip to a "normal" trip (based on trip averages for that day and time).

Now that *Traffic Reporter* displays multiple freeways, a single trip selection can include not only multiple routes, but individual routes can span more than one freeway. When a trip is selected, *Traffic Reporter* determines all possible routes, sorts them by travel time, and filters out "unreasonable" routes, thus displaying only relevant routes in the trip information window. Some trips have as many as eight different routes, but after filtering, the trip information window generally displays between two to four routes. Figure 3 shows a trip information window with multiple routes and HOV lanes. In cases where it is impossible to view all the routes at the same time in the trip window, users can either scroll down or press a button.

The final change to the trip information window was to display the columns showing route information and trip times side by side, with the route information column appearing first. This visual arrangement makes it easier to see the distance for each route.

Improved Menu Commands

Setup and Stats menus were added to the interface, and the Lanes menu was implemented. The following section describes these menus. Detailed descriptions of all the menus are found in Appendix M. In addition, keyboard shortcuts were added to several of the menus, and these shortcuts are also found in Appendix M.

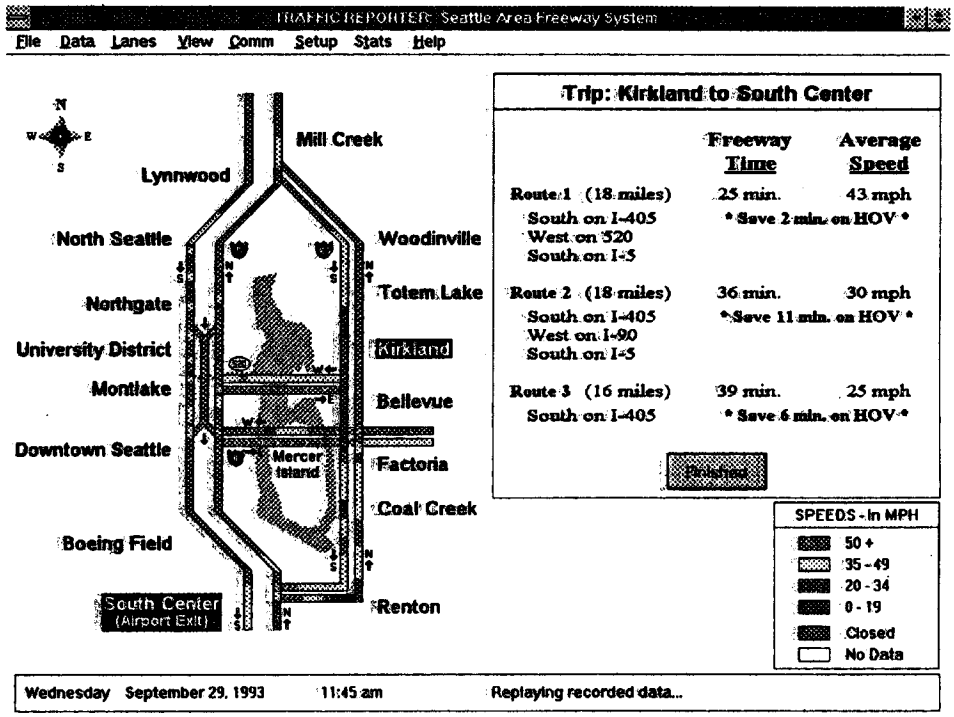


Figure 3. Trip Information Window Displaying Multiple Routes and HOV Lanes

Setup Menu

In the first version of *Traffic Reporter*, the setup commands resided in the Data menu. In this version, new setup commands have been added, and all setup commands now reside in the new Setup menu. This configuration allows *Traffic Reporter's* features to be easily customized to accommodate different types of users and different purposes. The new Setup menu commands are Map Setup, Zoom Setup, Trip Setup, Data Setup, Status Setup, and Window Setup.

In addition, the Record Setup and Range Setup commands were moved from the Data menu to the Setup menu.

Stats Menu

A Stats menu was also added to this version of *Traffic Reporter*. Commands in this menu allow *Traffic Reporter* to record statistics on

- how often the system was connected to the Traffic Systems Management Center (TSMC)
- how many trips each user selected
- how often a user selected each area or ramp label
- how often a user accessed the zoom feature
- how long the system was running
- how many times the user clicked the mouse button.

These statistics cover two types of time periods: the amount of time the system has been active since it was initially started, and the amount of time the system has been active since the most recent start-up.

Lanes Menu

The Lanes menu, which was included but not implemented in the previous version of *Traffic Reporter*, was implemented in the current version. The Lanes menu has two commands: Regular, which displays regular lanes only; and HOV, which displays freeway segments that have HOV lanes.

Handling Faulty Stations

Faulty data refers to data that, due to insufficient source data, can only be estimated. This project encountered two types of faulty data:

1. data that were detected as faulty by the central computer at TSMC
2. data that were detected as faulty by *Traffic Reporter's* internal error detection algorithm.

The following sections describe how these data types were handled.

Faulty Data Detected by TSMC

When TSMC determines that a station's data is faulty, the computer marks it as faulty in the data packet sent to *Traffic Reporter*, in which case *Traffic Reporter* estimates a speed value for that station. *Traffic Reporter* can also display that station on the screen with a color that identifies it as having faulty data.

Faulty Data Detected by *Traffic Reporter*

Because a station can have faulty data that still appear good when sent from TSMC, *Traffic Reporter* attempts to locate these stations with two methods. The first method uses a validity algorithm developed by Nancy Nihan. (See *Freeway Database Storage and Loop Detector Validity*. Transportation Northwest Report TNW90-15, February 1990.) This algorithm checks the station's volume and occupancy values against various threshold values to determine whether the station is reporting valid, suspect, or error data. This method produces validity codes that refer to station problems such as "chattering" and "hanging on." *Traffic Reporter* can then display these validity codes.

The second, less complicated method of detection compares the calculated speed to a threshold value. If the speed calculated is greater than the threshold value, the station is marked as producing "suspect" data, and the speed is reduced to the threshold speed. For example, if *Traffic Reporter* computes a speed of 85 mph for station #13 and the speed threshold is set to 65 mph, then station #13 is marked "suspect," and the speed is reduced to 65 mph.

Confidence Factors

In attempting to determine which sections of the freeway are receiving insufficient usable data, *Traffic Reporter* computes a confidence factor for all freeway sections (for example, northbound I-5). The confidence factor is the percentage of usable traffic data for a freeway section. Confidence factors for each freeway section can be

displayed to show not only where data problems exist, but also severity of problems for individual freeway sections. In addition, *Traffic Reporter* can be instructed to omit data for an entire freeway if it is not receiving enough usable traffic data. For example, if northbound I-5 were receiving only 18 percent of the relevant traffic data, *Traffic Reporter* would show that no data for northbound I-5 were available. This feature ensures that *Traffic Reporter* does not give out speed estimates that are based on too few data.

Improvement of Conversion and Accuracy of Sensor Data

To improve the accuracy of the algorithm that *Traffic Reporter* uses to convert traffic data to travel speeds, we incorporated custom "g" factors for 33 of the stations used by *Traffic Reporter.* (A "g" factor is a constant that is used in the equation that converts the volume and occupancy data to freeway speeds.) We also incorporated a better general "g" factor for the remaining stations. (See *Travel Time Estimation using Cross-Correlation Techniques*, Transpn. Res.-B Vol. 27B, no. 2, pp 97-107, 1993; and *Improved Estimates of Travel Time from Real Time Inductance Loop Sensors*, WSDOT Final Technical Report WA-RD 292.1, May 1993.)

Predictive Mode Investigated

Although algorithms exist for predicting traffic information, they are either too elementary or too complex for our purposes. The elementary algorithms do not provide enough information to be of significant use to *Traffic Reporter.* The complex algorithms require too many system resources—mainly memory and processor time—to be implemented into *Traffic Reporter* at this time.

Nihan's algorithm to detect bottlenecks could be implemented into a system like *Traffic Reporter*, but this algorithm predicts only traffic conditions; it does not predict traffic data values. (See *Predictive Algorithm Improvements for a Real-Time Ramp Control Systems*, Washington State Department of Transportation Final Report WA-RD

213.1, September 1991). *Traffic Reporter* is driven by actual traffic data values such as volume and occupancy. It may be possible to add another mode to *Traffic Reporter* that would calculate and display predicted bottleneck areas. But, first, useability testing would be needed to determine how useful such a feature would be to the system's users.

While other algorithms can predict future traffic data values, such algorithms require that much of the previous traffic history remain in the computer's memory at all times. These algorithms also require a substantial amount of processor time to compute predictions for each station. Currently, *Traffic Reporter* lacks the resources to both provide real-time traveler information and perform the lengthy calculations required for these algorithms. However, it is conceivable that a data fusion server (see the ATIS/ATMS System Plan) or the VAX computer system at the TSMC could make these calculations on a 1-minute basis and send them with the traffic data package currently sent to *Traffic Reporter.*

In summary, although a predictive algorithm could be implemented into a system like *Traffic Reporter*, it is inadvisable at this stage of the project.

CHAPTER 4. DELIVERY OF *TRAFFIC REPORTER*

Traffic Reporter's primary objective is to deliver real-time traveler information directly to commuters. While we are exploring numerous delivery methods (for example via pagers and telephones under the *Bellevue Smart Traveler* Project), under this project we pursued two methods of delivery: via TV and radio traffic reporters and via a touch-screen kiosk version. This chapter describes our efforts to deliver *Traffic Reporter* via these methods, as well as complications we encountered because of problems with the source data.

DELIVERY VIA TV AND RADIO

The *Traffic Reporter* prototype was installed at KIRO NewsRadio (for internal use only) in exchange for its suggestions for improving the system. During this time, minor but important enhancements and changes were made to *Traffic Reporter* to make it more attractive to TV and radio traffic reporters. In general, KIRO liked *Traffic Reporter* but was unable to use the system for on-air reports because of problems with the source data described in a later section of this chapter.

DELIVERY VIA TOUCH SCREEN

A touch-screen kiosk version of *Traffic Reporter* was created for use in public locations. This version has both interactive and noninteractive modes. In both modes, *Traffic Reporter* displays areas of congestion on the color-coded freeway map. In its interactive mode, *Traffic Reporter*'s information is accessed by a touch screen input device. Users simply touch their destination on *Traffic Reporter*'s screen and instantly receive trip information.

When *Traffic Reporter* is not being used, it goes into its noninteractive mode. In this mode, *Traffic Reporter* cycles through the most common trips. Trip cycling continues until someone touches the screen, returning it to interactive mode.

We demonstrated touch screen versions in Westlake Mall (downtown Seattle) and Bellevue Place (downtown Bellevue, east of Seattle). The demonstration in Westlake Mall lasted for about four months. However, after the demonstration period, at Westlake's request, we left TR there for an indefinite period. (Staff from the WSDOT agreed to maintain it.)

We took statistics at both demonstration sites. These figures are shown in Table 14. Note that there were occasions when source data were unavailable or were suspect because of problems with the data. These problems are described under "Problems with Delivering Traffic Reporter."

DELIVERY TO OTHER LOCATIONS

In addition to being used at KIRO, *Traffic Reporter* was demonstrated and delivered to the following organizations:

Traffic Systems Management Center in Seattle, Washington

Washington State Energy Office in Olympia, Washington

SRI International in Menlo Park, California

Paramax Systems in St. Paul, Minnesota

Texas Transportation Institute at Texas A&M University in College Station, Texas

Metro Toronto Transportation in Ontario, Canada

PROBLEMS WITH DELIVERING *TRAFFIC REPORTER*

We encountered several problems with delivering *Traffic Reporter*. These problems were all related to insufficient and unreliable source data.

Table 14. Statistics on Use of TR at Demonstration Sites

	Westlake Mall	Bellevue Place
Trips selected	4,448	7,082
Average routes	2.0	1.9
Average distance in miles	9.7	8.9
Area label searches	6,582	7,082
Dials	44,552	49,563
Connects	21,936	30,696
Busy	33,030	53,688
No answer	50,111	58,559
No carrier	4,961	37,652
Screen clicks	10,375	17,109

Problems with TSMC

Traffic Reporter's source data comes from TSMC's mainframe computer. This computer receives the raw volume and occupancy data from the sensors in the freeways. During *Traffic Reporter's* development, the TSMC upgraded its computer system and moved to a new location. These activities caused a lengthy disruption, during which *Traffic Reporter* was unable to receive the source data and to conduct testing to verify the accuracy of the travel speeds that it calculated.

Problems with Freeway Sensors

Once the TSMC's computer was back on-line and *Traffic Reporter* was receiving data, we discovered that *Traffic Reporter* was receiving only half of the normal data. This condition made it impossible for *Traffic Reporter* to display an accurate picture of the freeway conditions.

While there were several reasons for this problem, the main problem was freeway construction projects. Many areas of the freeway system were under construction, making it necessary for loop sensors to be off-line. This is an on-going problem.

Another problem was with the cabling that allows the sensors to communicate with TSMC's computer. First, a Fiber-Hub failure near Factoria took 15-20 stations off-line. Also, mainline cable on northbound I-5 fails intermittently, which can take all northbound stations from Northgate to 236th off-line.

Finally, some of the loop sensors are simply broken, often because the amplifier needs to be adjusted or replaced or because the modem needs to be replaced.

Problems with Freeway Station Software

Problems with freeway station software also resulted in bad data. Some of the 170s in the field are reporting invalid codes, making the data they provide useless.

FINAL COMMENTS

During Phase 3 of this project, we completed the prototype of the *Traffic Reporter* software. This development was based on extensive useability testing, conducted both during this phase and during the previous two phases.

In addition to developing the prototype software, we also conducted preliminary operational testing at Westlake Mall, Bellevue Place, and KIRO radio/TV. These preliminary tests uncovered numerous weaknesses in the larger infrastructure that supports *Traffic Reporter.* The following activities address these issues and would help make *Traffic Reporter* a viable ATIS for general use:

1. Institute a plan with sufficient resources to assure a reliable loop system and data availability.
2. Conduct tests of the reliability of the speeds and travel times predicted by *Traffic Reporter.*
3. Develop innovative methods for delivery and maintenance of the *Traffic Reporter* software, particularly to address the issue of reliable access to the real-time data stream that feeds application.
4. Incorporate other data sources and types of traveler information into the current, exclusively loop-based application.
5. Explore the use of *Traffic Reporter's* extended functionality for traffic management, as well as for traveler information.

APPENDIX A TESTING TRAFFIC REPORTER: SUBJECT PROFILE

1. Please fill out the following:

   Name: _____

   Address: _____

   Phone: Work_____ Home _____

   Gender: Female_____ Male _____

   Age: _____

2. How many days per week do you commute on Seattle-area freeways? **Check only one.**

   0_____ 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____

3. In an average week, how many days per week do you:

   _____ Commute using your own car
   _____ Commute using a company car
   _____ Drive the vehicle you commute in
   _____ Ride as a passenger in the vehicle you commute in
   _____ Commute alone
   _____ Give a ride to other passengers
   _____ Other (please explain):
   _____
   _____

4. How many times a week do you travel some portion of the following routes?

   _____ I-5 between Lynnwood and Downtown
   _____ I-5 between Downtown and Southcenter
   _____ SR-405 between Woodinville and Bellevue
   _____ SR-405 between Bellevue and Coal Creek
   _____ I-90 between the West and East side
   _____ SR-520 between the West and East side

5. What freeway route do you most frequently use to commute to work?

   _____
   _____

6. How do you feel about using computers? **Check only one.**

   _____ Not very comfortable
   _____ Somewhat comfortable
   _____ Very comfortable
   _____ I am comfortable with the idea of using computers but I never use them
   _____ I am not comfortable with the idea of using computers and I never use them

7. How often do you check media sources, such as television or radio, for traffic information before you drive on Seattle-area freeways?

   Never: _____ Seldom: _____ Sometimes: _____ Frequently: _____

8. If you answered FREQUENTLY or SOMETIMES to question 7, do you use the information:

   _____ To change the time you leave for your destination
   _____ To decide to take a different route from the one you normally take
   _____ To change your mode of travel (for example, you decide to take a bus rather than driving your own car)
   _____ To simply obtain information about what the commute will be like
   _____ Other (please explain) _____
   _____

APPENDIX B UNIVERSITY OF WASHINGTON CONSENT FORM

TRAFFIC REPORTER USABILITY TESTING

INVESTIGATORS:

Jan Spyridakis, Assistant Professor
Department of Technical Communication
College of Engineering, FH-40
(206)543-2567

Connie Miller
Department of Technical Communication
College of Engineering, FH-40
(206)543-2567

INVESTIGATORS' STATEMENT:

Purpose and Benefits

We are interested in commuter's responses to a real-time commuter information system known as Traffic Reporter. Traffic Reporter can alter the way we currently receive traffic information and can help commuters choose their travel routes.

Procedures

If you agree to participate in this study, you will be given a questionnaire to fill out that will ask general questions about your commute. You will read a brief set of instructions about using Traffic Reporter and then you will be given a set of tasks to perform on the system. After completing the tasks, you will be asked for your opinion about screen colors and screen and system design. You will be asked to read all tasks and questions aloud and to "talk through"" your thought processes and actions. Your responses will be audio- and videotaped.

Risks, Stress, and Discomfort

The only stress associated with this study is the normal stress associated with any non-graded test-taking activity and any possible frustration with looking at and using a computer application. You have the right to withdraw from this study at any time.

Other Information

Your identity will remain confidential. Only the investigators will have access to the data and that data will be retained for three years. You may refuse to participate or withdraw from the study at any time without penalty.

Signature of Investigator _____ Date_____

Signature of Investigator _____ Date_____

RESPONDENT'S STATEMENT:

The study described above has been explained to me. I voluntarily consent to participate in this activity. I have had an opportunity to ask questions. I understand that future questions I may have about the research or about my rights as a subject will be answered by the investigators listed above.

Signature of Respondent _____ Date_____

Using Traffic Reporter

Traffic Reporter provides up-to-the-minute traffic information about Seattle-area freeways.

- Colors in the freeway lanes show current traffic speeds.
- Labels by the freeways show areas where you can enter or exit.
- Freeway ramps are also available as entry and exit points.

- **To find route and travel time information:**

1. Touch the area label where you want to **enter** the freeway.

OR

To select a ramp, touch the area label, pull downward, and highlight the ramp where you want to **enter** the freeway.

2. Then, touch the area label or the freeway ramp where you want to **exit** the freeway.
3. Next, read the information in the window that appears.
4. Touch CANCEL or CLOSE to close the trip information window.

Traffic Reporter is sponsored by the U. S. and Washington State Departments of Transportation.
For more information, please contact Margaret Garner, Department of Technical Communication, College of Engineering, University of Washington, Seattle, WA 98195; (206)543-7616.

APPENDIX D INDEX OF AREAS WITH RAMPS

BELLEVUE
- 84th Ave. N.E.
- N.E. 8th St. (Midlakes)N.E. 4th St.
- S.E. 8th St. (Wilburton)

BOEING FIELD
- Spokane/Columbian Way
- Albro Pl/Swift Ave. S.
- S. Boeing Access Rd.

COAL CREEK
- Coal Creek Parkway
- 112th Ave. S.E.

DOWNTOWN SEATTLE
- Mercer St.
- Olive Way
- University St.
- Madison St.
- James St.
- Dearborn St.

FACTORIA
- S.E. Newport Way
- SR-901
- 148th/150th Ave. S.E.
- Richards Rd.
- S.E. Bellevue Way

KINGDOME
- Dearborn
- Spokane/Columbian Way
- Albro Pl/Swift Ave. S.

KIRKLAND
- N.E. 85th St.
- N.E. 70th St.

LYNNWOOD
- 220th St. S.W.
- 236th St. S.W.
- NE 205th St.

MERCER ISLAND
- 80th Ave. S.E.
- 76th Ave. S.E.

MONTLAKE
- Harvard Ave
- Boylston Ave.
- Mercer St.
- Lake Washington Blvd.
- Montlake Blvd.

NORTH SEATTLE
- N.E. 205th St.
- N.E. 175th St.
- N.E. 145th St.
- N.E. 130th St.

NORTHGATE
- N.E. 130th St.
- Northgate Way
- N.E. 85th St.

RAINIER VALLEY
- Maple Valley Rd.
- Rainier Ave./Valley Freeway
- West Valley Highway

SOUTH CENTER
- M. L. King Way S.
- SR-518/S. 154th St.

SUNSET/S-CURVES
- N.E. 44th St.
- N.E. 30th St.
- SR-900/N.E. Park Dr.
- Sunset Blvd.
- Maple Valley Rd.

SWAMP CREEK
- 128th St. S.W.
- 164th St. S.W.
- SR-525
- 196th St. S.W.
- 44th Ave. W.

TOTEM LAKE
- N.E. 124th St. (Totem Lake)
- N.E. 116th St.

UNIVERSITY DISTRICT
- Lake City Way
- Ravenna Blvd.
- N.E. 50th St.
- N.E. 45th St.
- N.E. 42nd St.(express)

WOODINVILLE
- SR 527/19th Ave. S.E.
- N.E. 195th St.
- SR-522 (Woodinville)
- N.E. 160th St./J-W Way

APPENDIX E INDEX OF RAMPS WITH AREAS

44th Ave. W. (**Swamp Creek**)
76th Ave. S.E. (**Mercer Island**)
80th Ave. S.E. (**Mercer Island**)
84th Ave. N.E. (**Bellevue**)
112th Ave. S.E. (**Coal Creek**)
128th St. S.W. (**Swamp Creek**)
148th/150th Ave. S.E. (**Factoria**)
164th St. S.W. (**Swamp Creek**)
196th St. S.W. (**Swamp Creek**)
220th St. S.W. (**Lynnwood**)
236th St. S.W. (**Lynnwood**)
Albro Pl/Swift Ave. S. (**Boeing Field, Kingdome**)
Boylston Ave. (**Montlake**)
Coal Creek Parkway (**Coal Creek**)
Dearborn St. (**Downtown Seattle, Kingdome**)
Harvard Ave. (**Montlake**)
James St. (**Downtown Seattle**)
Lake City Way (**University District**)
Lake Washington Blvd. (**Montlake**)
M. L. King Way S. (**South Center**)
Madison St. (**Downtown Seattle**)
Maple Valley Rd. (**Sunset/S-Curves Rainier Valley**)
Mercer St. (**Montlake, Downtown Seattle**)
Montlake Blvd. (**Montlake**)
N.E. 8th St. (Midlakes)N.E. 4th St. (**Bellevue**)
N.E. 30th St. (**Sunset/S-Curves**)
N.E. 42nd St.(express) (**University District**)
N.E. 44th St. (**Sunset/S-Curves**)
N.E. 45th St. (**University District**)
N.E. 50th St. (**University District**)
N.E. 70th St. (**Kirkland**)
N.E. 85th St. (**Kirkland**)
N.E. 85th St. (**Northgate**)
N.E. 116th St. (**Totem Lake**)
N.E. 124th St. (**Totem Lake**)
N.E. 130th St. (**North Seattle, Northgate**)
N.E. 145th St. (**North Seattle**)
N.E. 160th St./J-W Way (**Woodinville**)
N.E. 175th St. (**North Seattle**)
N.E. 195th St. (**Woodinville**)
N.E. 205th St. (**Lynnwood, North Seattle**)
Northgate Way (**Northgate**)
Olive Way (**Downtown Seattle**)
Rainier Ave./Valley Freeway (**Rainier Valley**)
Ravenna Blvd. (**University District**)
Richards Rd. (**Factoria**)
S. Boeing Access Rd. (**Boeing Field**)
S.E. 8th St. (Wilburton) (**Bellevue**)
S.E. Bellevue Way (**Factoria**)
S.E. Newport Way (**Factoria**)
Spokane/Columbian Way (**Kingdome, Boeing Field**)
SR 527/19th Ave. S.E. (**Woodinville**)
SR-518/S. 154th St. (**South Center**)
SR-522 (**Woodinville**)
SR-525 (**Swamp Creek**)
SR-900/N.E. Park Dr. (**Sunset/S-Curves**)
SR-901 (**Factoria**)
Sunset Blvd. (**Sunset/S-Curves**)
University St. (**Downtown Seattle**)
West Valley Highway (**Rainier Valley**)

APPENDIX F USEABILITY TEST CONTENT: SECTION I

Please use Traffic Reporter to answer the following questions. Refer to the Traffic Reporter instruction sheet and the Indexes of Freeway Ramps as often as you need to. Remember to read the questions aloud, to speak your answers aloud, and to talk aloud about the process you are using to come up with your answers. If you are unable to answer a question, explain aloud why you are having trouble and then go on to the next question.

1. a. At what speed is southbound traffic moving in the Northgate area?
   b. How do I know?

2. a. At what speed is northbound traffic moving in the Factoria area?
   b. How do I know?

3. a. At what speed is eastbound traffic moving in the Mercer Island area?
   b. How do I know?

4. a. I want to travel from the Montlake area to Bellevue. Using information from Traffic Reporter, which bridge would I take?
   b. Why?

5. a. I want to travel from Coal Creek to Northgate. Using information from Traffic Reporter, what route would I take?
   b. Why?

6. a. I want to travel from Swamp Creek to Boeing Field. Could I take the express lanes?
   b. How do I know?

7. a. I want to travel from Woodinville to Bellevue. At what speed is traffic travelling?
   b. Use the route and travel time information window to determine how much time the trip would take.

8. a. I want to travel from Totem Lake to the S. Curves using regular lanes. According to the route and travel time information window, how much time would the trip take?
   b. How much time would I save if I were using an HOV lane?

9. a. I want to travel from Northgate to Coal Creek. According to the route and travel time information window, how many different routes could I take?
   b. Which route would I choose and why?

10. Please use Traffic Reporter to name the freeway ramps in the Northgate area.

11. I want to travel from Rainier Valley to Swamp Creek. According to the route and travel time information window, **how many possible routes are there for me to take?**

12. a. I am near the Mercer St. entrance to the freeway and I need to travel to a company near N.E. 195th St. on the east side of Lake Washington. Based on the information in the route and travel time window, **what route would I choose?**

    b. Why?

13. I am planning to leave now from my east side office on N.E. 70th St. and travel to the SR 518 exit from I-5. According to the route and travel time information window, **what is the least amount of time the trip could take?**

14. Check my usual route between home and the office. **How much time will it take me to get to work?**

APPENDIX G USEABILITY TEST CONTENT: SECTION II

1. You answered the previous questions about using Traffic Reporter after reading this brief set of instructions.
   a. Is there any other information you wish these instructions had provided?
   b. If yes, what?
   c. Are there any changes you would like to see in these instructions?
   d. If yes, what?
2. Some of the questions you answered earlier about using Traffic Reporter asked you to locate and choose a specific freeway ramp, for example, Mercer St. or N.E. 70th St.
   a. Did you find selecting a specific ramp frustrating?
   b. If so, why?
   c. (Did you find this Index of Areas With Ramps:

      _____not useful _____ somewhat useful _____very useful

   d. Why?
   e. (Did you find this Index of Ramps With Areas:

      _____not useful _____ somewhat useful _____very useful

   f. Why?
   g. If you were going to use Traffic Reporter on a regular basis, which do you think you would use more frequently, area labels or specific ramps?
   h. Why?
3. a. When using Traffic Reporter, which do you think you would do more frequently: touch area labels or ramps to view the trip information window or just glance at the colors on the screen?
   b. Why?
4. In Section I, you were asked to interpret information about the express lanes on I-5. I'm now going to show you several different screens that display express lane information in different ways and ask you to answer questions about the screens.
   a. According to this Traffic Reporter screen, could you travel from Boeing Field to North Seattle using the express lanes?
   b. According to this Traffic Reporter screen, could you travel from Swamp Creek to downtown Seattle using the express lanes?
   c. According to this Traffic Reporter screen, could you travel from the Kingdome to Swamp Creek using the express lanes?
   d. According to this Traffic Reporter screen, could you travel from Lynnwood to South Center using the express lanes?

e. According to this Traffic Reporter screen, could you travel from South Center to Northgate using the express lanes ?

f(i) You just answered questions about these three express lane displays: one that used grey coloring to indicate nonfunctional lanes, one that used X's to indicate nonfunctional lanes, and one that used a combination of grey coloring and arrows to indicate direction and nonfunctional lanes. Please rank the three kinds of displays, with one indicating easiest to understand.

5-8. Earlier, you opened a trip information window to obtain travel time and speed for different routes between two locations.
I'm now going to ask you to look at several different designs of the trip information window and answer some questions about travel time and speed.
Remember to talk aloud not only your answer but also the process you use to arrive at your answer.

5. Trip Window #1

a. Which route takes the least amount of time?

b. On which route would you travel the fastest speed?

c(i) Which route would you choose to travel between South Center and Kirkland?

c(ii) Why?

6. Trip Window #2

a. Which route is the longest distance?

b. Which route takes the least amount of time?

c. Does the HOV time column give you: (i)time spent only in the HOV lanes or (ii) total trip time using some HOV lanes?

d(i) Which route would you choose to travel between Lynnwood and Coal Creek?

d(ii) Why?

7. Trip Window #3

a. On which route would you travel the fastest speed?

b. Which route is the longest distance?

c(i) Which route would you choose to travel between Factoria and Lynnwood?

c(ii) Why?

8. Trip Window #4

a. Which route takes the least amount of time?

b. On which route would you travel the fastest speed?

c(i) Which route would you choose to travel between Woodinville and Boeing Field?

c(ii) Why?

9. The next few questions address information in the trip window generally. As you answer the questions, feel free to refer to any or all of the trip window designs you used to answer earlier questions.

a(i) Do you prefer the horizontal or the vertical graph?

a(ii) Why?

b(i) Which of the two chart designs do you prefer?

b(ii) Why?

c(i) Which display of HOV information do you prefer, the HOV Time column or the the Save ??? minutes on HOV?

c(ii) Why?

d(i) Of the graph or chart format, which do you prefer?

d(ii) Why?

e. When a trip window tells you that the speed on Route 3 is 52 mph, do you think this means: constant speed or average speed?

f(i) When a trip window tells you that the time for Route 1 is 19 minutes, does this mean: freeway time or door to door time?

f(ii) Does freeway time include time on entry and exit ramps?

g(i) When the travel time and speed information windows came up while you were using Traffic Reporter, did you perceive any order among the different routes in the trip window?

g(ii) If so, what?

g(iii) In what order would you want the different routes to be displayed?

g(iv) Why?

g(i) Does it help you to know how many miles each route is?

h(ii) Why?

i(i) The current travel times and speeds displayed by Traffic Reporter may differ from normal or typical travel times and speeds for the same time and day of the week because of traffic volume, accidents, construction, or other factors.

Would it help you if Traffic Reporter displayed typical travel times and speeds as well as current travel times and speeds?

i(ii) If so, why?

j(i) Is there any additional information you would like to see displayed in the trip information window?

j(ii) If so, what is it?

k(i) Is there any information you would eliminate from the trip information window?

k(ii) If so, what is it?

l. Please rank order the importance of speed, time, and distance information in the trip information window, with one indicating most important.

m(i) On this sheet, the route for a specific trip is described in five ways. Which two descriptions (one indicating easiest and two indicating second easiest) are easiest for you to understand?

m(ii) Why?

10. Traffic Reporter has a zoom feature that allows you to zero in on a specific section of the freeway.
    a. Can you think of ways you might use this zoom feature?
    b. If so, what are they?
    c. Would you find the zoom feature:

    _____not useful _____ somewhat useful _____very useful

    d. Why?

11. You have seen Traffic Reporter with a white background screen. I would like you to look at these print outs of the screen with different background colors.

    a. Please rank the three screens according to which is easiest to read. One indicates easiest to read and three indicates hardest to read.

    b. Please rank the three screens according to which you prefer. One indicates your favorite screen and three indicates your least favorite screen.

12. Give the commuter a printed version of the TR screen including the location labels, freeways, lakes, etc. (Display 5) and a pen. This is a printed version of the Traffic Reporter map.

    a. First, draw a line through all of the area labels with which you are not familiar. Then, add to the map any landmarks, neighborhoods, street names, or other locations that you think would help you use Traffic Reporter more effectively.

    b. This is a list of some locations traffic reporters use when announcing traffic conditions on the radio. Could you please circle any locations on this list that would help you use Traffic Reporter more effectively.

c(i) Is there anything about the map display that you would change?

c(ii) If so, what?

d. Would you like to see arrows indicating the direction of the freeway lanes?

d(ii) If so, why?

13. I want to thank you for helping us test and improve Traffic Reporter. Before you go, I want to ask you a few final questions.

a. What did you like most about Traffic Reporter?

b. What did you like least about Traffic Reporter?

c. What did you find most useful about Traffic Reporter?

d. Did you find anything about Traffic Reporter confusing?

e. In terms of where Traffic Reporter could be located, what location would you find most useful?

f. If Traffic Reporter were available to you in the lobby of the building where you work, would you: glance at the colors, search for trip information, or ignore it?

g. If Traffic Reporter were available to you in your office at work, would you: glance at the colors, search for trip information, or ignore it?

h. If Traffic Reporter were available to you at home, would you: glance at the colors, search for trip information, or ignore it?

Trip: South Center to Kirkland

	Average Speed	Freeway Time
Route 1 (16 mi.) North on I-405	40 mph	20 min.
	* save 3 min. on HOV *	
Route 2 (18 mi.) North on I-5 East on I-90 North on I-405	48 mph	27 min.
	* save 1 min. on HOV *	
Route 3 (18 mi.) North on I-5 East on SR-520 North on I-405	32 mph	33 min.

Display 3a

7/1/92

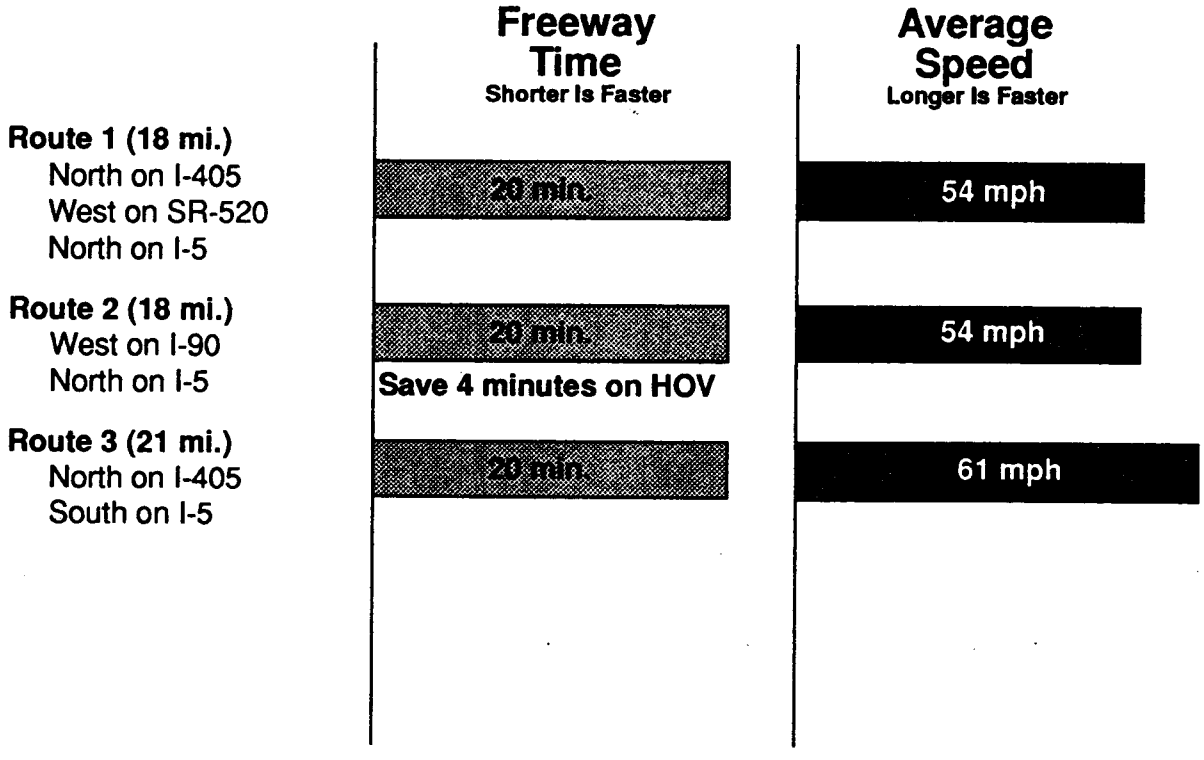
Trip: Lynnwood to Coal Creek

	Average Speed	Freeway Time	HOV Time
Route 1 (19 mi.) South on I-5 East on I-90 South on I-405	55 mph	19 min.	18 min.
Route 2 (20 mi.) South on I-5 East on SR-520 South on I-405	57 mph	21 min.	20 min.
Route 3 (23 mi.) North on I-5 South on I-405	60 mph	25 min.	24 min.

Display 3b

7/1/92

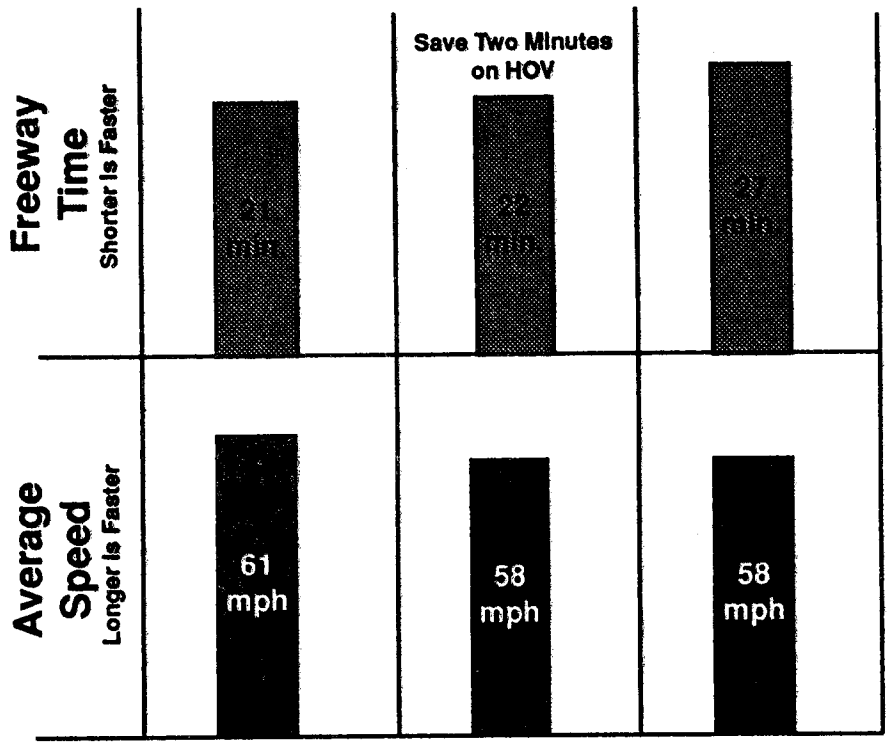
Trip: Factoria to Lynnwood



Display 3c

7/1/92

Trip: Woodinville to Boeing Field



Route 1
(21 miles)
South on I-405
West on SR-520
South on I-5

Route 2
(21 miles)
South on I-405
West on I-90
South on I-5

Route 3
(26 miles)
South on I-405

7/1/92

Display 3d

Route Descriptions

A. **Trip: Northgate to the S-Curves**

South I-5
East I-90
South I-405

B. **Trip: Northgate to the S-Curves**

South on I-5
East on I-90
South on I-405

C. **Trip: Northgate to the S-Curves**

South I-5
East I-90
South I-405

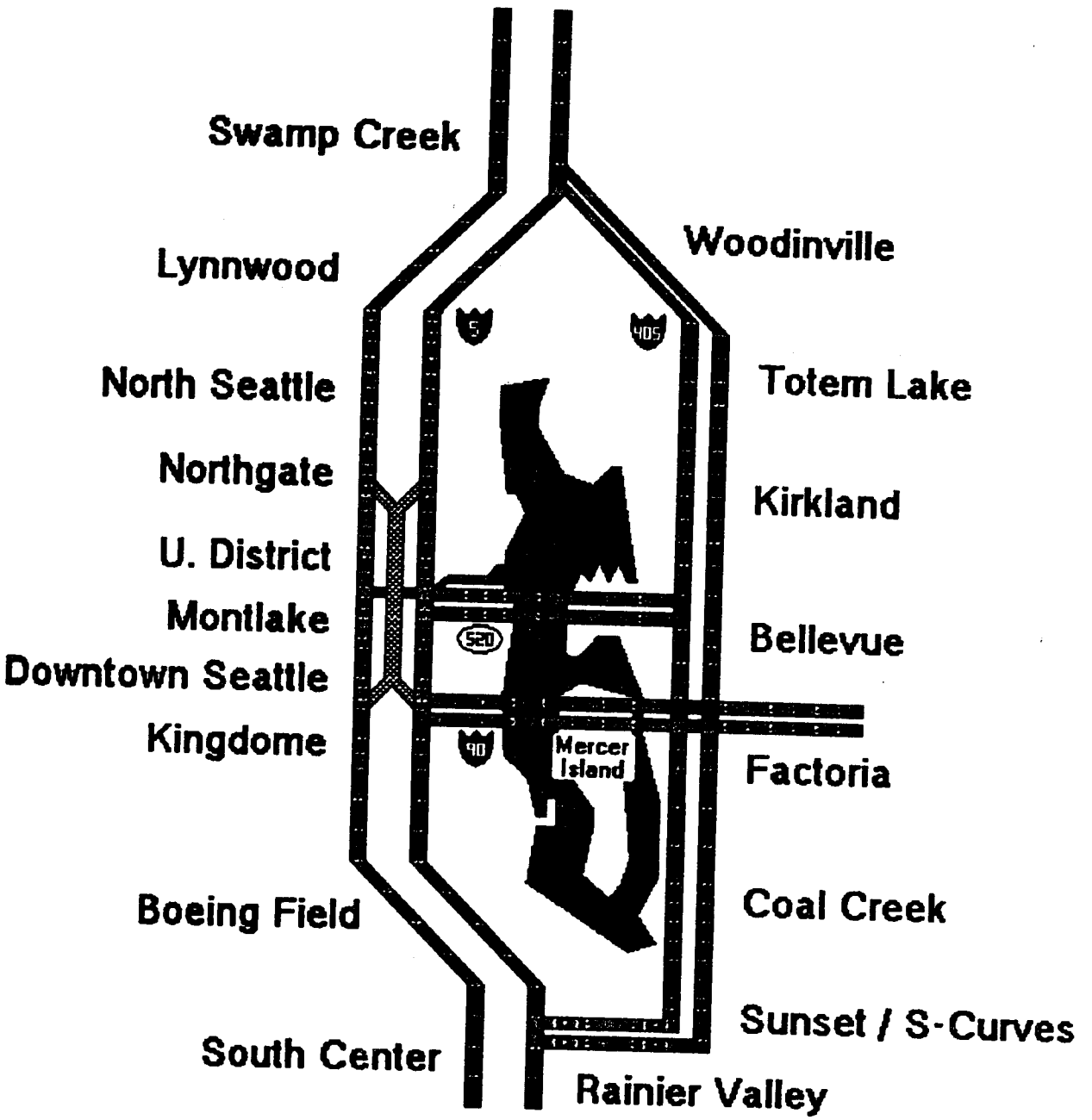
D. **Trip: Northgate to the S-Curves**

South on I-5
East on I-90
South on I-405

E. **Trip: Northgate to the S-Curves**

I-5 South
I-90 East
I-405 South

APPENDIX J TRAFFIC REPORTER



LANDMARKS USED BY RADIO TRAFFIC REPORTERS

I-5

Swamp Creek Interchange
King/Snohomish County Line
Bus Barn (N.E. 155th)
Jackson Golf Course
Northgate Shopping Center
Lake City Way
Ravenna
Shipcanal Bridge
SR-520 Interchange
Lakeview Blvd
Convention Center
Kingdome
I-90 Interchange
Brewery
North Boeing Field
Mid Boeing Field
South Boeing Field
Boeing Access Road
Seattle International Airport
Duwamish Curves
Southcenter Shopping Center
Kent/Des Moines Road/SR-516
Midway Landfill
Highway 18 Interchange
Enchanted Park's
Federal Way Scale House
King/Pierce County Line
Fife Curve

I-405

Canyon Miller/Old Bothell Highway-Mill Creek Exit/SR- 527
Bothell/Woodinville Highway Interchange/SR-522
Totem Lake
Wilburton Tunnel
Coal Creek Parkway
Kennydale Hill
Renton/Enumclaw Exit
Maple Valley Highway
S-curves
Valley Freeway Interchange/SR-181
Longacres
West Valley Highway/SR-181
I-5 Interchange

SR-520

Redmond/Fall City Highway Intersection/SR-202
Marymoor Park
West Lake Sammamish Parkway
I-405 Interchange
Evergreen Point Floating Bridge
Foster Island
Arboretum
Portage Bay Viaduct

I-90

Eastgate
East Channel Bridge
First Hill
Mercer Island Floating Bridge
Mount Baker Tunnel
Corwin curve

APPENDIX L TRAFFIC REPORTER: INTRODUCTORY SCRIPT

Traffic Reporter: Introductory Script

I'm Connie Miller, one of the investigators on the Traffic Reporter project, and this is Matt Winslow, a student in Technical Communications who is helping record data about your answers as you interact with the software.

We would like to thank you for agreeing to come to the University and help us test Traffic Reporter. Traffic Reporter is a computer-based system that provides up-to-the-minute information about traffic conditions on Seattle freeways. We have created a map of the Seattle-area freeway system and displayed it on a computer screen. The computer receives data from sensors buried in the pavement of the freeway lanes and uses that data to display current traffic conditions. Traffic Reporter may become available in the lobbies of buildings, in parking garages, at the airport, and in other locations where commuters are likely to want traffic information. Eventually, even phone access to Traffic Reporter might be available to commuters from their homes or offices.

Our goal is to make Traffic Reporter easy to use and informative. Your role today is to point out, by using the system and answering questions about it, how well we have achieved our goal. We are not testing you; we are testing Traffic Reporter. Any problems you have using the system may indicate problems with our design that we need to fix.

The first thing I need you to do is fill out the University of Washington Consent Form and the Subject Profile. Please notice that the Consent Form emphasizes that your participation is voluntary and you are free to withdraw from the study at any time. By signing the form, you are agreeing to be audio- and video-taped while you are using Traffic Reporter and answering some questions. Only your hands interacting with the screen will be videotaped and only the investigators will have access to the data. The second sheet, the Subject Profile, asks some general information about yourself and your commuting habits *(person fills out two forms).*

Before we start, let me describe what you will be doing for the next hour or so. If you have any questions as I'm talking, please ask them. Because we need to know the process you use to interpret information, we want you to talk out loud while you are using Traffic Reporter to answer questions. The things you say while answering the questions tell us a great deal about how easy the system is to use and where problems may exist. To accustom you to talking out loud while performing a task, we will ask you to practice by loading staples into a stapler. After you use Traffic Reporter to answer one set of questions while talking out loud, I will ask you a few more questions about various features of the system.

Are there any questions you would like to ask me before we begin?

To help you prepare to talk aloud while using Traffic Reporter, I would like you to talk aloud while loading some staples into this stapler. Remember to describe the thought processes going through your mind as well as every action you take.

APPENDIX M MENU DESCRIPTION

The following is a list of menus and commands available in each menu in the latest version of Traffic Reporter. Following this list is a detailed description of each command and option.

LIST OF MENUS

Setup Menu
Comm, Data, Map, Range, Record, Status, Trip, Window, and Zoom.

File Menu
Open, Save, Save As, Exit.

Data Menu

Display Speeds, Display Occupancy, Display Volume, Display Error States; Show Faulty Data, Show Confidence Factors, Apply Filter, Record,Traffic Data, and Replay Traffic Data.

Lanes Menu
Reular and HOV Lanes.

View Menu
Zoom In, Zoom Out, Normal View

Comm Menu
Dial, Hangup, Port Setup, Modem Setup

Stats Menu
Area Labels, Comm, Ramps, Trips, Zoom, System

Help Menu unavailable at this time.

DESCRIPTIONS OF MENUS

FILE MENU

Open

Opens an existing file.

OPTIONS

Select file to open.

Save

Saves new files and changes to existing files.

Save As

Saves and names a new file or copies and renames an open file.

Type in new filename or select file from list of existing filenames.

Exit

Exits Traffic Reporter.

DATA MENU

Display Speeds

Displays ranges of freeway speeds.

Freeway segments are color coded according to each station's speed value. Ranges of speed are displayed in Data Key window.

Shortcut. Press Ctrl + S.

Display Occupancy

Displays freeway occupany values. Occupancy refers to fraction of time a vehicle occupies a loop.

Freeway segments are color coded according to each station's occupancy value. Ranges of percentages are displayed in Data Key window.

Shortcut. Press Ctrl + O.

Display Volume

Displays freeway volume counts. Volume refers to number of vehicles traveling over a loop.

Freeway segments are color coded according to each station's volume count. Ranges of volume counts are displayed in Data Key window.

Shortcut. Press Ctrl + V.

Display Error States

Displays reliability of each station's traffic data.

Areas between freeway stations are color coded according to reliability of freeway data. Types of reliability are displayed in the Data Key window. Reliable means data is good;

Receive means data received categorized as unreliable; Suspect means data from DOT appears good but is potentially improbable; Error means data was categorized as good, but our algorithm determined it was errored.

Shortcut. Press Ctrl + E.

Show Faulty Data

Freeway segments are colored blue when faulty data is present. Faulty data refers to data can be only estimated due to insufficient source data.

Shortcut. Press Ctrl + F.

Show Confidence Factors

Shows percentage of usable data for each freeway segment.

DIALOG BOX

Lists each freeway segment.

Shortcut. Press Ctrl + C.

Apply Filter

Applies error detection algorithm to error data and filters out data that is determined to be errored.

Shortcut. Press Ctrl + A.

Record Traffic Data

Records traffic data and saves the data to a file.

Replay Traffic Data

Replays previously recorded traffic data.

Shortcut. Press Ctrl + P

LANES MENU

Regular

Shows only regular lanes. This is the default selection.

Shortcut. Press Ctrl + R

Hov

Shows freeway segments that have HOV lanes.

Shortcut: Press Ctrl + H

VIEW MENU

Zoom In

Increases the size of the freeway map.

Shortcut. Press the plus sign on the numeric keypad.

Zoom Out

Decreases the size of the freeway map.

Shortcut. Press the minus sign on the numeric keypad.

Normal View

Returns screen display to normal size.

Shortcut. Press the ENTER key.

COMM MENU

Dial

Connects to a computer to download freeway data.

Hangup

Hangups modem.

Port Setup

Sets up communications configuration.

DIALOG BOX

Sets parameters for baud rate, data bits, stop bits, parity, and connector by clicking in appropriate circles.

Modem Setup

Sets up modem parameters and data server phone number.

DIALOG BOX

Type in initial and handup strings, dial prefix, and phone number (preceded by a 9).

SETUP MENU

Comm Setup

Sets dialing options .

OPTIONS

Redial Wait. Number of minutes between dialing out for data.

Options.

Display modem progress displays message in status bar showing dialing progress.

Dial at startup allows modem to automatically dial when application is started.

Dial even if iconized allows modem to continue dialing even if the application is minmized.

Data Setup

Affects Data Key window, freeway map, colors for data ranges, confidence factors, and parameters for speeds.

OPTIONS

Colors. Sets colors for the four ranges of data, closed freeway stations, and stations with no data.

Options.

Flashing range-4 allows the color in the fourth data range to flash.

Apply confidence factors allows system to ignore freeway data if its confidence factor is too low. Confidence factors reflect what percentage of data is good. For example, a confidence factor of 80% means that 80% of the data is good.

Show Data-Key window shows or hides Data Key window.

Parameters.

Max Speed is the highest speed value that will be displayed on the freeway map. For example, if the Max Speed is 55 mph, any station reporting speeds over that value will appear on the map as 55 mph.

Suspect Speed is the highest speed value that will be considered reliable. For example, if the Suspect Speed is 70 mph, any station reporting speeds over that value will appear on the map as having suspect data. Stations with errored data are displayed only when the Display Error States command is chosen from the Data Menu.

Min Confidence determines how low the confidence factor for each freeway can be before the data are ignored. For example, if the minimum confidence factor is 10%, the freeways with confidence factors of less than 10% are ignored. Minimum confidence factors are enforced only when the Apply Confidence Factors option under the Data Setup command is checked.

Map Setup

Specifies horizontal and vertical alignment of the freeway map.

OPTIONS

Horizontal Justify. Places map to left, center, or right.

Vertical Justify. Places map to top, center, or bottom.

Range Setup

Sets up data range parameters.

OPTIONS

Speed Ranges. Sets values for speed ranges.

Occupancy Ranges. Sets values for occupancy ranges. Occupancy refers to the percentage of time a vehicle occupies (or is over) a loop in a given period of time.

Volume Ranges. Sets values for volume ranges. Volume refers to the number of vehicles that pass over a loop in a given period of time.

Record Setup

Establishes parameters for recording data in specific time periods.

OPTIONS

Amount of data to record determines percentage of data to be recorded. Lower percentages conserve disk space, thereby allowing system to record for longer periods of time.

Timers.

Active times set beginning and ending times for which system will automatically record data.

Active days sets days during which system will automatically record data. Disable option allows system to turn recording off and on without resetting parameters.

Status Setup

Controls messages that appear in status bar at bottom of screen.

OPTIONS

Presentation displays either the time stamp or a message.

Display Time Stamp displays the time the data was received.

Display Message reports whether the data is current or old.

Options

Display Status Bar shows or hides status bar.

Display Confidence Factor shows the overall freeway confidence factor in the status bar when this option is selected.

Trip Setup

Trip Cycling Data box controls trip cycling features and selects colors for text appearing in Trip Information window.

OPTIONS

Trip Cycling Data.

Source box specifies which area labels and/or ramps will be trip origin points.

Dest. box specifies which area labels and/or ramps will be trip destination points.

Options

Trip Cycling Active turns trip cycling on and off.

Always Display Trip Window always displays trip information window even if no trip points are selected.

Filter Trip Routes ignores trips that are much farther than the fastest or shortest trip.

Use Anchor allows one area label or ramp to always be selected as the origin point for trip selections.

Shows "Normal Info" displays the average travel time and speed for each route.

Time-out to Cycling automatically starts trip cycling if no interaction occurs for a specific period of time. Number of minutes must be typed in Time-out box under Parameters.

Selecting

Allow only Area Labels allows only area lables to be selected for beginning and destination trip points.

Allow only Ramps allows only ramps to be selected for beginning and destination trip points.

Allow Both allows both area labels and ramps to be selected for beginning and destination trip points.

Allow Quick Selections allows trips to be selected without first closing the Trip Information Window.

Allow Cycling Interruptions allows interactive trip selections while system is in Trip Cycling mode.

Parameters

Anchor specifies one area label or ramp to be origin point for all trips.

Time-out sets number of seconds after an interactive session before system automatically begins trip cycling.

Max Routes specifies maximum number of routes that will be displayed in the Trip Information window. If this value is zero, all routes are displayed.

Cycle Delay specifies number of seconds between each trip display when trip cycling is active.

Colors specifies colors for various text and background in Trip Information window.

Title Text specifies color for text header.

Route Hdrs specifies color for headings for rows.

Route Text specifies color for text for route location information.

Hov Text specifies color for text for HOV information.

Title Area specifies background color for text header.

Column Hdrs specifies color for headings of columns.

Column Text specifies color for time and speed text under columns.

Background specifies background color for window.

Messages specifies color for trip selection instructions.

Window Setup

Sets up options related to window control, input devices, and background color of sreen.

Options

Menu Bar shows or hides menus.

Allow Shortcuts allows keyboard shortcuts.

Window Controls allows window to be moved, resized, and closed.

Perm. No Control disallows any type of window control as soon as application is started.

Hide Cursor shows or hides cursor.

Input specifies whether the mouse, the keyboard, or the touch screen will be the main source of input.

Colors specifies background of screen.

Zoom Setup

Determines zooming parameters.

Levels. Specifies scale factors by which size of freeway map is increased or decreased.

Parameters. Specifies minimum level for data values to be overlayed onto the freeway segments on the map.

Options. Allow zooming in only, out only, or both.

STATS MENU

Alab Statistics

Displays how often individual area labels were selected.

Global refers to number of times area labels were chosen since the initial session; Local refers to number of times area labels were chosen since current session began.

Dates of initial and current sessions are found in System Statistics command in this menu.

Comm Statistics

Displays outcome of communications operations

Dates of initial and current sessions are found in System Statistics command in this menu.

Ramp Statistics

Displays how often individual ramp were used.

Trip Statistics

Displays:
number of trips selected
average number of routes
distance, speed and travel times per trip for both regular and HOV lanes.

Global refers to number of times ramps were chosen since system began; Local refers to number of times ramps were chosen since current session began.

Dates of initial and current sessions are found in System Statistics command in this menu.

Zoom Statistics

Displays number of times zoom features were used.

Global refers to number of times ramps were chosen since system began; Local refers to number of times ramps were chosen since current session began.

Dates of initial and current sessions are found in System Statistics command in this menu.

System Statistics

Displays how long the system was running and how many mouse clicks occurred.

Global refers to number of times ramps were chosen since system began; Local refers to number of times ramps were chosen since current session began.