Real-Time Motorist Information for Reducing Urban Freeway Congestion: Commuter Behavior, Data Conversion and Display, and Transportation Policy

Final Technical Report
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16. ABSTRACT

This report documents results of a project to design and develop a real-time, advanced traveler information system (now called *Traffic Reporter*) for the Puget Sound area. In previous work, we had identified four types of commuters: (1) Pre-trip Changers, (2) Route Changers, (3) Route & Time Changers, and (4) Non-changers. Each type of commuter showed distinct preferences and needs for design and delivery of traveler information. In this project, we confirmed that the commuter types identified earlier, as well as their preferences for design and delivery of traveler information, were consistent across geographical areas in the Puget Sound area.

Based on this knowledge of commuter behavior and information needs, we designed and began implementing *Traffic Reporter*, a PC-based, graphical, interactive, advanced traveler information system. The *Traffic Reporter* prototype receives traffic data from freeway detectors and converts those data into information that can be explored both for general freeway conditions and specific trip information. Information is designed for use by commuters, traffic reporters, and traffic engineers.

We conducted usability tests on the *Traffic Reporter* prototype to ensure its effectiveness and ease of use. Overall, these tests showed that the prototype is easy to use and will be accepted by commuters. Future development of *Traffic Reporter* will be guided by the results of these tests. Furthermore, we will continue usability testing on future versions of *Traffic Reporter*.

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SUMMARY

This section is a summary of the results of Phase 2 of a project to design and develop a real-time, PC-based, interactive, advanced traveler information system (now called *Traffic Reporter*) for the Puget Sound area. This summary begins with a review of Phase 1 of this project.

Review of Phase 1

For an advanced traveler information system to be effective, its design must be based on an understanding of commuter behavior and information needs. Therefore during Phase 1, we conducted an extensive on-road survey of motorists traveling south on I-5 into downtown Seattle. We also conducted a series of in-person interviews. The results of this study identified four types of commuters according to their willingness to change some aspect of their commute in response to traveler information. The four types identified were Pre-trip Changers, Route & Time Changers, Route Changers, and Non-changers. Among our many conclusions, we found that the single most flexible driving decision is the departure time of the Pre-trip Changer and Route & Time Changer groups, and that only the Pre-trip Changer group showed a willingness to change transportation mode. Furthermore, we found that most commuters prefer to receive traveler information prior to departure and that commercial radio is the current preferred medium.

Phase 2 Survey

In Phase 2 of this project, we conducted another extensive on-road survey, this time of commuters traveling north on I-5 into downtown Seattle. We also extracted data on commuters traveling east and west as part of their commute. The most significant finding from this survey was that the four commuter types identified in our first survey are consistent throughout the Puget Sound population and are not significantly impacted by geographical differences. Thus,

the major conclusions from our survey of southbound commuters held true for northbound and east/west commuters.

Non-Response Survey

A non-response survey was conducted to determine if non-respondents constituted a subgroup of commuters with markedly different commuting patterns and behaviors. Results of this survey revealed that a high percentage of the non-respondents were actually non-commuters who realized that the survey was not intended for them. Therefore, we concluded that the non-respondents did not constitute an additional subgroup of commuters.

Implementation

The majority of Phase 2 was spent using our knowledge about Seattle commuters to develop a prototype of a real-time, PC-based, interactive, traveler information system. We call this system *Traffic Reporter*. *Traffic Reporter* converts traffic data collected from freeway sensors into up-to-the-minute information that can be delivered directly to commuters. This information is displayed on *Traffic Reporter's* graphical screen. The central feature of this screen is a graphical representation of a map of a northern corridor of I-5. All north and south entry and exit ramps on that freeway corridor are active elements of the display. Segments of the freeway are color-coded according to one of four speed ranges. The current time and date, as well as the time the displayed information was gathered, are also shown. The screen is updated every minute.

Traffic Reporter has features that allow users to interactively explore traffic conditions and alternatives, such as average mph at a particular location instead of broad speed ranges, average travel time and speed for a specific trip, and the "best" exit or entry ramp for a specific trip.

In addition to providing traffic information to commuters, *Traffic Reporter* provides information that is of specific interest to traffic engineers. First, *Traffic Reporter* can store and play back commute data, creating a historical record of freeway activity. Second, *Traffic Reporter* can indicate a malfunctioning station. Third, *Traffic Reporter* can display up-to-the-minute data on volume (number of vehicles passing over a loop) and occupancy (fraction of total time vehicles occupy a loop).

Currently, *Traffic Reporter* is in the prototype stage and resides in the Department of Technical Communication at the University of Washington. Direct delivery of traveler information to commuters is not yet available. However, in the next phase of *Traffic Reporter's* development, traveler information will be delivered directly to commuters, first via TV and radio announcers and then via a touch-screen kiosk version. We will also expand *Traffic Reporter's* coverage, explore delivery via other modes, improve the accuracy of the delivered data, and record data for monitoring traffic patterns.

Usability Testing

We conducted usability tests on *Traffic Reporter* to ensure its effectiveness and ease of use. We tested two groups of users: (1) commuters, the primary users and (2) traffic reporters, who will use *Traffic Reporter* to enhance their reports. We also solicited evaluations from traffic engineers who will use *Traffic Reporter* as one of their information tools. The questions we sought to answer fell into five categories: (1) impact on commuter behavior, (2) interaction with the system, (3) interface design, (4) potential use of the system, and (5) preferred method for receiving information.

From our usability tests, we found that commuters overall like the interface and find interacting with *Traffic Reporter* to be fairly easy. To use the information provided by *Traffic Reporter*, however, commuters said they need further information about alternative routes, alternative modes, and traffic incidents. They also need to be convinced that the system's information is both timely and accurate. Finally, they want a feedback mechanism to confirm that they have made the best commuting choices.

Although the commuters we tested expressed a desire to control the information themselves, current cost and hardware constraints mean this may not always be feasible. Therefore, we are investigating delivery not only by touch-screen kiosk, PC, and TV and radio reporters, but also by cable TV and audio delivery via phone.

An important issue that needs to be investigated as a result of these usability tests is the expansion of *Traffic Reporter*, specifically how the addition of geographical areas, HOV and express lanes, arterials, and incident indicators would affect the interface and user interaction with the system. It is imperative that testing and evaluation continue as system expansion occurs. The needs of commuters must periodically be confirmed, as they are the ones who will ultimately be making decisions based on the information.

BACKGROUND

In a previous two-year study of real-time traveler information systems and Puget Sound commuting behaviors, we reported on the results of an on-road survey of commuters traveling on I-5 south into downtown Seattle. The results of that survey identified four types of commuters, which we named Pre-trip Changers, Route & Time Changers, Route Changers, and Non-changers. We also reported on in-person interviews that were conducted mainly to clarify points from this initial survey and to gather information for screen design of a computer-based, traveler information system (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).

The work reported here builds upon these past efforts and takes a number of additional major steps toward the development of a PC-based, interactive, real-time traveler information system (now called *Traffic Reporter*). Specifically, the objectives were as follows:

(1) To further enhance our fundamental knowledge of Puget Sound commuter behavior and decision-making.

(2) To apply that knowledge to the design and development of a *Traffic Reporter* prototype.

(3) To develop a personal computer front/end interface for *Traffic Reporter* capable of (a) receiving existing real-time traffic data; (b) converting those data into information designed to impact commuter choice of route, transportation mode, and time of departure; and (c) displaying that information through a user interface designed to meet the needs of individual drivers, TV and radio traffic reporters, and traffic engineers.

(4) To perform usability testing on *Traffic Reporter*.

(5) To provide a high-level analysis of commuter behavior and decision-making to state agencies, legislators, and public groups involved in transportation policy decisions. This analysis was accomplished by producing six issues of a newsletter titled *Commuter Information Systems* (see Appendix F.)

This report covers the work done to accomplish the above objectives. The report is organized into three chapters plus appendices. In Chapter 1, we present the results of a second on-road survey, this time of motorists traveling north on I-5 into downtown Seattle. The major purpose of this survey was to determine whether the commuter types identified in our previous survey were consistent across the Puget Sound area, or if they changed according to geographical differences.

In Chapter 2, we describe implementation of the *Traffic Reporter* prototype. This chapter begins with a brief summary of the process of converting traffic data into information that can be delivered via a personal computer. Then we describe how *Traffic Reporter* actually works: how commuters can use *Traffic Reporter* to determine travel strategies that make efficient use of transportation options; how TV and radio reporters can use *Traffic Reporter* to deliver traffic information to motorists; and how traffic engineers can use *Traffic Reporter* as a tool for managing traffic flow.

In Chapter 3, we present the results of usability testing of the *Traffic Reporter* prototype. Usability testing was conducted to determine *Traffic Reporter's* usefulness to potential users and effectiveness in influencing commuter behavior. We tested two groups of users: commuters (the primary users) and media personnel (the secondary users). We also present suggestions and comments from traffic engineers at the Traffic Systems Management Center in Seattle. Input was solicited from this group because they will use *Traffic Reporter* as one of their traffic information tools.

CHAPTER 1 SURVEYS

In this phase of the real-time traveler information study, we conducted an extensive on-road survey of motorists traveling north on I-5 into downtown Seattle during their morning commute. From the sample, we also extracted data on two subgroups: (1) motorists who stated they were non-commuters and (2) motorists traveling east or west as part of that commute. The primary purpose of this survey was to determine whether commuter characteristics held constant across geographical differences. We also conducted a non-response survey of motorists who did not respond to a previous southbound survey. The purpose of the non-response survey was to compare characteristics of non-respondents with respondents. This chapter discusses the research approach, findings, and conclusions of these two surveys.

In addition to these two formal surveys, we conducted telephone interviews with respondents to our earlier southbound on-road survey. The purpose of these interviews was to answer questions concerning TV delivery of traveler information at home. The results of these interviews are included in this report as Appendix A.

NORTHBOUND ON-ROAD MOTORIST SURVEY

The northbound survey conducted under this project was a follow-up to a southbound survey conducted in September 1988. The previous southbound survey (Survey 1) gave us considerable data on commuter decision-making and use of traffic information, data that were needed to help in designing a graphical, interactive, real-time traveler information system. Perhaps most interestingly, Survey 1 identified four types of commuters:

(1) *Route Changers*, commuters willing to change route before or after entering the freeway (21%).

(2) *Route & Time Changers*, commuters willing to change departure time and route (40%).

(3) *Pre-trip Changers*, commuters willing to change departure time, route, and travel mode before leaving their residence, but unwilling to change route during their trip (16%).

(4) *Non-changers*, commuters unwilling to change departure time, route, or travel mode (23%).

The remainder of this section reports on a second on-road survey (Survey 2) that was conducted in March 1990 and focused on motorists traveling north on I-5 into downtown Seattle. In addition to the targeted population, data were extracted from both Survey 1 and Survey 2 on east/west commuters and non-commuters. The primary purpose of Survey 2 was to determine whether motorists from a different geographical location and commuting from a different direction grouped into the same motorist types and had similar commuting behavior as those identified in Survey 1. The following sections describe the research approach, findings, and conclusions of Survey 2.

Research Approach

Survey 2 was conducted by distributing questionnaires to motorists traveling north into downtown Seattle as part of their morning commute. The questionnaires were returned by mail to the Washington State Department of Transportation (WSDOT), which then forwarded them to the University of Washington where they were analyzed. The materials, subjects, and procedures are described below. The procedure was conducted in two stages: (1) the distribution of the questionnaires and statistical analysis of individual variables and (2) the cluster analysis.

Materials

In Survey 2, we used a four-page questionnaire with questions in five categories: (1) characteristics of the commute, (2) motorist choices and behavior, (3) delivery and use of traffic information, (4) characteristics of east/west commuters who used one of the Lake Washington bridges or I-405, and (5) demographic data.

The Survey 2 questionnaire differed from the Survey 1 questionnaire only in that it included a section with questions for motorists who used one of the Lake Washington bridges or

I-405 for their morning commute to work. Copies of the questionnaires for both on-road surveys are included for comparison in Appendix B.

The layout and physical form of the questionnaire were determined by the distribution/return methodology. Space was provided in the margins for respondents to add comments. To facilitate accurate data entry, response boxes or input lines were provided for each question. Each survey was stamped with a case ID number between #0001 and #5200. A statement on the survey requested that motorists return it by April 16, 1990. The survey (a three-fold, self-mailer) when folded and stapled or taped displayed the WSDOT address and a postal permit number.

Subjects

The Survey 2 initial sample consisted of about 4,700 Washington State freeway commuters who exited downtown Seattle between 6:00 am and 9:00 am on a weekday and were likely to have arrived from the south. The points at which we surveyed had both south to north and east/west commuters, who would be compared with the commuters in Survey 1. The final Survey 2 sample consisted of 1,996 motorists who mailed in their surveys. The response rate was 42%.

Survey Procedure

As in Survey 1, exit ramps off I-5 were chosen for distribution of the questionnaires. This method was chosen because it allowed us to (1) access motorists easily and without much delay, (2) obtain a representative sample, and (3) reduce the time between a motorist's commute and receipt of the survey.

March 29, 1990 (a weekday) was chosen for survey distribution. The off-ramps in downtown Seattle were Madison, James, Olive and Seneca.

Survey distribution times were based on peak hour data from WSDOT ramp figures. Rush hour (6:00 am to 9:00 am) was selected because it permitted direct access to motorists who were the target population. One person was assigned to match IDs with license plates (see Non-response Survey).

One survey administrator and one to three distributors worked at each distribution site. They waited for traffic to stop at the first red light at the end of the freeway exit and then proceeded to each driver in sequence and handed him or her a questionnaire. When the light turned green, the survey administrators moved to the shoulder of the freeway and waited for the next red light. In total, 4,700 questionnaires were distributed. In addition, media coverage from various radio stations encouraged motorists to fill out and return their questionnaires.

The questionnaires were mailed to WSDOT and forwarded in batches to the University of Washington for processing. The daily rate of return was initially very high but decreased as the April 16, 1990 deadline approached. By April 16, 1990, 1,996 questionnaires had been returned. Any questionnaires that arrived after that date were not processed.

Before the surveys could be given to data entry personnel, I-5 entrance/exit answers were recoded to obtain the number of miles for the respondents commuting to and from work. Additionally, where respondents reported their average times commuting to and from work, research assistants averaged any range responses to obtain discrete data.

The data were analyzed in SPSS-X on the Max mainframe at the University of Washington. Frequencies were calculated for all variables; Pearson correlations were applied to interval scaled data; and Spearman correlations were applied to all ordinal and a few nominal scaled variables if the coding met the assumptions of the Spearman routine. Finally, cluster analyses and chi squares within clusters were conducted to determine how the make-up of motorist groups from the south compared to those from the north, and to find any significant differences between the groups' responses on specific questions.

Findings

This section presents the findings of Survey 2 and compares them to the findings of Survey 1 when relevant. The results of the tested variables are grouped similarly to the major sections of Survey 2 (see Appendix B): (1) characteristics of the commute itself, (2) route choices, (3) delivery of traffic information, (4) characteristics of motorists who used one of the Lake Washington bridges or I-405, and (5) demographic information. The order of the survey questions has been adjusted for discussion purposes. As expected, due to the large sample size, numerous correlations were found to be significant at the $p \leq .01$ and $p \leq .001$ levels. Because many correlations would be statistically significant yet have no constructive value, we arbitrarily decided for the purpose of this discussion to focus only on those correlations that accounted for a minimum of 9% of the variance (i.e., r values $\geq$ 3 or $\leq$ -3).

Commute Characteristics

Commute characteristics are examined in two general areas: the situational aspects of the commute and respondents' attributes.

Situational Aspects

This section discusses the survey results on commute frequency, vehicle occupancy, distance, and duration of respondents' commute on I-5 from the south into downtown Seattle and back again after work. Most respondents commute to work 5 days per week (70%), with the next highest number being 6 days per week (9%). Five other response categories (1, 2, 3, 4, and 7 days per week) each received about 3% of the responses (5% of the respondents were non-commuters). Most respondents (76.3%) travel alone in their cars, and 18% of respondents travel with one other person in their car.

Respondents use I-5 (northbound to work and southbound from work) for an average of 9 miles each way. The reported northbound and southbound distances are quite similar and significantly correlate with each other, $r = .97, p \leq .001$. On this freeway corridor, respondents' average distance between home and work is 19 miles. This distance is traveled during the morning commute in about 35 minutes and during the evening commute in about 40 minutes. Respondents in Survey 2 travel about 5 miles more between home and work than respondents in Survey 1 and spend about 5 minutes more each way. A Pearson correlation revealed that the distance between home and work significantly correlates with travel time between home and work, $r = .78, p \leq .001$, and with travel time between work and home, $r = .75, p \leq .001$. As expected, travel time between work and home and between home and work significantly correlate with each other, $r = .86, p \leq .001$.

In summary, for this I-5 corridor, most respondents appear to commute alone 5 days per week, travel about 19 miles to work, with about 9 miles of this total distance driven on I-5, and spend about 35-40 minutes for their entire commute.

Respondents' Attributes

This section examines respondents' answers regarding flexibility in time leaving home and work, perceived stress during the commute, and importance of selected commute qualities. As shown in Table 1, twice as many respondents (29.2%) have a lot of flexibility in the time they leave work for home than in the time they leave home for work (14%), while three times as many respondents (34.2%) have a lot of flexibility in arriving home than in arriving at work (12.6%). A Spearman correlation revealed that flexibility in the time leaving work positively correlates with flexibility in the time leaving home, $r_S = .35, p \leq .001$. These results are similar to Survey 1.

Table 1. Flexibility in Leaving and Arriving at Work and at Home

	A lot	Some	Very little
Leave home for work	14.0%	52.7%	33.2%
Leave work for home	29.2%	49.3%	21.5%
Arrive at work	12.6%	50.1%	37.4%
Arrive at home	34.2%	52.7%	13.1%

Most respondents (59.2%) experience some stress during their commute; 16.9% experience a lot of stress, and 23.9% experience very little. These results are similar to Survey 1.

When asked about the importance they place on various commuting qualities, most respondents (65.6%) said they believe that saving commute time is very important; 59.4% of the respondents believe that increasing commute safety is very important; roughly one-third believe that increasing commute enjoyment is very important; and only about one-fifth place a lot of importance on reducing commute distance. These results are similar to Survey 1. In both surveys, people are more concerned about saving commute time than they are about increasing commute safety. (See Table 2.)

Table 2. Importance Placed on Commuting Qualities

Commuting Qualities	A lot	Some	Very little
Saving commute time	65.6%	29.4%	5.0%
Reducing commute distance	20.9%	40.2%	38.8%
Increasing commute safety	59.4%	32.6%	8.0%
Increasing commute enjoyment	38.4%	44.2%	17.4%

In summary, a number of generalizations can be drawn about the quality of respondents' commutes. First, respondents have greater flexibility as to the time they leave work for home and arrive home than the time they leave home for work and arrive at work. Most respondents experience some stress during their commute. Respondents place the greatest value on saving commute time.

Route Choices

When asked about their familiarity with northbound and southbound alternatives to I-5, 55% of respondents believe that they are very familiar with alternative routes (about 7% less than in Survey 1); 36.2% are somewhat familiar with alternative routes; and 8.8% are not at all familiar with alternative routes.

Respondents modify their routes from home to work less frequently than they modify their routes from work to home: 62.2% of respondents rarely change routes between home and work, as opposed to only 44.5% who stated that they rarely change routes between work and home. (See Table 3.) These results are similar to Survey 1. Responses to these two issues positively correlate, $r_S = .53, p \leq .001$.

Table 3. Frequency of Modifying or Changing Commuting Route

	Frequently	Sometimes	Rarely
Home to work	6.2%	31.5%	62.2%
Work to home	13.4%	42.2%	44.5%

When asked what length of delay would cause respondents to divert from I-5, the average response was 18.1 minutes to routes they know and 27.9 minutes to routes they do not know. As expected, these two variables (length of delay causing diversion to known versus unknown routes) significantly correlate, $r = .76, p \leq .001$. Respondents in this survey stated they will wait about two minutes longer than respondents in Survey 1 to change routes. The amount of delay that causes respondents to switch to a known route or an unknown route inversely correlates with the likelihood of changing routes between work and home: (delay versus known route, $r_S = -.26, p \leq .001$; delay versus unknown route, $r_S = -.21, p \leq .001$, respectively.)

When respondents were asked where they choose their commuting routes, 42.9% stated that they make this choice while still at home or work; 18.5% choose on city streets, 19.1% choose near entrance ramps, and 19.6% choose after entering I-5. Northbound commuters are somewhat more likely to select their route prior to leaving than southbound commuters. (See Figure 1 for comparison with Survey 1.)

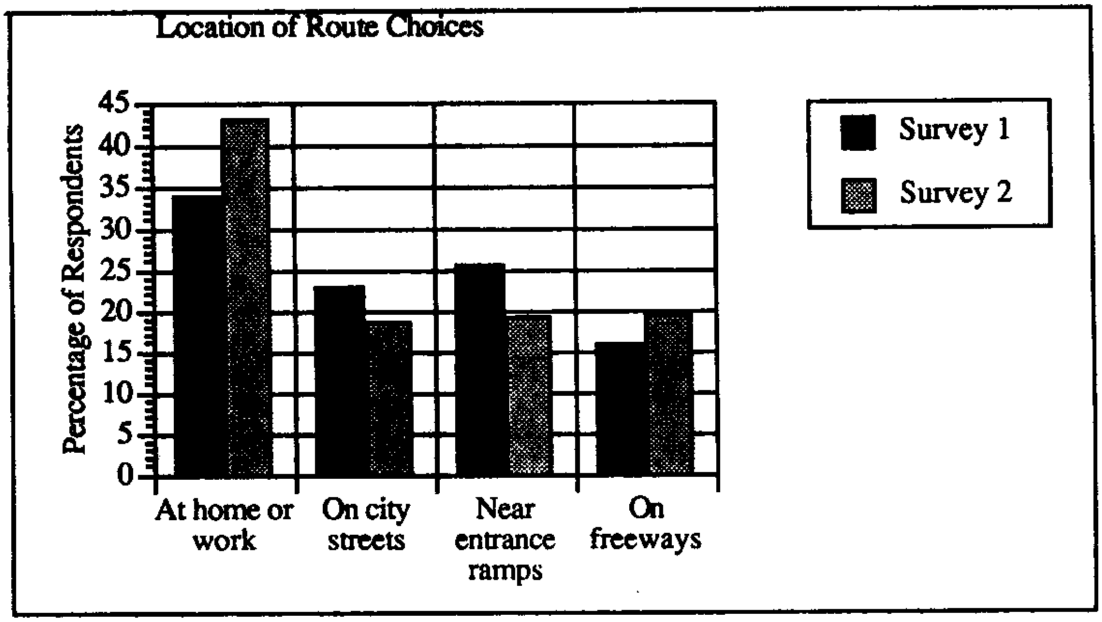

Figure 1. Comparison of Where Route Choices Are Made

When asked about the influence of six factors on their choice of commuting routes, about 36.4% of the respondents reported that traffic messages frequently influence their choice (compared to only 28% in Survey 1); 29.4% reported that traffic congestion frequently influences their choice; about 23.1% reported that time of day frequently influences their choice. Only 8.1% believe weather conditions influence their choice of commuting routes, and only 11.2% believe that time pressures have an influence. The last three factors were similar to Survey 1. Finally, 10.3% reported that errands frequently influence their choice (this factor was not included in Survey 1). (See Table 4.)

Table 4. Environmental Factors Affecting Choice of Commuting Routes

Environmental Factors	Frequently	Sometimes	Rarely
Traffic reports and messages	36.4%	45.1%	18.5%
Actual traffic congestion	29.4%	49.8%	20.8%
Time of day	23.4%	34.6%	41.9%
Weather conditions	8.2%	28.5%	63.2%
Time pressures	11.2%	34.9%	53.9%
Errands	10.3%	47.7%	41.9%

When Spearman correlations were run on the first five variables with each other and with frequency of changing route, all correlations were significant at $p \leq .001$. In Table 5, the first two columns show that motorists who do change their routes are affected by these five environmental factors, although time pressure has the lowest correlation with changing route to work, $r_S. = .24$. Interestingly, the influence of traffic information correlates most strongly with congestion, congestion correlates next most strongly with time of day, time of day correlates strongly with weather and time pressure, and weather also correlates strongly with time pressure.

Table 5. Spearman Correlation Matrix of Selected Variables
(All correlations below are significant at $p \leq .001$.)

	Variable numbers and names	1	2	3	4	5	6	7
1	Frequency of changing route to work	–						
2	Frequency of changing route to home	.53	–					
3	Frequency of traffic information affecting route choice	.30	.33	–				
4	Frequency of traffic congestion affecting route choice	.37	.43	.48	–			
5	Frequency of time of day affecting commuting route	.29	.33	.34	.43	–		
6	Frequency of weather affecting commuting route	.28	.26	.28	.34	.49	–	
7	Frequency of time pressure affecting commuting route	.24	.28	.28	.39	.51	.44	–

Some generalizations can be drawn about respondents' route choices. Respondents are more likely to change their routes from work to home than from home to work. Route changes are most influenced by traffic information, congestion, and time of day. Motorists will divert to known routes sooner than to unknown routes.

Delivery of Traffic Information

This section examines the influence of and respondents' preference for timing and location of traffic information as well as their use of and receipt of traffic information from different media.

Influence of and Preference for Timing of Traffic Information

When asked about their preference for time and place to receive traffic information, half the respondents (56.5%) said they prefer to receive traffic information before leaving home or work. Almost one-third prefer to receive traffic information after beginning their commute but before entering I-5 (21.5% prefer city streets; 12.2% prefer near entrance ramps). Respondents least prefer to receive traffic information after entering I-5. (See Table 6 for comparison with Survey 1.)

Table 6. Preference for Timing of Traffic Information: Comparison between Both Surveys

Time Preference	Survey 1	Survey 2
Before leaving home or work	53.2%	56.5%
While driving on city and county streets	22.4%	21.5%
When approaching entrance ramps	15.9%	12.2%
While driving on freeways	3.8%	9.8%

As shown in Table 7, depending on the driving decision, between 2% and 17% of respondents stated they are frequently influenced by traffic information before they drive. (In Survey 1, between 2% and 14% were frequently influenced by traffic information before they drove.) The data show that route choice and time for leaving are more influenceable than transportation mode; additionally, the influence of traffic information on pre-trip route choice and departure time significantly correlate, $r_S = .49, p \leq .001$. Further, many respondents who said that their route choice is influenced before driving also responded on an earlier question that their route choice is influenced by traffic information in general, $r_S = .47, p \leq .001$. The reported influence of traffic information on departure time also correlates with influence on transportation mode, $r_S = .26, p \leq .001$.

Table 7. Factors Influenced by Traffic Information Before the Commute

Factors	Frequently	Sometimes	Rarely	Never receive
Departure time	16.7%	44.1%	29.9%	9.3%
Transportation mode	2.4%	8.2%	53.4%	36.1%
Route choice	13.7%	51.5%	27.4%	7.4%

For 62.9% of respondents en route, traffic information frequently or sometimes causes them to divert to an alternative route. This is about 10% more than in Survey 1. Spearman correlations revealed that respondents who divert en route because of traffic information are also influenced by traffic information before they drive, $r_S = .48, p \leq .001$. Respondents who said that their route choice is influenced while they were en route also replied to an earlier question that their route choice is influenced by traffic information in general and by actual traffic congestion, $r_S = .49, p \leq .001$, and $r_S = .39, p \leq .001$, respectively.

Receipt of Traffic Information from Different Media

When asked about availability of phones and computers, most respondents (97.3%) reported having access to a phone in their home and/or place of business. Almost three-fourths (70.4%) have access to a computer in their home or at their place of business. More than one in ten people have access to a phone in their car (12.1%), and 4.6% have access to a computer in their car.

	Access to Phone	Access to Computer
Home (only)	4.7%	28.4%
Office (only)	.5%	42.0%
Car (only)	.7%	4.6%
Home/Car	1.0%	
Home/Office	80.8%	.1%
Home/Office/Car	10.4%	
None	2.0%	25.0%

When asked about their preferences for sources of traffic information, 81% of the respondents said that they prefer commercial radio before and during driving. The second most helpful source for receiving traffic information is TV reports (14.2%), followed by electronic message signs over I-5 (11.3%), and CB radio (4.7% before driving and 6.1% while driving). Least preferred is HAR (.8%). In Survey 1, 75% of the respondents preferred commercial radio before driving, and about 80% during driving. The second most popular source for receiving traffic information in Survey 1 was TV reports (11.7%), followed by electronic message signs over I-5 (8%), HAR (5.2%), phone (3.4%), and CB radio (0.2% to 0.3%). See Table 8 for a comparison of both surveys.

Table 8. Sources of Preferred Traffic Information

	Before Driving		While Driving	
	Survey 1	Survey 2	Survey 1	Survey 2
TV	11.7%	14.2%	-	-
Electronic message sign over I-5	-	-	11.4%	11.3%
Advisory radio indicated by flashing lights on highway signs	-	-	7.2%	0.8%
Commercial radio station	75.5%	81.1%	80.2%	81.4%
Phone	3.4%	-	0.8%	-
CB radio	0.2%	4.7%	0.4%	6.1%

When asked about helpfulness of traffic information received from various media, 66.9% of the respondents said that they consider information received from commercial radio stations very helpful. See Table 9 for considerations of other media. In Survey 1, the majority

(54.8%) also rated messages received via commercial radio the most helpful. Spearman correlations revealed that respondents who found the electronic message signs over I-5 helpful also found HAR helpful, $r_S = .41, p \leq .001$; respondents who found traffic information delivered by commercial radio station helpful also stated on a later question that traffic information frequently causes them to divert to alternative routes, $r_S = .33, p \leq .001$. About 12% more respondents in Survey 2 than in Survey 1 considered commercial radio stations very helpful.

Table 9. Rated Helpfulness of Traffic Information Sources

Traffic Information Source	A lot	Some	Very little	Never used
TV	4.7%	13.5%	22.8%	59.0%
Electronic message sign over the freeway	5.8%	21.9%	42.6%	29.7%
Advisory radio indicated by freeway sign	5.3%	17.1%	37.4%	40.2%
Commercial radio station	66.9%	24.8%	6.2%	2.1%
Phone	.9%	3.5%	9.8%	85.9%

Respondents were asked whether they would use various media to receive continual, up-to-the-minute traffic information if it were available. A vast majority of the respondents (92.1%) stated that they would use a radio station dedicated to traffic information. Additionally, 35%, 26.9%, and 22.4%, stated that they would use a phone hot line, a cable TV station dedicated to traffic information, and a computer delivery system, respectively. The only significant difference from Survey 1 is that only 15% in Survey 1 stated they would use a computer.

When asked which media they would like to see developed first, most respondents (85.7%) said that they would prefer to see the development of a radio station dedicated to traffic information, then a phone hot line (8.2%), a dedicated cable TV station (3.3%), and a computer delivery system (2.8%). These results are similar to Survey 1.

Demographic Information

The distribution of the sample across gender was 53.9% male respondents and 46.1% female respondents. With regard to age, half of the respondents were under 41 (50.6%) compared to 61.1% in Survey 1. The largest difference is that 36% were in the 41-49 age group in Survey 2, while only 24.6% were in that group in Survey 1. (See Table 10.)

Table 10. Age of Motorists

Survey 1*		Survey 2*	
Under 31	24.5%	Under 31	22.6%
31-40	36.6%	31-40	28.0%
41-50	24.6%	41-49	36.0%
51-64	12.3%	50-65	11.1%
65 and over	1.5%	66 and over	2.3%

*Survey 1 and Survey 2 age categories differ due to revision to Survey 1 questionnaire.

The northbound respondents seem to be better off financially than the southbound respondents. Survey 2 respondents (53.6%) reported living in households with earnings above $60,000 per year. In Survey 1, only 35.1% reported living in households with earnings above $60,000 per year. (see Table 11.)

Table 11. Annual Income For Respondent's Entire Household

	Total Yourself	Household
No income	.2%	.2%
Under $10,000	2.0%	.2%
$10,000-$19,999	11.1%	2.7%
$20,000-$29,999	23.8%	5.6%
$30,000-$39,999	20.2%	10.2%
$40,000-$49,999	13.9%	14.4%
$50,000-$59,999	8.6%	13.0%
$60,000-$74,999	7.3%	18.9%
$75,000-$100,000	5.4%	16.9%
Over $100,000	7.4%	17.8%

The majority (54.2%) have no children 18 years or younger living with them; 39.2% have one to two children 18 years or younger living with them. (This question was not asked in Survey 1.) Finally, only 22% of respondents were willing to participate in a follow-up interview at the University of Washington, compared to 44% in Survey 1.

Lake Washington Bridges and I-405 Users

The main objective of this part of Survey 2 was to break out east/west travelers and to determine how their commute compares with commuters who travel only north or south into downtown Seattle. Subjects were motorists who said they used bridges on I-90 or SR-520 or traveled on I-405 north or I-405 south around the lake. However, because distribution sites were selected to capture commuters from the south, east/west commuters who used I-90 were most likely to appear in the sample.

Slightly more than half the respondents (55.5%) who travel on I-90 east or west to downtown Seattle commute five days per week, while only 3.9% of respondents who use SR-520 commute five days per week. Again, this is because the natural route of east/west commuters who received the survey was across I-90. Of the respondents who travel on I-405 north and I-405 south, 16.2% and 16.3%, respectively, commute five days per week.

Table 12 shows the commute frequency of respondents who travel the Lake Washington bridges or I-405. As Table 12 shows, the majority of respondents who use SR-520 or I-405 are non-commuters.

Table 12. Frequency of East/West Travel by Survey Respondents

Days	7	6	5	4	3	2	1	0
I-90 Bridge	5.0	16.7	55.5	5.6	3.3	4.7	5.7	3.4
SR-520 Bridge	.4	1.1	3.9	.7	3.7	9.9	26.5	53.6
I-405 North	3.2	4.6	16.2	2.5	5.8	7.9	17.6	42.3
I-405 South	2.8	4.2	16.3	2.8	5.0	8.0	17.9	43.0

When asked which sources of traffic information east/west commuters prefer to use in selecting a bridge for commuting to work over Lake Washington, over three-fourths (78.1%) chose a commercial radio station. This is just slightly less than north/south respondents (about 81%), who prefer a commercial radio station.

Half the east/west respondents are likely to choose a bridge for commuting over Lake Washington before leaving their homes (56.2%), with the next choices being while driving on city and county streets (19.1%), while driving on freeways (14.5%), and when approaching entrance ramps (10.2%). In this regard, east/west route choice is very similar to north/south route choice.

This section has reported results for the entire response group for Survey 2, as well as the east/west subgroup. The next section reports results of a cluster analysis designed to divide the response group into commuter types, and compare those types with a similar analysis from Survey 1.

Cluster Analysis

A cluster analysis guided by that conducted in Survey 1 (Haselkorn, et al., 1990) was used to analyze the results from Survey 2. The goal was to determine whether commuters from the south could be categorized similarly to those from the north for the purpose of designing traveler information. Cluster analysis seeks to group cases according to similar responses.

Procedure

The same four questions used in Survey 1 were used to cluster Survey 2 respondents. These questions were:

- When you are on I-5, how often does traffic information cause you to divert to an alternate route?
- Before you drive, how often does traffic information influence the time you leave?
- Before you drive, how often does traffic information influence your means of transportation (e.g., car, bus)?
- Before you drive, how often does traffic information influence your route choice?

The four possible responses were frequently, sometimes, rarely, and never. These responses were recoded in descending order: 3, 2, 1, and 0.

Before the program began grouping the cases into clusters, it approximated the center for these clusters. The centers were described by four numbers, one for each of the questions; the values were the response variables: 3 (frequently), 2 (sometimes), 1 (rarely) and 0 (never). It is possible to "seed" the cluster analysis program by defining the starting centers before the program calculates and assigns the cases. Because these starting values were somewhat arbitrary, we chose the starting values for the Survey 2 analysis to approximate the starting values chosen for Survey 1. For example, a commuter who responded to the first question with "frequently," the next two questions with "rarely," and the last question with "sometimes" would be classified into the cluster that we had named *Route Changers*. Any other commuters answering similarly would be grouped with that commuter and so on until all the commuters were assigned to one of the four clusters according to their responses. This ensured that the analysis started at the same point for the Survey 2 data and thus made it easier to compare Survey 2 and Survey 1 results. The initial cluster centers are given below in Table 13.

Table 13. Initial Cluster Centers for Surveys 1 and 2

Survey 1 Questions

Clusters	Divert	Time Change	Mode Change	Route Change
Route Changers	2	0	1	3
Non-changers	0	0	0	0
Route & Time Changers	3	3	0	1
Pre-trip Changers	0	3	2	3

Survey 2 Questions

Clusters	Divert	Time Change	Mode Change	Route Change
Route Changers	3	0	0	3
Non-changers	0	0	0	0
Route & Time Changers	2	3	0	2
Pre-trip Changers	0	3	2	3

The initial centers used to seed the cluster analysis for Survey 2 were not exactly equal in all cases because we wanted to exaggerate the distances for some questions. After the cluster analysis groups all the cases, the routine calculates the final centers based on all the cases. The final centers for each survey are given in Table 14. The final values, though rather different from the initial values, were very similar to each other in the end.

Table 14. Final Cluster Centers for Surveys 1 and 2

Survey 1 Questions

Clusters	Divert	Time Change	Mode Change	Route Change
Route Changers	1.7	.9	.7	2.0
Non-changers	1.1	.6	.4	.6
Route & Time Changers	1.8	2.2	.7	1.8
Pre-trip Changers	1.3	2.3	1.5	2.2

Survey 2 Questions

Clusters	Divert	Time Change	Mode Change	Route Change
Route Changers	1.9	.9	.6	2.1
Non-changers	1.3	.7	.5	.7
Route & Time Changers	1.9	2.3	.6	2.0
Pre-trip Changers	1.4	2.2	1.7	2.1

Findings of Cluster Analysis

Responses to the four key questions for both surveys were compared by cluster group. Tables 15a-d compare the percentage of responses to each question in each survey.

Table 15a. Pre-trip Changers

Question

Response	Alternative Route		Departure Time		Trans. Mode		Route	
	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2
F	2	6	31	28	11	15	26	24
S	29	35	69	69	27	43	67	65
R	63	54	1	3	60	42	7	11
N	6	6	0	0	2	0	0	0

F = frequently S = some R = rarely N = never

Table 15b. Route & Time Changers

Question

Response	Alternative Route		Departure Time		Trans. Mode		Route	
	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2
F	11	13	21	28	0	0	15	18
S	61	67	79	72	1	1	55	60
R	28	20	0	0	64	62	30	22
N	0	0	0	0	35	37	1	0

F = frequently S = some R = rarely N = never

Table 15c. Route Changers

Question

Response	Alternative Route		Departure Time		Trans. Mode		Route	
	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2
F	6	12	0	0	0	0	11	11
S	62	64	0	0	3	5	80	87
R	30	24	93	89	66	54	10	2
N	2	0	7	11	31	41	0	0

F = frequently S = some R = rarely N = never

Table 15d. Non-changers

Question

Response	Alternative Route		Departure Time		Trans. mode		Route	
	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2	Survey 1	Survey 2
F	1	1	0	0	0	0	0	0
S	19	31	1	3	1	2	0	1
R	71	59	56	63	37	43	60	67
N	9	8	43	34	62	56	40	32

F = frequently S = some R = rarely N = never

This comparison reveals whether the clusters for each survey are made up of similar types of cases and, consequently, whether the groups chosen by cluster analysis have similar meanings. Responses to key questions were very similar by clusters across surveys. For example, Route Changers from Survey 1 showed a similar distribution of responses to each of the four questions.

In addition, cluster data from the two on-road surveys were extracted on one subgroup: respondents traveling east/west on the Lake Washington bridges or I-405 into downtown Seattle. Table 16 compares the east/west commuter types with the southbound and northbound commuter types.

Table 16. Comparison of I-5 Southbound, I-5 Northbound, and East/West Respondents

	Southbound Commuters	Northbound Commuters	East/West Commuters
Pre-trip Changers	16%	15%	12%
Route & Time Changers	40%	45%	47%
Route Changers	21%	17%	15%
Non-changers	23%	23%	26%

The commuter types are relatively stable across geographical differences. The only noticeable differences were that east/west commuters are slightly more flexible about the time they leave but slightly less flexible about route and mode of transportation.

Conclusions

From Survey 2, we concluded that generally there is little difference between southbound, northbound, and east/west commuters. Most importantly, the clusters held across both on-road surveys, so similar design principles for traveler information can be used for the entire Puget Sound area. Northbound commuters showed themselves to have somewhat longer commutes. Southbound commuters are somewhat less familiar with alternative routes, take somewhat longer to change routes when faced with a delay, are somewhat less responsive to traveler information, and are somewhat more likely to select their route prior to leaving. East/west commuters are slightly more flexible about the time they leave but slightly less flexible about route and mode of transportation.

NON-RESPONSE SURVEY

Of approximately 10,000 surveys distributed to southbound commuters in Survey 1, about 40% were returned. Extrapolation of the Survey 1 data to the 60% who did not respond is problematic because non-respondents may constitute a subgroup with markedly different commuting patterns and behaviors. Therefore, we designed a non-response study to coincide with data collection and analysis from Survey 2. This study was aimed at identifying and obtaining information from a random sub-sample of Survey 2 non-respondents. The objective of the non-response study was to compare characteristics of non-respondents with respondents. The following describes the research approach, findings, and conclusions of this survey.

Research Approach

The research approach for the non-response survey was to identify and contact non-respondents by phone or mail and to compare their answers to selected key questions with those of the respondents. The materials, subjects, and procedures are described below.

Materials

The materials used were the Survey 2 questionnaire (see Appendix B) and a short questionnaire that asked for demographic characteristics, as well as answers to the four questions used to cluster commuters in the on-road survey.

Subjects

Survey administrators recorded license plate numbers for 700 of the motorists who were handed a questionnaire during Survey 2. Assuming a non-response rate of 57%, we estimated that roughly 400 of the 700 drivers would not respond to this questionnaire. We decided that a non-response sub-sample of 60 cases chosen from the 400 would be small enough to manage, given limited time and resources, but large enough to provide useful information about non-respondents. In order for the information obtained from the non-response sample to be unbiased, we chose the 60 subjects at random. The 60 motorists in the non-response sub-sample consisted of 21 women (35%) and 39 men (65%). For Survey 2 respondents, the corresponding figures were approximately 46% women and 54% men. Thus, the breakdown according to sex in the non-response survey appears to be slightly different than the initial survey, with more men in the non-response survey.

Of the 60 cases selected at random from the candidates for non-response follow-up, ten were quickly eliminated: three had invalid license plate numbers; four had been driving rental vehicles or vehicles licensed to corporations; one was registered in Washington but gave a Texas home address; and two had moved since registering their vehicles, leaving no forwarding information. This left 50 non-respondents available for follow-up questions. Of these, 29 were reached by phone and 21 by mail. It should be noted, however, that most, if not all, of the ten eliminated cases were in all likelihood non-commuters.

Procedures

To study a sub-sample of non-respondents, we had to first identify such a sample and devise a way to contact those in the sample. We decided that license plate numbers could be used for these purposes. Under a formal agreement with the Washington State Departments of Transportation and Licensing, we were given access to the names and addresses of registered owners of vehicles for which we recorded license plate numbers.

At each of the four Survey 2 distribution sites, one surveyor was designated as both a survey distributor and license plate recorder. These surveyors recorded, for each automobile surveyed, the sex of the driver, the vehicle license plate number, and the serial number of the survey form handed to the driver. We obtained these three pieces of information for roughly 700 of the motorists in the survey sample, with the understanding that some proportion of the 700 would not return their surveys.

Since non-respondents had already indicated some unwillingness to participate in the study, it was not feasible to try to obtain responses to all of the survey questions from them. We therefore attempted to obtain only a few pieces of important information. First, we used the sex and home zip-code of sample non-respondents to draw some conclusions about demographic characteristics in this sub-population. In addition, we asked whether the sample non-respondents were Seattle-bound commuters and how many days per week they commuted. Finally, for those who indicated that they were commuters, we asked the four questions used in Survey 1 to assign motorists to the commuter clusters. The questions were:

- When you are on I-5, how often does traffic information cause you to divert to an alternate route?
- Before you drive, how often does traffic information influence the time you leave?
- Before you drive, how often does traffic information influence your means of transportation (e.g., car, bus)?
- Before you drive, how often does traffic information influence your route choice?

The non-respondents available for follow-up consisted of a group whose households were reached by phone, and a group who had unlisted phone numbers or whose households could not be contacted by phone after repeated attempts. The households not reached by phone were mailed a short survey form, a stamped return envelope, and a cover letter giving directions for completing and returning the form. In both cases, we asked either a male or female Seattle-bound commuter (if such a household member existed) to answer the survey questions according to whether he or she had received the initial survey on the distribution day. In the households reached by phone, we asked to call back at a later time if the desired household member was not available. The name of the interviewer and information about the traffic study were provided to all households contacted, but the initial survey was not mentioned.

Findings

First, we made inferences about the proportion of non-commuters. Of the 29 households reached by phone, only 11 (about 38%) reportedly contained a Seattle-bound commuter of the desired sex. This finding suggests that the subject who received the initial survey was only incidentally passing through the Seattle business district and was not a Seattle commuter in the usual sense.

The response rate among those who were contacted by mail was low: only four out of 21 (19%). Again, we inferred that most of these respondents were also only incidentally passing through the Seattle business district.

Given these three pieces of evidence--(1) 17% of the sample were eliminated because they were unavailable for various reasons and were in all likelihood non-commuters; (2) 62% of the households contacted by phone did not contain a Seattle-bound commuter of the desired sex; and (3) 81% of the households in the mail-survey group did not respond, likely because they did not contain a Seattle-bound commuter--we concluded that most non-respondents are non-commuters.

Even though it appeared that most non-respondents are also non-commuters, we still assigned the 15 non-respondents (11 contacted by phone and 4 by mail) who commuted to Seattle into one of the four clusters used to categorize respondents. Table 17 compares the non-respondents with the respondents in Survey 2.

Table 17. Comparison of Survey 2 Respondents and Non-respondents According to Commuter Type

	Respondents	Non-Respondents
Pre-trip Changers	15%	13.5%
Route & Time Changers	45%	33%
Route Changers	17%	40%
Non-changers	23%	13.5%

The most striking difference between the percentages observed in the non-respondents and those observed in the respondents is that of Route Changers: there appear to be substantially more Route Changers in this (small and non-random) sub-sample of commuting non-respondents than in the Survey 2 respondents. This difference may be due to the fact that a higher proportion of the non-respondents were men.

Conclusions

The high percentage of non-commuters among the non-respondents raises the likelihood that many of the non-respondents realized that they were not in the target population; i.e., they might have assumed that the survey was not intended for them. This conclusion makes us more comfortable in asserting that our on-road survey findings describe the general population of Seattle commuters.

CHAPTER 2 IMPLEMENTATION OF *TRAFFIC REPORTER*

Traffic Reporter is a PC-based, graphical, interactive, real-time traveler information system. It receives data originating from sensors buried below the freeway and displays current traffic conditions, speeds, and trip travel times. This system currently exists in a prototype version covering I-5 traffic from the northern King-Snohomish County line to downtown Seattle. In the prototype version, all lanes are aggregated. The actual system, currently under development, will geographically be expanded to cover the entire Puget Sound area, and will break out HOV and express lane information. The expanded system will also have additional features beyond those described here and will include a touch-screen mode.

Traffic Reporter's interface design targets commuter types who desire pre-trip information and are likely to alter specific travel behavior based on appropriately designed information. The system allows users to explore specific trip alternatives, thereby enabling travelers to devise efficient strategies for using available transportation options. The design of the *Traffic Reporter* system draws heavily on the findings from surveys of Seattle commuters reported here and in previous reports. (For more information on screen design studies, see Appendix C. Appendix C also includes a bibliography related to screen design considerations.)

The first step in implementing *Traffic Reporter* was to import freeway data into the PC environment. Then, a graphical, interactive display was designed and coded that uses those data to provide real-time traveler information. These steps are described below.

FREEWAY DATA CONVERSION

The procedure for accumulating traffic data and converting those data on a PC screen to be used for later display is summarized here. Traffic data are accumulated from freeway stations positioned about every half mile along I-5 between Dearborn Street and the King-Snohomish County line. Each station consists of loop detectors (one for each lane) embedded in the pavement, a microprocessor, and a modem. The loops detect vehicles 60 times per second. These data are processed at the station, and then one-second summaries of the output, consisting of volume (number of vehicles passing over a loop) and occupancy (fraction of total time a vehicle occupies a loop), are sent to the Traffic Systems Management Center (TSMC).

At the TSMC, a Perkin-Elmer mainframe computer (soon to be replaced by a VAX) converts these data into one-minute summaries. These summaries are transferred to the PC each minute over a 9600 baud modem. The summaries are converted to speed and travel time on the PC. The volume/occupancy to speed and travel time conversion algorithm is detailed in Appendix D. There is ongoing work to improve this algorithm, particularly through two related projects: (1) *Improved Estimates of Travel Time From Real-Time Induction Loop Sensors* and (2) *Travel Time Estimates Using Cross-Correlation Techniques*. This improved algorithm will be implemented in the next phase of *Traffic Reporter's* development. (See Dailey, 1991a, 1991b.)

The current hardware requirements include an IBM PC compatible microcomputer with a DOS operating system running Microsoft Windows 3.0, a color monitor (Enhanced Graphics Adapter), a modem, and a mouse. (Note: While this system is too sophisticated for many home-based machines, a modified version for less sophisticated systems exists; furthermore, home-based delivery is only one of several delivery options we are exploring.)

TRAFFIC REPORTER'S SCREEN DESIGN

The following section describes the traveler information screen, along with features and functions that were developed on the basis of information presented thus far. Results of the on-road surveys indicate that the Pre-trip Changer and Route & Time Changer groups are actively seeking pre-trip information and are likely to act on it. Therefore, the current version of *Traffic Reporter* is tailored as much as possible for those two groups. First, we describe the screen as it initially appears (Figure 2) and then as it appears in various stages of manipulation (Figures 3 to 5). These figures are in black and white, but the screen uses color codes to distinguish categories of speed, volume, and occupancy between freeway stations.

Initial Screen Display

The central feature of *Traffic Reporter's* screen (Figure 2) is a graphical representation of an approximately 15-mile stretch of I-5, from the King-Snohomish County line in the north to downtown Seattle in the south. The left-hand side of the map shows 15 southbound ramps; the right-hand side of the map shows 19 northbound ramps. The ramps are labeled according to well known street designations. The map displays segments of the freeway (about half a mile each) between each freeway station. Each segment is colored according to a speed range: green for 50+ mph, yellow for 35-49 mph, purple for 20-34 mph, and red for 0-19 mph.

The top of the screen, directly above the map, displays the title: *Traffic Reporter*. Underneath the title, in the upper left-hand corner is a list of menus: File, Data, Lanes, Communications, and Help. These menus will be explained later. In the lower left-hand corner of the screen is a box showing the current colors and associated ranges of speeds. Finally, the current day, date, time, and time the displayed information was gathered appear at the bottom of the screen. The screen is updated every minute.

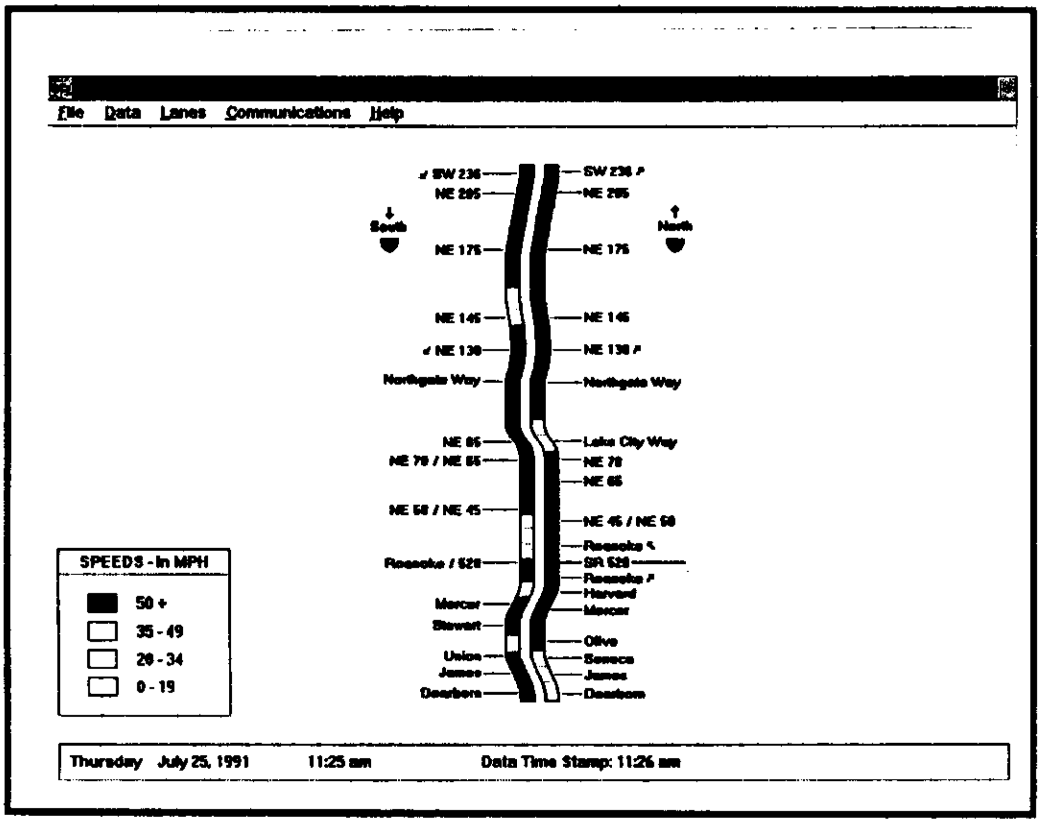

Figure 2. Freeway Map Screen As It Initially Appears

Features

This section describes the features implemented during this phase of *Traffic Reporter*. These features are designed not only for our commuter audience, but for two other audiences as well: TV/radio traffic reporters and traffic engineers. Several features appear in the illustrations but will not be implemented until the next phase. The next section describes how the screen appears when features are used that cause the screen to change.

FILE. This menu opens and saves configuration files and exits the program. Configuration files include map information, program settings, etc.

DATA. All selections in this menu may be accessed by pulling down the menu or by the keyboard. The selections are as follows:

Display Speeds. This is the default selection. It displays freeway speeds between each station. Speeds are indicated in one of four colors according to ranges of speeds: green for 50+ mph, yellow for 35-49 mph, purple for 20-34 mph, and red for 0-19 mph.

Display Occupancy. This selection is for traffic engineers. It displays the percentage of time vehicles are sensed by loop detectors. Occupancy is displayed according to one of four colors: green for 0-14%, yellow for 15-21%, purple for 22-34%, and red for 35%+.

Display Volume. This selection is also for traffic engineers. It displays the number of vehicles traveling over loop detectors. Volume is displayed according to one of four colors: green for 200+, yellow for 150-199, purple for 100-149, and red for 0-99.

Set Range. This selection controls the numbers associated with the color coding feature. This feature allows these ranges to be easily changed temporarily or permanently. The current ranges were selected in consultation with engineers at the TSMC and confirmation from user testing.

Show Faulty Data. When this selection is chosen, the areas of the freeway where the data are faulty are indicated in blue. Currently this covers only ill-formed data, but the next version of *Traffic Reporter* will show improbable faulty data as well.

Record Traffic Data. This selection allows the user to manually record traffic data as they are received. Recorded data can be played and interacted with in the same manner as live data.

Record Options. This selection allows the user to select up to ten different time frames during which traffic information can be automatically recorded; for example, a time frame could be 3:00 pm to 6:00 pm, Monday to Friday. This selection also controls how much data will be gathered; for example, it can be set to collect traffic information every other minute instead of every minute, thus saving disk space. Currently, this feature is being used to record peak hour traffic each day.

Replay Traffic Data. This selection allows the user to replay traffic data from a specific day by entering a date or by selecting a date from a list. A box then appears with controls similar to a tape recorder; the selections are rewind, play, fast forward, stop, and close.

LANES. This menu will not be implemented until the next stage of this project. It will allow display of different types of lanes (for example, HOV versus regular lanes).

COMMUNICATION. This menu establishes a communications connection with the source data. Through this menu a port is chosen, a modem initialized, and the dial feature implemented. The dial feature allows *Traffic Reporter* to continue dialing when there is no answer or when the line is busy.

HELP. The only help displayed currently is a screen introducing *Traffic Reporter*. On-line help will be implemented in the next stage of this project.

Screen in Various Stages of Manipulation

From the initial screen, a user can quickly determine the current traffic situation. If the overview of the screen displays all stations in green, the user need go no further because our goal is to get users (other than traffic reporters and traffic engineers) in their cars and on their way--not to have them access all the system's functions. However, if the overview of current speed ranges reveals a need to explore further (such as an area of red stations), other traffic information may be accessed as follows.

(1). Mean speed rates of selected stations. This information is accessed by the zoom function. The zoom function works by moving the cursor over the freeway map. At that point, the cursor turns into a magnifying glass. By clicking the mouse button, a box appears to the left of the freeway map and shows the stations magnified with specific mean speed rates rather than speed ranges. (See Figure 3.)

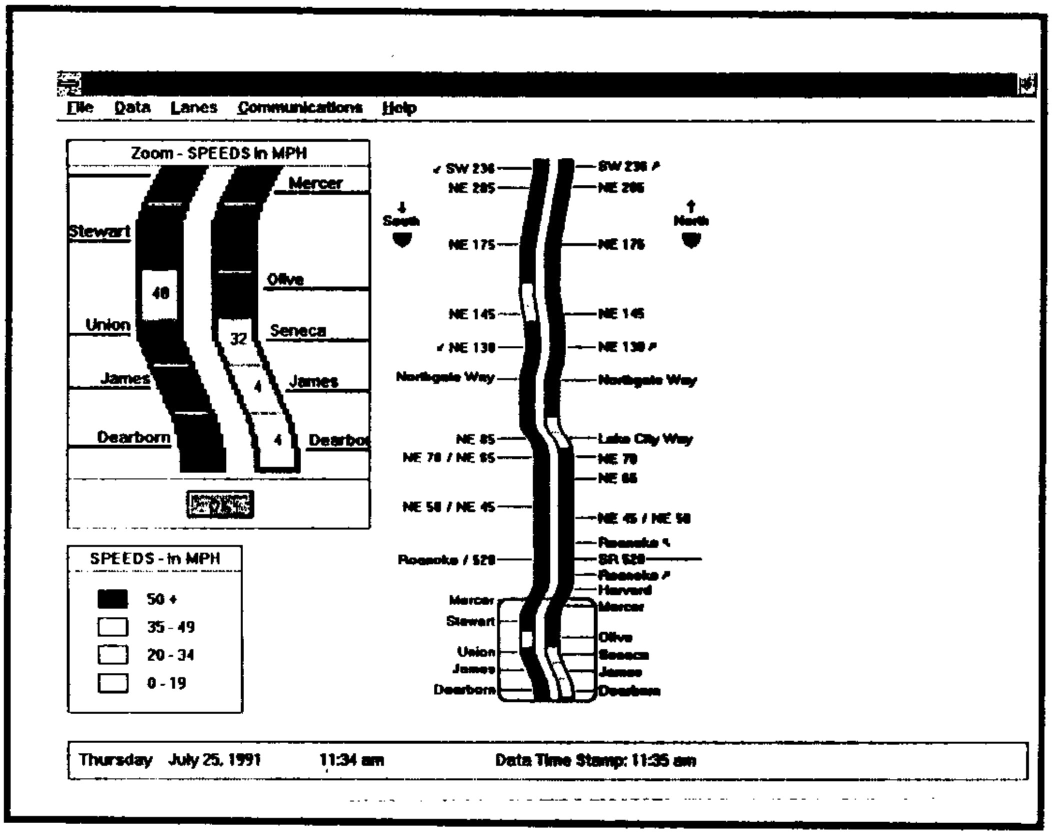

Figure 3. Freeway Map Showing Zoom Function

(2). Estimated time and vehicle speed for a trip between any two ramps. This information is accessed by clicking the mouse button on an entrance and exit ramp. A box to the right of the freeway map indicates the ramps selected and shows estimated travel time and speed between those two ramps. (See Figure 4.)

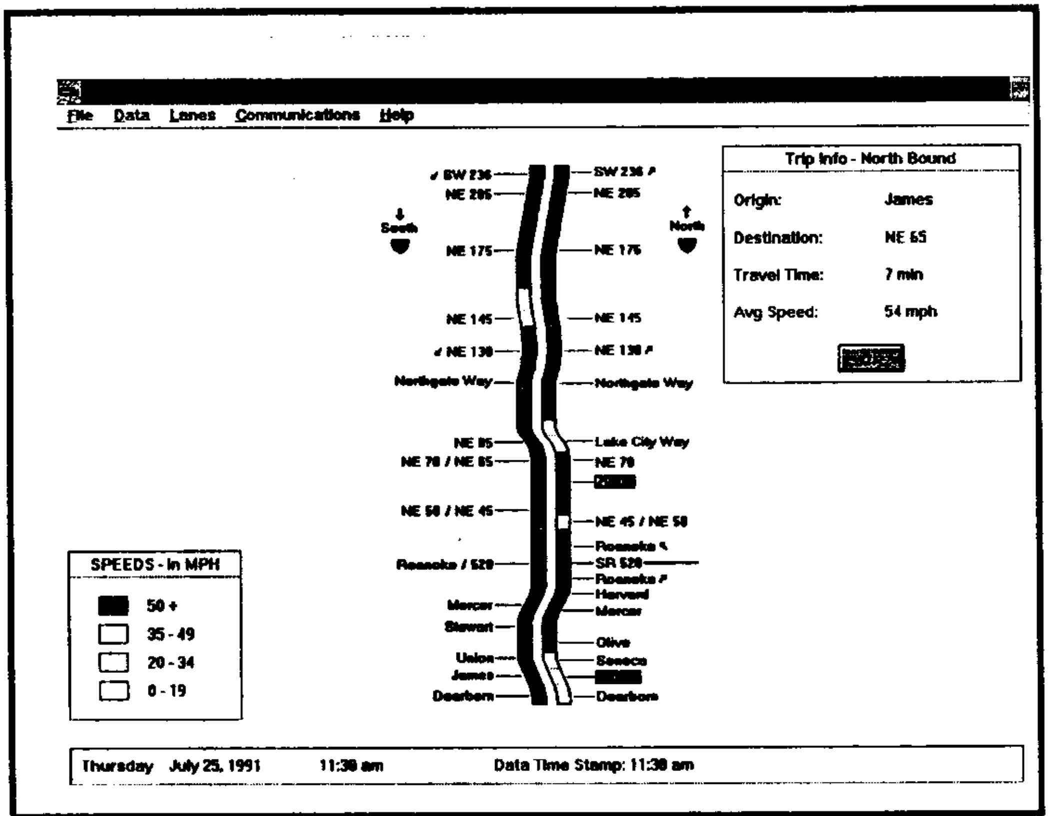

Figure 4. Freeway Map Showing Estimated Speed and Travel Time between Two Ramps

(3). <u>The best exit ramp or entry ramp to take for a specific trip.</u> The best exit ramp can be determined by double-clicking the right button on the mouse at an origin ramp. A table appears to the right of the freeway map showing estimated rates of speed and travel time to all possible exit ramps currently displayed. The best entry ramp can be determined by double-clicking the left button on the mouse at a destination ramp. A similar table appears, this time showing estimated rates of speed and travel time to the destination ramp from all possible entry ramps currently displayed. (See Figure 5.)

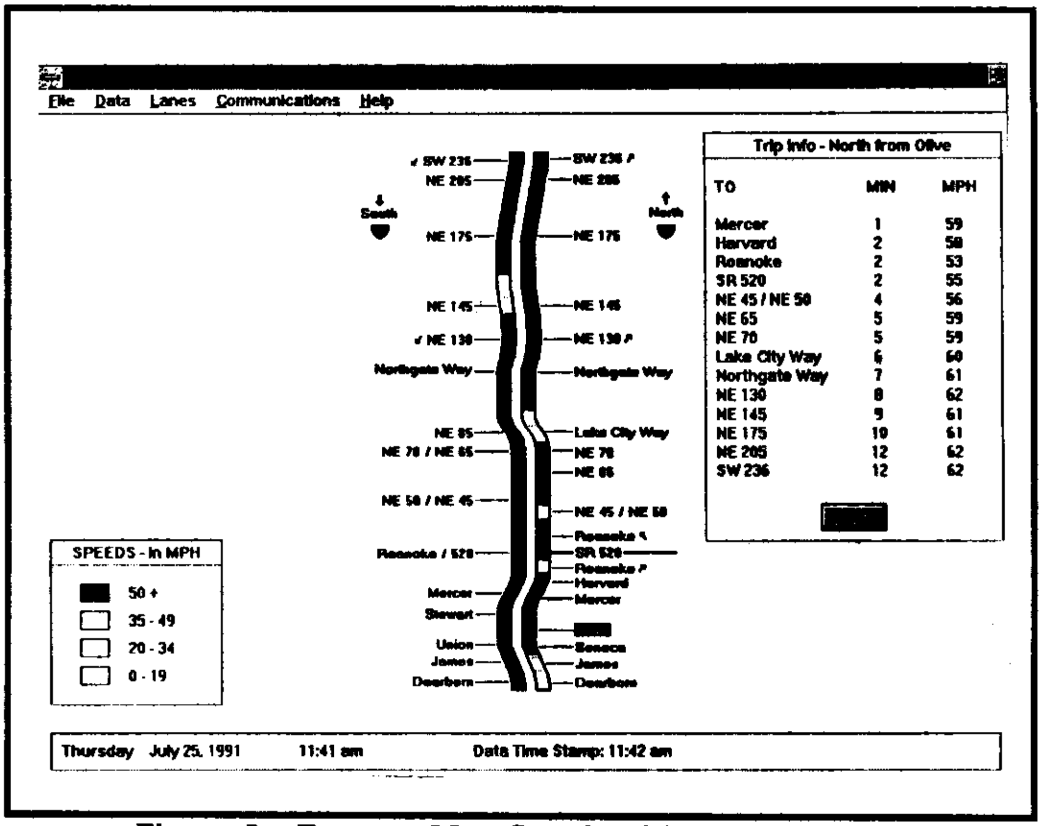

Figure 5. Freeway Map Showing Times and Speeds to Possible Exit Ramps

Design elements and features like these need to be tested to determine if they serve the needs of commuters and other potential system users. The next chapter describes such an effort.

CHAPTER 3 USABILITY TESTING

Usability testing consists of having subjects from a target audience test a design concept or product for ease and importance of use. Developers of hardware, software, and documentation have found usability testing to be an extremely useful tool for producing products that their intended users will find both easy to use and will actually meet the users' needs.

When usability testing is performed on a product, developers attempt to answer numerous questions. These questions range from ease of use; to the "look and feel" of an interface; to quantitative measures of how long it takes someone to use a feature or function of the product; to qualitative issues of whether the users like the product or think they might use it. (For an excellent introduction to some of the issues raised during usability testing, as well as a beginner's bibliography to usability testing, see the Special Issue: Usability Testing, *IEEE Transactions of Professional Communication, Dec. 1989, Vol. 32, #4.*)

This chapter focuses on the usability testing of the *Traffic Reporter* prototype, a PC-based, graphical, traveler information system, developed at the University of Washington in conjunction with the Washington State Department of Transportation (WSDOT). These tests were conducted at the University of Washington between September 1990 and February 1991. *Traffic Reporter's* interface was developed using information obtained from on-road surveys and interviews of motorists who were commuting into downtown Seattle on I-5. The surveys and interviews were designed to gather information on motorists' driving patterns, route and time flexibility, and the preferred medium for receiving traffic information (Spyridakis, et al., 1991). The survey responses were then analyzed for generalizations about commuters and their preferences.

From these surveys, we identified four types of commuters:

(1) *Route Changers* (RC), commuters willing to change route before or after entering the freeway (21%).

(2) *Route & Time Changers* (RTC), commuters willing to change departure time and route (40%).

(3) *Pre-trip Changers* (PC), commuters willing to change departure time, route, and travel mode before leaving their residence, but unwilling to change route during their trip (16%).

(4) *Non-changers* (NC), commuters unwilling to change departure time, route, or travel mode (23%).

The surveys and interviews also revealed commuters' preferences for delivery of traveler information:

- Commuters prefer information delivered before departure rather than on the freeway.
- Commuters in the on-road surveys least prefer information delivered via computer; however, commuters in the in-person interviews, once exposed to it, were quite open to information delivery via computer.
- The RC, RTC, and PC groups need commute time information and time estimates for alternative routes and desire feedback to help them verify that they indeed had made the best choice.
- Commuters like getting time information in a numerical format and are willing to receive graphical information.
- Commuters want to be reassured that traffic information is credible.

While this list reveals only a few of the surveys' findings, these ideas quickly began to suggest the types of issues that we would test in assessing the usability and effectiveness of *Traffic Reporter*.

We concluded from these surveys that traveler information could influence four types of commuter choices: departure time, transportation mode, selection of pre-trip route, and selection of on-road route. In response to these conclusions, we designed the following goals for a traveler information delivery system:

- To develop a system for pre-trip delivery of traveler information.
- To tailor pre-trip information to the RTC and PC groups--those commuters most likely to alter departure time and other behavior.
- To develop a feedback mechanism.

In the case of *Traffic Reporter*, the primary end user is the Puget Sound commuter. However, because of cost and hardware constraints at this time, the initial users of the system will likely be TV and radio media personnel, as well as WSDOT traffic engineers. Therefore, in conducting usability tests, we assessed three different user groups: commuters, media personnel, and WSDOT traffic engineers. We sought responses from commuters to five broad areas of questions: (1) potential change in commuter behavior, (2) interaction with the system, (3) interface design, (4) potential use of the system, and (5) desired delivery method of the information provided by the system. We sought similar information from media personnel but with the focus on traffic reporting; from WSDOT traffic engineers we sought subjective evaluations of *Traffic Reporter* as an addition to other management tools.

In this section we discuss usability testing of the three user groups, including materials, subjects, testing procedures, and findings and conclusions of each of the three tests. We then present overall conclusions and recommendations.

TESTING OF COMMUTERS

The functions of *Traffic Reporter* that we tested are described in Chapter 2 of this report. In particular, we focused on those functions that directly affect commuters: (1) zooming to obtain specific speed information, (2) locating speed and time estimates for specific trips, (3) selecting the best entry ramp, and (4) selecting the best exit ramp.

Materials

Two types of materials were used for this usability test: introductory materials and test materials.

Introductory Materials

The introductory materials consisted of a consent form, subject profile questionnaire, introduction/demonstration, tutorial, and diversionary task.

When subjects arrived at the test site, they were given a consent form. The consent form described the purposes and benefits of the test, and any risk, stress, or discomfort associated with the test. It also stated that the identity of the subjects would remain confidential and that subjects could withdraw at any time. By signing this form, subjects acknowledged that the above issues were explained and that they had voluntarily agreed to participate in the test. (See Appendix E for a copy of this form.)

The subject profile questionnaire was used to confirm that subjects did in fact belong to the anticipated commuter groups. The majority of the questionnaire asked questions from the original traffic survey that the commuters completed in September 1988. We were especially concerned with the questions that would indicate whether the commuters belonged to the RTC or PC groups, as these groups would be most likely to alter their departure time. The questionnaire also asked about commuters' employment and computer use. We believe the answers to these questions can prove useful in the future for long-range planning. (See Appendix E for a copy of this questionnaire.)

After the subjects filled out the consent and profile forms, they were introduced to the system. The introduction--a brief statement about the purpose of the usability test and the purpose, scope, and limitations of the system--was in the form of a script that the test administrator read aloud so that each commuter heard the same information (see Appendix E). Next, a scripted demonstration was read aloud and provided information about the main screen, the mouse, the four functions of the system, and the help screen (see Appendix E).

Subjects were then given a tutorial that allowed them to watch the cursor change shape and to become familiar with the mouse. The tutorial also described the four system functions: (1) zoom, (2) time and speed information between two ramps, (3) information about specific entrance ramps, and (4) information about specific exit ramps. For each function, the tutorial contained two tasks. In task A, the subject not only interacted with the system to find the answer to a question but also received detailed instructions about how to answer that question. In task B, the subject again interacted with the system, but this time no instructions were given. For functions 1 and 4, task A used a northbound scenario, and task B used a southbound one. For functions 2 and 3, task A used a southbound scenario and task B a northbound one.

After the tutorial but before the actual test, subjects were given a diversionary task consisting of setting an alarm clock to counteract the effect of immediate memory on the ensuing experimental tasks; we wanted to test how well subjects had learned the system by doing the tutorial, not how well they could recall the tutorial. A secondary purpose of this task was to give the subjects further opportunity to practice the talk-aloud protocol method they would use in the test.

Test Materials

We wanted to obtain both quantitative and qualitative information from commuters about a number of questions regarding the system. This information fell into five main categories: (1) potential change in commuter behavior; (2) interaction with the system; (3) interface design; (4) potential use of the system; and (5) preferred method for receiving information.

The test materials consisted of a task sheet and an open-ended interview. The task sheet for commuters consisted of two parts. Part one had two commuting scenarios (northbound and southbound) with four tasks in each scenario. Each task required the subjects to perform one of the four system functions being tested, record their answers, and at times answer qualitative questions on a five-point scale pertaining to the function they had just performed. The qualitative questions focused on commuter behavior (changing route or time), as well as certain aspects of the interface (clarity of main screen information and usefulness of various dialog boxes.) (See Appendix E.)

Part two examined the system overall. It consisted of 11 scaled questions about the interface, three scaled questions about commuter behavior based on *Traffic Reporter's* information, a scaled question rating *Traffic Reporter's* information relative to current forms of traffic information, two open-ended questions about additions or changes to the system, one open-ended question about the meaning of some arrows on the main screen, two ranked questions about preference for delivery of *Traffic Reporter's* information, and two two-choice questions about use of the system. (See Appendix E). All of the scales in parts one and two were five-point scales numbered 1 through 5. On all of the scales but one, the numbers 1, 3, and 5 had subjective adverbs--"not at all," "somewhat," and "very"--written above the corresponding number (numbers 2 and 4 had no adverbs). In part two, a frequency scale was labelled "not at all," "occasionally," and "frequently."

The open-ended interview consisted of questions about commuters' thoughts concerning expansion of the system, different color codes or ways to show traffic flow, and other issues related to commuting and the Seattle freeway system in general.

Subjects

Subjects were selected from the 1,697 respondents to the first on-road survey (September 1988) who expressed willingness to participate in an in-person interview. We selected commuters from the groups who were most likely to change their driving behavior based on traffic information: Route Changers (RC), Pre-trip Changers (PC), and Route & Time Changers (RTC). Non-changers were not tested because their principle commuting characteristic was that they would not change their driving behavior. Additionally, because a majority of commuters in the initial on-road survey ranked computers last as a preferred medium for receiving traffic information, while many in the in-person interviews expressed interest in computer delivery, we thought it important to test both commuters who stated they would and those who stated they would not like to have a computer system developed for delivering traffic information. Therefore, our sample consisted of six commuter groups. Table 18 shows the number of commuters belonging to each of the six groups.

Table 18. Number of Subjects per Commuter Group

Computer Pref.	Commuter Group		
	RC	RTC	PC
Yes	2.0	3.0	3.0
No	3.0	2.0	3.0

To identify subjects, we sorted the database of the initial survey results to identify all subjects who fit the characteristics of the six groups and who had indicated willingness to participate in further studies by including their names and phone numbers on their questionnaires. From these groups, we randomly selected subjects and then phoned them to schedule a two-hour time slot to participate in a usability test at the University of Washington.

Although we initially planned to test four to five commuters per group, we finally tested only 16 commuters because many commuters had changed telephone numbers, were no longer willing to participate, could not arrange their schedules, or cancelled their appointments. (The scheduling problems we encountered emphasize the necessity for maintaining an up-to-date subject database.)

Test Procedure

The usability tests of the *Traffic Reporter* system took between 1-1/2 and 2 hours per commuter. Results were obtained by timing subjects on tasks, tape recording subjects' talk-aloud protocols during task performance, and having subjects record their answers on task sheets. Additionally, both the data keeper and test administrator recorded the number of mouse moves, uses of help, and types of functions that commuters used for each task. The testing procedure consisted of a preliminary stage and the actual test stage.

Preliminary Test Stage

When subjects first arrived, they were taken to the testing area, made comfortable, and then asked to fill out the consent form and the subject profile questionnaire. When they finished filling out these forms, the preliminary stage began, which consisted of listening to the introduction, watching the system demonstration, and completing the tutorial and the diversionary task.

Before the introduction, the test administrator reiterated the importance of the subject's input and stressed that the subject was not being tested but rather was helping test the system.

The test administrator then read the introduction aloud while demonstrating the system to each participant so that everyone would hear the same information. The introduction and demonstration took about ten minutes. The subjects were allowed to ask questions afterward, although they were not yet allowed to use the system.

Next, subjects performed the tutorial while reading aloud to practice the talk-aloud protocol method. If subjects seemed unusually lost during the tutorial, the administrator tried to get them back on track by asking them questions to help them re-think what they were trying to do. Also, if subjects answered the tutorial correctly but used functions other than the necessary ones, the administrator told them that they had obtained correct information but asked them to try to find the answer again using the specified function. Subjects were told that if at any time during the tutorial or tasks they needed a reminder on what the various functions were, they would have to use the Help screen. Finally subjects completed the diversionary task.

Actual Test Stage

The actual test stage consisted of two components: the usability tasks and an open-ended interview. When subjects were ready for the usability tasks, the test administrator turned on the tape recorder and asked them to proceed. Using a stopwatch, the data keeper timed the subjects from the moment they finished reading a task until they recorded the correct answer on the task sheet. The test administrator and the data keeper both recorded the number of times subjects went to the Help screen and the order of the functions used to obtain the answer. In addition, the data keeper noted any special circumstances, such as pertinent comments, outside interruptions, etc.

After a subject finished the usability tasks, the test administrator conducted the open-ended interview. The test administrator, subject, and data keeper talked about various aspects of the system, as well as overall traffic situations that commuters encounter. Some subjects offered solutions to Seattle's growing traffic problem.

When the subjects were finished, they were thanked and given a silk screened T-shirt of the *Traffic Reporter* system as a token of appreciation for their participation.

Findings

As stated earlier, the questions we sought to answer fell into five categories:

(1) Changing commute behavior.

(2) Interacting with the system.

(3) Interface design.

(4) Potential use of the system.

(5) Preferred method for receiving information.

The answers were measured through scaled information, timed information (including mouse clicks), and ranked information. Additionally, commuters were asked open-ended questions about why they would or would not change a commute behavior, what additional information they might use to help with their commute decisions, and any other comments they might have pertaining to the system or their commute. These comments appear at the end of each related section. While both parametric and nonparametric statistical routines were applied to the data and support the conclusions that follow, the statistics themselves are not reported because of their instability, given the small cell sizes. Rather, we report descriptive statistics--medians, minimums, maximums, and frequency.

Changing Commute Behavior

Eight scaled questions asked commuters whether, on the basis of information received from *Traffic Reporter*, they would change their (1) departure time, (2) route, or (3) transportation mode.

Departure Time

Subjects were asked three times whether the information presented by *Traffic Reporter* would influence them to change departure time. Adding the scores from these three questions revealed that the lowest median for any group was 9, a value that corresponds to "somewhat likely" to change departure time on the basis of information received from *Traffic Reporter*. The medians for each of the six groups, as well as the row and column medians by computer preference and commuter group, are shown in Table 19.

Table 19. Median Scores for Changing Departure Time
(3 = Not at all likely, 9 = Somewhat likely, 15 = Very likely)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	13.0	13.0	11.0	13.0
No	9.0	10.0	9.0	9.5
Column Medians	11.0	13.0	10.5	

From these results, it appears that subjects who are predisposed to receiving traffic information via computer (row median of 13) would be most easily influenced by *Traffic Reporter* to change departure time. In addition, it appears that the RTC group is most likely to change departure time on the basis of computer-based information.

Many commuters commented that they would change their departure time on the basis of the type of information they received from *Traffic Reporter*, but added that they would feel more comfortable doing so if they had more information about overall traffic conditions. For example, they want to know which arterials were clear and how long the congestion on I-5 would last.

A number of other commuters said that they would change their departure time if they could, but they often have very rigid schedules either going to or leaving from work. It was interesting to note that many of the commuters travel during peak rush hours only if they have to. Several of the commuters have flexible hours, so they can often arrange their commute accordingly. Interestingly, one of the commuters "builds in" any unforeseen problems into his commute--he leaves himself over double the time that it would take to get to work if there were no traffic. When asked what he would do if the morning rush hour kept starting earlier and earlier, he replied that he, too, would keep leaving home earlier and earlier.

Route

In four tasks, subjects were asked whether time and speed information would influence their route choice. When the scores of the four questions pertaining to changing route were summed, the medians for all groups but one were at least 13, which corresponds to slightly more than "somewhat likely" to change route on the basis of information received from *Traffic Reporter*. The one group that scored much lower was the PC non-computer group. Its aggregate median was 8, which falls between "not at all" and "somewhat likely" to change route on the basis of *Traffic Reporter's* information. The medians for each of these groups are shown in Table 20.

Table 20. Median Scores for Changing Route
(4 = Not at all likely, 12 = Somewhat likely, 20 = Very likely)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	16.0	16.0	16.0	16.0
No	13.0	16.5	8.0	14.0
Column Medians	15.0	16.0	14.5	

Once again, it appears that computer preference (row median of 16) is a determining factor in whether members of a group are likely to use *Traffic Reporter's* information in deciding whether to change their route.

Comments from commuters generally focused on desiring feedback about route choices and information about causes of delays. The commuters fairly consistently said that they would change their route if they could be sure that they would save time doing so. (While the current prototype of *Traffic Reporter* does not provide information regarding alternative routes, the next version will provide comparisons not only of alternative routes, but also of HOV and express lanes versus regular lanes.) Many commuters stated that more than once they had tried alternative routes, but the alternatives were so backed up, the commuters felt they would have been better off staying on the freeway. Several commuters noted that even with large back-ups, the freeways seem to move more steadily than city streets or other routes they might choose.

A number of commuters said they would change their route on the basis of information from *Traffic Reporter*, but that they really needed to know what the cause of the delay was on the freeway in order to feel they had made the correct decision. If the delays were due to normal heavy traffic, the commuters probably would not change their route; but if the delays were caused by an accident, closed freeway, or some other incident that would take a long time to clear up, the commuters would probably change their route.

Transportation Mode

We asked the commuters only one question about whether they would change their mode of transportation on the basis of information they received from *Traffic Reporter*. The median for all six groups fell somewhere between "not at all willing" and "somewhat willing" to change mode in response to traffic information received from *Traffic Reporter*. These medians are shown in Table 21.

Table 21. Median Scores for Changing Transportation Mode
(1 = Not at all likely, 3 = Somewhat likely, 5 = Very likely)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	2.5	1.0	2.0	1.5
No	2.0	1.0	1.0	1.0
Column Medians	2.0	1.0	1.5	

Most of the commuters commented that they are fairly unwilling to change their mode of transportation. (A few commuters already ride in shared transportation modes.) Many other commuters had considered carpooling or bus-riding but are unable to, mainly because of scheduling problems. Also, some commuters have jobs requiring they use their own cars, and some commuters feel unsafe at park-and-ride lots. Several commuters commented that they could probably arrange their schedules to carpool with only one other person; however, since at the time of the test there was little benefit to two-person carpools, these commuters would continue to commute by the most convenient mode--single occupant vehicle. Several commuters mentioned that if there were a light rail system with a convenient schedule, they would reconsider their stance on transportation mode. Almost none of the commuters totally ruled out the idea of changing transportation mode; but at present they said changing their transportation mode is restricted to severe weather conditions or other major problems, such as the collapse of the I-90 bridge.

Interaction with the System

Three scaled questions asked commuters their opinions about interacting with *Traffic Reporter*. These three questions pertained to (1) using the mouse, (2) ease of interacting with the system, and (3) ease of extracting information from the system. Because the answers to these three questions were similar for each group, we summed them to derive one set of "interaction" medians. The medians on the ranked questions for all of the groups fell between "somewhat" and "very easy" to interact with, as shown in Table 22.

Table 22. Median Scores for Interaction with *Traffic Reporter*
(3 = Not at all easy, 9 = Somewhat easy, 15 = Very easy)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	10.5	12.0	14.0	12.0
No	12.0	12.0	11.0	12.0
Column Medians	12.0	12.0	13.0	

In addition, subjects were timed in two ways: (1) the amount of time they spent using the mouse and (2) the number of mouse clicks they used to obtain a correct answer. As Table 23 shows, the RTC group took longer on average than the other groups to complete the tasks. However, interestingly, the computer and non-computer group averages (70.9 versus 68.9 seconds, respectively) were very similar.

Table 23. Mean Time per Task (Seconds)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	46.2	75.0	83.2	70.9
No	80.7	77.0	51.7	68.9
Column Medians	66.9	75.8	67.5	

Timed information is interesting in that it reveals how long it takes subjects to do specific tasks. Most commuters are in a hurry and want a system that involves the least amount of their time. The time results must be interpreted, however, in light of the fact that all the subjects were talking aloud. In other words, timing differences may have been influenced by uncontrolled factors such as the speed at which individuals talk or process questions.

Although each task required only one mouse move, commuters averaged about one and a half times that number, as shown in Table 24. The PC computer group used more mouse clicks per task (m=1.9) than any of the other groups. Interestingly, the computer group used more mouse clicks (m=1.8) to obtain the correct answer than did the non-computer group (m=1.6).

Table 24. Mean Number of Mouse Moves per Task

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	1.8	1.5	2.2	1.8
No	1.5	1.9	1.5	1.6
Column Medians	1.6	1.6	1.9	

There were differing mean times and number of moves for each task type. Table 25 shows the average number of times per task and mouse actions for each of the four types of tasks. Mouse actions were counted as a completed (or aborted) process to bring up any of the four possible dialogue boxes, regardless of the number of mouse clicks or mouse actions taken.

Table 25. Mean Times and Mouse Actions per Task

Task Type	Seconds/task	Actions/task
Zoom	51.2	1.4
Left click on two ramps	51.8	1.5
Left double-click on exit ramp	87.5	2.1
Right double-click on entrance ramp	89.4	1.8

Almost all commuters commented that with practice they would feel more comfortable moving around the system. However, several commuters mentioned that they found the double-clicking confusing; they were not sure when to double-click with the right button versus the left button. Although only several of the commuters expressed confusion regarding the double-click tasks, a general confusion was reflected in the longer time and the greater number of mouse actions per task when a double-click was required (2.1 and 1.8 actions and 87.5 and 89.4 seconds) versus when a single-click was required (1.4 and 1.5 actions and 51.2 and 51.8 seconds). The confusion possibly was caused by the memorability of the right and left double-clicks and not the actual number of mouse clicks required to complete a process, since the zoom (one click) and left-click on two ramps (two clicks) have similar results.

Interface Design

Ten scaled questions assessed the design of the user interface. The questions focused on the trip information dialog boxes, zoom dialog boxes, the main screen, and speed representations. Again, because of the small differences between groups on each individual question, the answers to all questions were summed. The medians for all groups were at least 40.5, which corresponds to between "more than somewhat" understandable/usable to "very" understandable/usable. Table 26 shows medians for each of the six groups, as well as the medians for computer preference and commuter type groups. It appears that computer preference is only slightly more of a deciding factor in determining understandability/usefulness of the interface design than is commuter group membership.

Table 26. Median Scores for Interface Design
(10 = Not at all understandable, 30 = Somewhat understandable, 50 = Very understandable)

Computer Pref.	Commuter Group			*Row Medians*
	RC	RTC	PC	
Yes	43.5	44.0	44.0	43.5
No	49.0	40.5	41.0	45.0
Column Medians	44.0	43.0	43.0	

Commuter comments on the interface design addressed three areas: dialog boxes, speed ranges and colors, and arrows.

Most commuters thought that the type of information presented in dialog boxes was useful. However, because commuters drive to and from work from the same starting point to the same ending point every day, they would probably go to information dialog boxes only if the main screen showed a problem--i.e., if there were a lot of red and purple showing up. This seemed especially true of the zoom dialog boxes. Most commuters said that they might use the zoom to see if traffic on a "red" section of freeway was just moving slowly or had stopped. However, they noted that if traffic had stopped, they would prefer to see that information on the main screen.

The second question regarded speed ranges and colors. Although most commuters said they thought the speed ranges were both appropriate and useful, they would like some indication, such as a blinking light or other flagging device, to indicate when traffic was stop and go or completely stopped. Many commuters said they would like the slower speed ranges further divided, although they acknowledged that adding more speed ranges might clutter the screen and actually be confusing and therefore counterproductive. The commuters like the choice of colors used to indicate speeds, except for the color purple, which is used to indicate speeds between red and yellow. Several commuters mentioned that the purple and red colors tended to run together when large blocks of those colors occurred next to each other. One commuter who was partially color-blind noted that color-blind individuals can tell what color a traffic light is by its position but that this method of distinguishing colors is not available on the *Traffic Reporter* screen.

The third question regarded the arrows next to six of the exits. These arrows are supposed to indicate ramps that are exit-only or entrance-only, but many of the commuters had no idea what the arrows meant. Some of the answers were: slope of the ramp, exits from a given side of the freeway, entrances and exits from/to other freeways, and metered ramps. Commuters who did guess correctly based their ideas on prior knowledge rather than representations on the screen.

Potential Use of the System

Commuters were directly asked a yes/no question regarding whether they would use the *Traffic Reporter* system if it were readily available and, if so, how frequently. In addition, they were asked three scaled questions on (1) usefulness before commute, (2) frequency of access, and (3) usefulness of information compared to current forms of traffic information.

All of the commuters seemed impressed with the system and said that if *Traffic Reporter* were readily available, they would use it. In addition, the median for all groups as to the usefulness of *Traffic Reporter* before the commute was 5, corresponding to "very" on the scale. The median for all groups as to frequency of use of *Traffic Reporter* was also 5, corresponding to "frequently" on the scale. Furthermore, the median for all groups as to usefulness of *Traffic Reporter's* information compared to other forms of traffic information currently available was 4, falling between "somewhat" (3) and "very" (5).

As stated earlier, all the commuters tested commented that they would use *Traffic Reporter* if it were readily available. They seemed to think that any additional traffic information they could obtain would be useful. Almost all commuters especially liked the timeliness of *Traffic Reporter's* information compared to their current sources of traffic information. Almost all commuters, however, said that they would use *Traffic Reporter* only if (1) arterials and alternative routes were included and (2) traffic delays were explained (e.g., which lanes were affected, how long delays would be, etc.). Also, several commuters said that they would make consistent changes on the basis of *Traffic Reporter's* information only if over time they found that their changes saved them time and frustration.

Three other issues were raised concerning the current version of the *Traffic Reporter* system. First, several commuters asked about access and cost: how they would access the system in their homes, what type of equipment they would need, and how much the equipment and service would cost.

Second, extremely high speeds on some sections of the freeway map prompted several commuters to question the credibility of *Traffic Reporter*. We explained that *Traffic Reporter* is in the prototype stage with bugs still being corrected. Although most of the subjects accepted this explanation, some commented that they would not trust the system until they themselves used it and confirmed its credibility.

Third, commuters questioned whether a system such as *Traffic Reporter* would really help solve the traffic problems that are plaguing Seattle. Several commuters, believing that traffic flow patterns need to be further studied, cited poor road design (especially at certain exits and entrances) and poor HOV (high-occupancy vehicle) lane flows. Additionally, a number of commuters said that although they would use *Traffic Reporter* because it gave them additional information, they wondered what effect this increased information might have on congested alternative routes, such as neighborhood and city streets.

Preferred Medium for Receiving Traffic Information

Finally, subjects were asked two ranked questions and one two-choice question regarding delivery medium. The minimums, maximums, and medians for each of the three delivery mediums are presented in Table 27. The first question asked commuters to rank their preference for receiving traffic information from the choices of (1) screen, (2) radio, and (3) variable message signs (VMS). The relative rankings are screen, radio, and VMS.

Table 27. Rankings of Screen, Radio or VMS Delivery Medium
(1 = Most desirable, 3 = Least desirable)

	Screen	Radio	VMS
Minimum	1	1	2
Maximum	3	3	3
Median	1	2	3

It is interesting to note here that whereas both screen and radio had minimums of 1 and maximums of 3, VMS only had a minimum of 2, meaning that no one ranked VMS as a first choice.

Many commuters commented that their choice of medium would depend on where they were when they needed traffic information. If they were in their cars, they would prefer to hear the information on the radio; if they were either at home or work before departing, they would prefer the information on a screen. Commuter opinions about delivery medium are summed in Table 28.

Table 28. Overall Commuter Opinions on Delivery Medium

Screen:	Provides instant visualization of the traffic situation and can be tailored to each individual's commute.
Radio:	Reaches the greatest number of commuters.
	Can be accessed in the car; then changes can be made during the commute based on the information.
	Takes longer to hear about an individual's particular commute, if it is mentioned at all.
VMS:	If there is an exit between the VMS message and the area of the traffic problem, then VMS is all right; otherwise, it would not be possible to make any detours.

The second ranked question asked commuters to rank eight mediums for receiving information for usefulness. (Note: some of these mediums do not exist currently, so commuters were told to answer as if all mediums were available.) The eight mediums that commuters were asked to rank were computer at home, computer at work, cable TV, TV kiosk in a store or parking garage, computer kiosk, commercial TV, commercial radio, other (specify). The eighth category--other--was left open for the commuter to fill in. Table 29 presents the number of commuters choosing each medium and the minimums, maximums, and medians for the eight delivery mediums that commuters ranked. The delivery mediums are ordered from most to least useful.

Table 29. Rankings of Usefulness of Delivery Medium
(1 = Most useful, 8 = Least useful)

Delivery Medium	*Minimum*	*Maximum*	*Median*
Home Computer	1	8	2
Work Computer	1	8	2
Radio	1	6	3
TV	2	8	4
Other	1	8	5
Cable TV	2	8	5
TV Kiosk	4	8	6
Computer Kiosk	3	8	7

Commuters who had an entry for the "other" category (eight of 16 subjects) chose a medium that they could access from their car, as shown in Table 30.

Table 30. "Other" Mediums Chosen by Commuters

Mode	Number of Comments
None	7
Dedicated Radio	5
More VMS	2
Mobile Phone	1
No Comment	1

Here again, it is important to look at minimums and maximums. None of the commuters chose radio as their last choice, although computers at home and work had higher medians. Also important to note is that none of the commuters chose TV, cable TV, TV kiosk or computer kiosk as their first choices. In fact, the highest ranking that computer kiosk received was a 3; TV kiosk ranked even lower, with a 4 as its highest rank. Since respondents to our on-road survey ranked computer delivery much lower than those who took part in the usability tests, it seems clear that lack of familiarity with a delivery medium causes it to receive a low ranking.

An important result to notice above is the high ranking of both computer at home and computer at work. This is consistent with the fact that when commuters were asked on the two-choice question if they would prefer to view and manipulate the information or have it interpreted, 81% said that they would prefer to manipulate the system themselves. The inconsistent finding is that the choice of computer kiosk, which would allow users to manipulate the system, ranked the lowest of all delivery modes. Since computer kiosks do not currently exist, this again demonstrates that exposure to a medium will increase its acceptance.

Commuters overwhelmingly expressed the desire to be able to view and manipulate the system for themselves so that they could access information quickly and customize the system to their own commute. Many commuters expressed great displeasure with the traffic information that they currently receive from TV or radio. The most common complaints were that the information was old and inaccurate, and that the TV and radio stations tend to focus on only certain locations. Although commuters want to have more control over the information they receive, most of them also expressed a concern about the time lapse between seeing *Traffic Reporter* before their commute and actually entering the freeway. Mainly for this reason, several commuters expressed the desire for a dedicated radio station for traffic information.

Conclusions and Recommendations Based on Commuter Testing

On the basis of results of the usability testing of commuters and their comments, we have reached several conclusions and recommendations regarding the design of *Traffic Reporter*.

Changing Commuter Behavior

This study has shown that all commuters who evaluated the system were willing to change their departure time, route, and occasionally even transportation mode given the right kind of information. We recommend the following in order to help influence commuter behavior:

- Add graphical arterial information to the screen display.
- Add graphical incident information to the screen display.
- Add a feedback mechanism. (This could perhaps have comparisons of times commuting in a single occupant vehicle with HOV and bus modes.)
- Ensure credibility of the information.

Interaction with the System

None of the commuters who evaluated the system had any undue problems interacting with the system. However, all of the commuters used more mouse moves than necessary, indicating that there are probably too many mouse actions to remember and use. Therefore, we recommend that some of the mouse moves be deleted while still retaining the information they provide.

Interface Design

The only portion of the interface that commuters had trouble understanding was the use of arrows on the main screen. Several commuters questioned the use of the color purple to represent the speeds between those represented by the colors red and yellow. Furthermore, almost all of the commuters expressed a desire to see on the main screen whether traffic was at a standstill versus moving slowly. Based on commuters' concerns and needs, our recommendations are:

- Delete the arrows from the main screen.
- Look at alternatives to the color purple.
- Add a flashing color or some distinct marking on the main screen to let commuters know when traffic is completely stopped.

Potential Use of and Delivery Medium for the System

All the commuters said that they would use *Traffic Reporter* if it were readily available to them. The majority of the commuters expressed a desire to view and manipulate the system themselves. On the basis of the above conclusions, we recommend the following:

- Develop *Traffic Reporter* for the use of radio and TV media.
- Develop a dedicated radio station that would use *Traffic Reporter*.
- Continue development of a PC-based system geared toward commuters who would be willing to pay for additional information via home services, such as Compuserve.

- Expose the public to computer kiosks and then re-evaluate their potential as a delivery medium for real-time traveler information.

TESTING OF MEDIA PERSONNEL

In addition to commuters, usability testing was conducted with media traffic reporters.

Materials

Two types of materials were used for this usability test: introductory materials and test materials. The introductory materials consisted of a consent form, introduction/demonstration, and tutorial. These materials were identical to those used during the commuter usability tests, with the exception of the subject profile questionnaire and the diversionary task. The questionnaire and diversionary task were not required because of the nature of the media usability test.

The test materials consisted of a task sheet and an open-ended interview. The task sheet for media personnel consisted of two scenarios (the morning and afternoon commutes), with four tasks in the first scenario and three tasks in the second scenario. The open-ended interview examined the overall system through a series of questions pertaining to the media personnel's thoughts on expansion of the system, different color codes or ways to show traffic flow, and other issues related to displaying information about commuting on the Seattle freeway system.

Subjects

The media personnel consisted of three volunteers from Seattle news media: a radio traffic reporter, a radio news manager, and a radio/TV reporter (accompanied by a radio reporter/pilot).

Test Procedure

The usability tests of the *Traffic Reporter* system took between 2 and 2-1/2 hours per media person. The total test time was slightly longer with the media personnel because of the volume of responses during the open-ended interview portion of the test. The testing procedure was accomplished in two stages: a preliminary stage and the actual test stage. During the preliminary stage, *Traffic Reporter* was introduced and demonstrated by the test administrator, and then the media personnel were encouraged to complete a self-paced tutorial. This portion of the usability test was conducted in a manner identical to the commuters' test. There were two components to the actual test stage: completion of a task sheet and participation in an open-ended interview.

When subjects were ready for the usability tasks, the test administrator turned on the tape recorder used to record the verbal protocol and asked them to proceed. Using a stop-watch, the data keeper timed the subjects from the moment they finished reading a task until they recorded the correct answer on the task sheet. The test administrator and the data keeper both recorded the number of times the subjects went to the Help screen and the order of the functions used to obtain the answer. In addition, the data keeper noted any special circumstances, such as pertinent comments or outside interruptions.

After completing the tasks, the media personnel were asked to comment on *Traffic Reporter* through a series of scaled and open-ended questions regarding the interface, current sources of information, applicability to radio and TV broadcast, and any other comments the subjects wished to share about *Traffic Reporter* and its usefulness to their jobs.

When the subjects were finished, they were thanked for their participation and given a silk screened T-shirt of the *Traffic Reporter* system.

Findings

The results were divided into two categories: (1) interaction with the system and (2) interface design. The answers were measured through scaled information, timed information (including mouse clicks), and ranked information. The timed data were not useful because the media personnel were overly comfortable with the verbal protocol and tended to be verbose.

Interaction with the System

In general, the media personnel liked the system's interactive capability. They believe the system's ability to determine time and speed estimates would be helpful for regular checks on normally congested areas. By comparing speed in a specific congested area with average speed in that area, reporters could tell commuters how much extra time it would take them if they used that route. The media personnel also thought time and speed estimates would be advantageous when comparing the traffic on the two bridges. However, the media personnel favor being able to compare the information about the two bridges rather than providing specific time and speed information per bridge to commuters; although in other situations they believe commuters often would want the specific traffic information also provided by *Traffic Reporter*. The media personnel also believe time information is more important to commuters than speed information.

Regarding the function that displays the best entrances or exits, two of the subjects commented that information to an exit is more valuable than from an entrance. One subject also felt that the choice of double-clicking on the left or right mouse button would depend on the situation. All subjects thought that double-clicking was the fastest way to get the most information.

Regarding the function that provides information between any two ramps, one subject felt this function was the least useful because it took too long to compare several scenarios and the information provided was too specific for general broadcasting. On the other hand, one subject felt this function was best because it did provide specific information.

The subjects thought the zooming function was most useful if a specific problem arose, but that they would not know why the back-up or problem was happening.

Finally, the media personnel commented that *Traffic Reporter* cannot replace other sources of information, such as scanners, Metro, planes, cameras, cellular phone callers, or TSMC, but that it could help with sending out watchers, giving earlier confirmation of problems, and clearly focusing traffic information.

Interface Design

The subjects made the following comments and suggestions regarding the interface design. They thought the color coding useful except for the color purple. They suggested adding an incident box to provide information on traffic incidents. They would also like to integrate TSMC camera shots into the *Traffic Reporter* system. One way might be to use menus or layers, or a main screen showing incident information and camera shots confirming incident reports. The subjects felt that the display of northbound trip information to an exit was backwards. The ramps were displayed such that the nearest ramp (the most southern ramp) was first in the list. The subjects suggested sticking with a map metaphor, which would display the nearest ramp at the bottom (or southern) part of the list.

The subjects provided suggestions for increasing the scope of the system. They recommended adding HOV lanes, I-405, I-90, SR-520, Aurora, West Seattle Freeway, Alaskan Way Viaduct, Lake City Way, Bothell Way, First Avenue S. Bridge, SR-518, SR-167, Meridian, Ballard Bridge, Holman Road, Airport Way, East Marginal Way, and the Swamp Creek Interchange. Furthermore, they want coverage of I-5 extended to Marysville in the north and to Olympia in the south.

Other Comments by Media Personnel

The media personnel also recommended developing a touch-screen version of *Traffic Reporter*, adding more sensor loops, and changing the name of the system (the term *Traffic Reporter* is confusing because many of the media who report traffic information refer to themselves as traffic reporters). In general, they felt that all the functions were potentially useful and necessary for media, and that all functions should be kept if media were to be one of the main audiences.

Conclusions and Recommendations Based on Media Testing

On the basis of usability testing of media personnel, along with their comments, we have reached several conclusions and recommendations regarding the design of *Traffic Reporter*. The media believe that *Traffic Reporter*, in a simplified form and with a reduced number of exits, could feasibly be delivered by cable TV but were skeptical about regular TV. This is because of the nature of regular TV, where time and technological constraints make complex graphical information too difficult to be extracted and formatted directly for broadcast. They also believe the following additions would be useful:

- A comparison of current traffic information with average traffic information.
- A database that would incorporate weather, time of day and year, and road conditions, as well as average traffic information.
- The addition of a blinking symbol or box around areas of unusual congestion, as well as changing speed thresholds depending on the time of day.
- The addition of other routes to the screen.

EVALUATION BY TRAFFIC ENGINEERS

Traffic engineers were a third subject group but were not given formal usability testing. Instead, they took part in an open-ended evaluation.

Materials

An introduction and demonstration were provided to the traffic engineers. The introduction was a brief statement about the purpose, scope, and limitations of the system. The demonstration provided information about the main screen, the mouse, the four functions of the system, and the Help screen.

Subjects

Six traffic engineers from the TSMC were asked by the WSDOT to help in our evaluation.

Evaluation Procedure

The traffic engineers were not given formal tasks but were only given a demonstration of the system and then asked to explore the system and make comments. The traffic managers' comments tended to fall into two categories: (1) concerns and (2) possible additions/improvements.

Concerns

The main concerns of the traffic engineers were about validity, time at ramps, the purple speed color, sensor loops on arterials, resolution, and distribution to the public. The traffic engineers were concerned about the validity of time and speed information. The information they currently receive comes in the form of volume and occupancy data directly from sensors in the roadways. In order for *Traffic Reporter* to deliver the speed and time information that commuters want, we employ an algorithm (also used by the TSMC) to translate volume and occupancy data into speeds. However, the traffic engineers felt that the algorithm was not calculating speeds with sufficient accuracy. (When TSMC personnel give congestion information, they use general terms, such as "heavy," "light," "moderate," and "stop and go.")

The traffic engineers cautioned that the time commuters spend at approach ramps may considerably increase their commute time, although the *Traffic Reporter* time indications are only for the time spent on the freeway itself. The traffic engineers felt that in order to paint a more accurate picture for commuters (thereby allowing them to make more informed choices), time spent on ramps should be included in the trip information box.

Almost all of the traffic engineers commented on the color coding used for *Traffic Reporter*. The two major complaints had to do with the use of the purple as a speed indicator and no color code for stop and go traffic. (TSMC's color scheme is green, yellow, red, and flashing red as compared to *Traffic Reporter's* green, yellow, purple, and red, respectively). Several of the traffic engineers commented that the color purple seemed to run into the color red. Additionally, the traffic engineers wanted a color for stop-and-go traffic. The flashing red on the current TSMC system provides a quick visual overview of where traffic problems are occurring.

The traffic engineers agreed that commuters need arterial information. However, because of the way road sensor loops operate and because of the number of traffic lights on most arterials, they felt that other methods of collecting congestion information, such as cameras or lasers, will need to be developed before arterial information can be useful.

At least one of the traffic engineers stated that *Traffic Reporter's* current screen display is too detailed for either TV or CATV, where screen resolution is vastly reduced. If the information were to be transferred to a TV screen, ramp labels would need to be larger, but then the labels probably would not fit on the display.

Finally, the traffic engineers were concerned about the WSDOT's inability to distribute its traffic information to the general public. With the Perkin-Elmer system that currently receives and interprets sensor loop data, as well as with the new VAX system that will replace it, there is a limit on the number of users at any one time. Currently, not only is *Traffic Reporter* using the data, but so too are TCI cable and several radio and TV stations in the area. The issue of access to the data raises questions about who will pay and who will receive free information.

Possible Additions/Improvements

The traffic engineers offered a number of suggestions for additions and improvements to *Traffic Reporter*. Among those suggestions were the following:

- More blow-up maps showing cities, mileposts, and landmarks.
- Incorporation of weather conditions.

- Integration of cameras and text blocks explaining incidents and accidents.
- Addition of HOV lanes, express lanes, and ramp information.
- Separate lane information as opposed to the current aggregate lane information.

Other suggestions that would allow commuters to make more informed choices included the following:

- Color coding of trip information to compare specific trip information with average trip information.
- Icons of cars on the roadways to indicate spacing, speed, and congestion.
- Integration of bus information into the system (schedules, and time and cost comparisons with driving, etc.).

USABILITY TEST CONCLUSIONS

On the basis of the usability testing results from commuters and media personnel, as well as the evaluations from traffic engineers, several conclusions can be made about *Traffic Reporter*.

Although all three groups--commuters, media personnel, and traffic engineers--addressed common issues and expressed some common needs, all three were also distinctly different. Therefore, it is vital to keep in mind which user group is being addressed in the development of any feature or display.

Commuters are the ultimate end-users of the information provided by *Traffic Reporter*. Only by modifying their behavior can urban congestion be reduced. They are the ones that need to be targeted to help alleviate traffic problems. The purpose of *Traffic Reporter* is to provide commuters with information that will help them change their commuting behavior by changing departure time, route, and mode of transportation. From our usability testing we have found that commuters like the interface and find interacting with *Traffic Reporter* to be fairly easy. To use the information provided by *Traffic Reporter*, however, they need further information about alternative routes, alternative modes, and incidents. They also need to believe that the system information is both timely and accurate. Finally, they want a feedback mechanism to confirm that they have made the best commuting choices.

Although the commuters we tested expressed a desire to control the information themselves, cost and hardware constraints may mean that a PC-based system will be the first delivery option. Therefore, further development of the system should be directed toward the media who, via radio, TV, and cable TV, might be able to reach the largest number of commuters at the lowest cost. The type of graphics being developed for *Traffic Reporter* may well lead to a new generation of TV traffic reporters who, in addition to presenting up-to-the minute real-time traffic information, will be able to present traffic patterns, incidents, and histories in a way similar to the weather reporters of today. In this way, *Traffic Reporter* could be a tool for increasing public awareness and affecting long-term attitudes and behavior.

If media personnel became our primary audience, the conclusions and recommendations reached from their usability testing should be considered (e.g., adding incident information, arterials, camera shots, ensuring accuracy of information, and changing the name). In addition, because the resolution of TV and CATV is lower than the high-resolution PC-monitor currently employed by *Traffic Reporter*, simplified displays for those media should be investigated. Because TSMC is currently providing the media with traffic maps, the developers of *Traffic Reporter* should work closely with them to provide an optimum system.

An important issue that needs to be investigated as a result of these usability tests is the expansion of the system: specifically, how the addition of geographical areas, HOV and express lanes, arterials, and incident indicators would affect the interface of and interaction with the system. Most of the results of these tests deal with interface design and interaction and are limited to the current system. It is imperative that testing and evaluation continue as system expansion occurs. Not only should media personnel be involved in this testing, but the needs of commuters must periodically be confirmed, as they are the ones who will ultimately be making decisions based on the information.

FINAL COMMENT

In Phase 2 of this project, we found that the commuter types identified in an earlier survey were consistent throughout the Puget Sound area, so similar design principles could be used for the entire Puget Sound area. Based on these principles, we designed *Traffic Reporter* (currently in the prototype stage). Usability testing of this prototype confirmed that *Traffic Reporter* has the potential to meet the traffic information needs of Puget Sound area commuters. In fact, as you finish reading this report, the program has already evolved to better meet the needs of commuters, TV and radio reporters, and traffic engineers. For up-to-date information on the project, call Mark Haselkorn at (206) 543-2577.

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APPENDIX A TELEPHONE INTERVIEW

Most commuters indicate they prefer to receive traffic information before leaving home for work. Although commuters currently receive most of their traffic information via commercial radio, it is reasonable to anticipate that in the future they will receive this information via TV. Therefore, we conducted a survey focusing on what kind of traffic information commuters would like to receive at home on a TV-based system that would help them make commuting decisions before leaving for work. The research approach, findings, conclusions, and recommendations are described below.

Research approach

The research approach was to telephone respondents to on-road Survey 1. Results of these interviews were analyzed statistically. The interviews focused on delivery of traffic information at home via TV.

Materials

The interviewers asked questions from a questionnaire titled *Determining User Requirements for Seattle Traffic Information Systems* (see Attachment). The questions focused on delivery of traffic information at home via television. Questions assumed normal traffic conditions. Responses were selected from either a list of options and ranked, or open ended questions. The questions took about five minutes to answer.

Subjects

Subjects were selected from respondents to the first on-road survey who indicated they would be willing to participate in a telephone interview. A total of 100 subjects were selected (25 from each of the four clusters of commuters: Pre-trip Changers, Route Changers, Route & Time Changers, and Non-changers). These four groups were then combined into two groups:

(1) groups willing to change departure time--Pre-trip Changers and Route & Time Changers, and (2) groups unwilling to change departure time--Route Changers and Non-changers.

Interview Procedure

Subjects were contacted by one of two interviewers Monday through Sunday, usually in the evening from 6:00 to 9:00 pm. These times were based on previous experience with scheduling subjects for the in-person interview. Subjects were reminded of their participation in the first on-road survey (and the in-person survey if applicable) and asked if they would be willing to participate in a ten minute telephone survey. If they responded positively, the survey continued. If they responded negatively, they were asked if they would be willing to participate at a more convenient time. If so, arrangements were made. Table 1 summarizes the telephone contact log.

Table 1. Telephone Interview Contact Log

		Cluster					
Parameter	RC	NC	RTC	PC	Total	Average	
Number of calls attempted		65	76	77	100	318	
Number contacts attempted	42	58	54	70	224		
Number refused to participate		0	2	2	1	5	
Number moved since initial survey	7	6	8	18	39		
Number surveys administered		25	25	25	25	100	
Number of calls/survey		2.60	3.04	3.08	4.00		3.18
Percentage moved since initial survey		17	10	15	26		17

Surveys were coded and entered into a data file on the University of Washington IBM mainframe computer and analyzed using the SAS software package. Most of the questions were analyzed for significant differences in response across clusters using either Pearson's Chi square or one-way analysis of variance. Analysis was done first using all four clusters as categories. Then clusters were combined to make two new groups. The first group consisted of commuters unwilling to change departure time: Route Changers (RC) and Non-changers

(NC). The second group were those willing to change departure time: Route and Time Changers (RTC) and Pre-trip Changers (PC).

Effect of interviewer

Two interviewers conducted the phone survey. Total response time was significantly different for the two interviewers, $t > 2.8$. Mean time for one interviewer was 13.7 versus 10.7 for second interviewer. To check for the effect of interviewer, a difference of means test was done for questions 4. and 6. Only question 4. showed a significant difference for each interviewer, but the difference was insignificant.

Findings

Questions revealed some strong preferences that traffic information on TV should be displayed, but only a few questions showed significant differences in responses across clusters. Those questions that showed differences across clusters concerned display of alternate route information, aspects of congestion, and time of delivery for traffic information. The only question that showed a significant difference in responses for the two group analysis that did not show a difference in the four cluster analysis was the question about average speed versus range of speed.

Following is a summary for each question. These summaries include whether each cluster responded differently, which test was used, what the "average" response was for each cluster if clusters differed, or for the average commuter if clusters did not differ. Clusters were also grouped as Changers versus Non-changers, and responses were checked for significant differences.

1. *Would you prefer to know (A) expected time delay to downtown or (B) actual drive time to downtown?*

Pearson's Chi square: no significant difference across clusters.

60% chose (B) *actual drive time*.

2a. *Would you like to know alternate routes to downtown? (A) yes (B) no*

Pearson's Chi square: no significant difference across clusters.

73% chose *(A) yes*

2b. *Do you want alternate route information shown as (A) text, (B) map, (C) both?*

Pre-trip Changers prefer alternate route information shown in the form of text more than the other motorist groups (55% of Pre-trip Changers verses 41% for all other groups combined). All other motorist groups prefer alternate route information displayed in the form of both text and map (46% listed as first choice, 51% listed as second choice).

One-way analysis of variance for each choice:

(A) text: significant across clusters, $F(3,67) = 5.15$, $p < .003$;

(B) map: no significant difference across clusters.

(C) both: significant across clusters. $F(3,67) = 2.91$, $p < .05$;

Results for two groups (Changers versus Non-changers) using same test were:

(A) significant, $F(1,69) = 4.08$, $p < .05$

(B) and (C) not significant.

A test of ranks was not possible because there were too many ties.

Two thirds of the PC cluster chose *(A) text* as their first choice. NC and RTC clusters chose text as their last choice. Cluster was not a significant factor in explaining the variance in the ranking of *(B) map*. Results for ranking of *(C) both* were significant across clusters. Clusters NC and RTC showed strong preference for *(C) both*.

Dividing respondents into two groups, Changers and Non-changers still did not explain a significant amount of variance. Time-changers (RTC and PC) showed an equal preference for *(A)* and *(C)*. Non-time changers showed a strong preference for *(C) both*.

Overall, the choice *both map and text* is preferred; 31 out of 77 respondents ranked it first.

3. *How would you rank in importance the display of areas of congestion? (A) text (B) map (C) both.*

One-way analysis of variance for each choice across clusters; no significant difference across clusters.

Choice *(A)* was ranked first by 31 respondents. *(B) map* was ranked first by 27, and *(C) map and text* was ranked first by 41. So there is some preference for both, but it is not strong.

4. *Rank in importance the following aspects of congestion (A) the reason (B) the time delay caused (C) the location (D) way to avoid it.*

One-way analysis of variance for each choice across clusters revealed that only choice *(C) the location* showed a difference in importance across clusters. Grouping by Changers vs. Non-changers showed no significant differences.

(C) significant across clusters, $F(3,93) = 3.22$, $p < .05$

The cluster RC showed a very strong preference for *(C) location* while PC showed less of a preference with the other two clusters falling somewhere in the middle. Overall, *location* is clearly the first choice with 68% of the respondents ranking it first. The modal response for each choice was:

4th *(A) reason*

3rd *(B) time delay caused*

1st *(C) location*

2nd *(D) way to avoid it*

The modal response did not change when grouped as Time Changers and Non-changers. So order of importance is (1) *location,* (2) *how to avoid it,* (3) *time delay caused, and* (4) *the reason.*

5. *When would you like weather information displayed with traffic information? (A) all the time (B) only when significant effect (C) never.*

Pearson's Chi square: no significant difference across clusters.

78% chose (B) only when it may have a significant effect on driving.

6. *How early would you like to receive traffic information?*

All motorist groups preferred 6:00-6:30 AM as the earliest they would like to receive TV-based traffic information (52%). But, there was a significant difference between clusters (means being 6:30, 6:08, 6:08, and 5:52 AM for RC, NC, RTC, and PC, respectively).

One-way analysis of variance, four cluster categories: explained a significant amount of the variance, $F(3,94)$, $p < .05$

One-way analysis of variance, clusters grouped, *changers vs. non-changers:* significant across clusters, $F(1,96)$, $p < .05$

Mean	Cluster
6:30	RC
6:08	NC
6:08	RTC
5:52	PC
	Group
6:19	non-changers
6:10	changers

7. *Would you like to know how current information is? (A) yes (B) no.*

Pearson's Chi square: no significant difference across clusters.

98% responded yes.

8. *How current would the info need to be?*

One-way analysis of variance: not significant

Mean = 9 minutes

Summing across all clusters, 34 respondents chose 5 minutes or less, 36 chose 5-10 minutes, 29 chose 10-30 minutes.

9. *What percentage of the time is radio traffic accurate?*

One-way analysis of variance: no significant difference across clusters.

Mean = 61% SD = 25

10. *What percentage of the time does TV traffic info need to be accurate?*

One-way analysis of variance: no significant difference across clusters.

Mean = 78% SD = 15

Drivers expected TV to be more accurate than radio.

11. *How much time do you have to watch TV for traffic in the morning?*

One-way analysis of variance: no significant difference across clusters.

Mean = 17.5 SD = 20.72

Most motorists, (61%) have 5-15 minutes in the morning to view television for traffic information. This attention is largely divided.

Only 7 out of 93 respondents said they had no time to watch TV for traffic information. Most respondents (57/93) said they had 5-15 minutes.

12. *How much time between last time you access traffic information and the time you leave work?*

One-way analysis of variance: no significant difference across clusters.

Mean = 9.8   SD = 11.3

Most motorists, (77%) access traffic information within 10 minutes of departure.

13. *Would you prefer (A) the average speed at a specific location or (B) range of speed over your commuting area?*

Pearson's Chi square, four clusters: not significant

Pearson's Chi square, changers versus non-changers: significant, $p < .05$, $df = 1$.

Non-changers preferred to know speed at a specific location, whereas the changers preferred to know the average speed over the range of their route.

14. *What ranges of speed would you prefer to be shown?*

Summary of responses:

no response	22
5 mph increments	8
10 mph "	18
15 mph "	5
< 30 <	9
< 40 <	4
< 45 <	3
0-30 / 30-50 / 50 <	11
0-30 / 30-45 / 45 <	5
< 30 / 35-45 / 45 <	2

Eight other different answers broke 0-60 mph into three intervals. Four other different responses chose four intervals.

15. *If we consider heavy traffic conditions, would you change any of your answers?*

100% responded *no*

Questions 16. to 19. were based on an affirmative response to question 15.; therefore these questions were omitted.

20. *Tell me all the features you would like to have on a TV-based traffic information system viewed at home before you leave for work. What do you think it should show?* Table 2 shows frequency of answers to these open-ended questions.

Table 2. Frequency of answers to open-ended questions on motorist telephone survey.

Desired Screen Features	RC	NC	RTC	PC	Total
	Cluster				
Location of problem spots identified	16	13	12	16	57
Map	13	5	2	7	27
Weather that is severe	7	6	6	7	26
Speed of traffic	7	4	6	7	24
Anticipated incident clearing time	7	4	6	7	24
Alternate routes	6	5	5	6	22
Timeliness of information	6	5	4	7	22
Location/landmarks	4	4	4	5	17
Severe/abnormal conditions	4	2	4	3	13
Geographically specific info	3		5	5	13
Audio/voice over	3	4	3	3	13
Text	3		1	7	11
Accuracy of information	3	2	3	2	10
Type of incident	1	3	3	2	9
Time delays on Freeway	3	3	2		8
Color	2	3	1		6
Lane of incident	2	3	1		6
Travel times to downtown	1	2		2	5
Time incident occurred	2		2		4
Time of day			1	3	4
Side street traffic information	2	1			3
Geographically broad			1	2	3
Icons	1		1		2
Severity of incident		1		1	2
Predictive information		1			1
Volume at specific locations				1	1
Teletext	1				1
Difference between stop and slow		1			1
Air pollution conditions		1			1
Time delay on ramps		1			1

General Traffic Information Needs/Comments	RC	NC	RTC	PC	Total
Need mass rapid transit	1	2	3	1	7
Current traffic info is untimely	2	1		3	6
Radio and TV station dedicated to traffic/weather info needed	2	1		2	5
Need light rail		2	2		4
Current traffic info is inaccurate	3			1	4
More HOV lanes needed	1		1	1	3
Cellular phone group dedicated to collecting traffic info needed	1		1	1	3
Don't want cable-TV delivery due to cost and limited availability				2	2
Changed jobs due to bad traffic		1	1		2
Want transit system info- schedule, on time?, park and ride full?		2			2
Remove/restrict trucks in Seattle area during commute			1		1
Barricades force unsafe lane switching			1		1
Restrict lane switching during commute			1		1
Need mass transit that highly flexible to meet demand- games, ferry	1				1
Need stronger measures to combat HOV violators				1	1
Need train system		1			1
Increase gas prices				1	1
Encourage use of mass transit		1			1
Longer/wider HOV lanes needed				1	1
HOV lane management poor	1				1
Convert Aurora to heavy in/out-bound use	1				1
Usable evening traffic info needed		1			1
Need heavy traffic warning sign 1-2 blocks before freeway		1			1
Need dedicated traffic info source		1			1
Consider non residents- user friendly, alt. routes		1			1
Ferry info- abnormalities display		1			1
Run ferries North-South		1			1
School closures displayed				1	1

21. *Is any TV station best?*

65% said no

12% chose Channel 4

16% chose Channel 5

In summary, the phone survey did not reveal a strong difference between clusters. However, it did reveal some strong preferences that respondents have for how motorist information is displayed.

ATTACHMENT TO TELEPHONE INTERVIEW

Date ______________
Time ______________
Response time ________

ID # ___________
Cluster Label _________
Interviewer ___________

Determining User Requirements for Seattle Traffic Information System

Phone Interview Motorist Information System Screen Design

(Boldface-spoken)

Introduction-

Hello, my name is _________. May I please speak with Mr./Mrs. _______? I'm conducting a telephone survey for the Department of Transportation and the University of Washington. You were kind enough to return a written survey we handed out last summer and indicated at that time that you were willing to participate in another survey. We can't help develop a good motorist traffic information system without your input. Do you have five minutes to answer a few questions?

YES - continue survey
NO - May I call you back at a more convenient time?
  YES - Get day and time
  NO - Thank them for their time and hang up.

Let me give you some background information. We are working with the State to develop a traffic information system for you, the commuter. To do this we're trying to learn more about your traffic information needs. Part of the information may be delivered by TV. The information would be delivered at home before you left for work. We would like you to base your answers during this interview on what YOU need or would like to see developed in terms of a traffic information system, NOT on what is currently available. We basically need to know what kind of traffic information you are interested in receiving at home to help you make your commute decisions. Remember, this concerns a TV-based system that will provide traffic information to you at home before leaving for work. If at any point you want me to repeat a question, just let me know.

First I'd like you to answer the following questions based on the normal commute you typically experience each day on your way to work, not a

day when congestion is worse than you normally experience.

1) **Under <u>normal commuting conditions</u>, if you were provided with the time it takes to reach downtown Seattle, would you prefer to know:**

(circle one)

A. the expected time delay to reach downtown, or
B. the anticipated, or actual travel time to downtown?

(An example of expected time delay would be if it would take 20 minutes longer than normal to reach downtown you would be given 20 minutes. An example for actual time would be a trip that normally takes 30 minutes with a delay of 20 minutes would be given as 50 minutes travel time).

2A) **Again, under normal commuting conditions, would you like to know viable alternate routes to downtown?**

(circle one)

A. yes, or
B. no

(<u>If yes</u>:)

2B) **Do you want alternate route information shown to you in the form of:**

A. text, such as "Use Aurora after 85th Street", or
B. in the form of a map, or
C. both, text and map

Please tell me which of these three you prefer first, second, or third?

-----------1st ------------2nd -------------3rd

3) Under normal commuting conditions, would you prefer areas of freeway congestion shown as:
(rank order would be better)

(circle one)

A. a text message, such as "heavy traffic between 85th and 45th street"
B. location on a map, or
C. both text and map

4) In general, under normal commuting conditions, which of the following aspects of congestion would you like to know about: You can select any or all of the possibilities.
(rank ordering would be best if they can do it, Woody 2-18-90)

(circle as many as apply)

A. the reason for congestion
B. the time delay caused by the congestion, or
C. the location of congestion.
D. the way to avoid congestion

5) When would you like to have weather information displayed along with traffic information:

(circle one)

A. All the time
B. Only when it may have a significant effect on your driving
C. Never shown

6) If your could receive traffic information at any time in the morning, how early would you like it, please round your answer to the nearest 15 minutes

(circle one)

5:00	6:00	7:00
5:15	6:15	7:15
5:30	6:30	7:30
5:45	6:45	7:45

7) **Would you want to know how current, that is up-to-date the information is:**

(circle one)

A. yes, or

B. no

8) **How current or up-to-date would the traffic information need to be for you to rely on it in making a driving decision. Your choices are:**

(circle one)

A. < 1 min.
B. 1 min.
C. 2 min.
D. 3 min.
E. 4 min.
F. 5 min.
G. 5-10 min.
H. 10-30 min.
I. >30 min.

9) **If you rely on commercial radio for traffic information, what percent of the time do you feel that the information is accurate?**

For example, Out of 100 days, how many times does the system mislead you.

% ______________

10) **What percent of the time would TV-based traffic information need to be accurate for you to rely on it?**

For example, Out of 100 days, how many times could the system mislead you and you still rely on it?

% ______________

11) In general, how much time in the morning would you actually have to turn on your TV and look at it to receive traffic information?

amount of time ______________________________

12) How much time is there in the morning between the *last time* you access traffic information at home and the time you leave for work?

amount of time ______________________________

13) Would you like to know the average speed of traffic at a specific location, or general ranges of speed over your entire commuting route.

circle one
A. average at location, or
B. ranges of entire route

14) What ranges of speed would you prefer to be shown to give you an idea of the speed of traffic. For example, 0-30, 30-50, 50-60?

______________________range

______________________other

15) If we now consider heavy traffic conditions, such as stop-and-go and possibly an accident, do you think you would change any of your answers given so far

(circle one)
A. Yes, or
B. No

(if Yes, go to question 15,
otherwise, skip to question 19)

{For the following I want you to answer the questions for a day that consists of very heavy traffic congestion, for example stop-and-go traffic and possibly an accident.}

16) **Under <u>heavy commuting conditions</u>, if you are provided with the time it takes to reach downtown Seattle** (did we say Seattle last time, Barfield 2-18-90), **would you prefer to know:**

(circle one)

A. the expected time delay to reach downtown, or
B. the actual travel time to downtown?

(An example of expected time delay would be if it would take 20 minutes longer than normal to reach downtown you would be given 20 minutes.
An example for actual time would be a trip that normally takes 30 minutes with a delay of 20 minutes would be given as 50 minutes travel time).

17A) **Again, under heavy commuting conditions, would you like to know about viable alternate routes to your destination?**

(circle one)

A. yes, or
B. no

(<u>If yes</u>:)

17B) **Do you want alternate route information shown to you in the form of:** (rank order would be better for us)

(circle one)

A. text, such as "Use Aurora after 85th Street", or
B. in the form of a map, or
C. both, text and map

18) **Under heavy commuting conditions, would you prefer areas of freeway congestion shown as:**

(rank order would be better)

(circle one)

A. a text message, such as "heavy traffic between 85th and 45th street"
B. location on a map, or
C. both text and map

19) In general, under heavy commuting conditions, which of the following aspects of congestion would you like to know about: You can select any or all of the possibilities:

rank order would be better

(circle as many as apply)
A. the reason for congestion
B. the time delay caused by the congestion, or
C. the location of congestion.

20) Tell me all the features you would like to have on a TV-based traffic information system viewed at home before you leave for work. What do you think it should show?

----

21) Is there any TV station whose traffic reports you find particularly helpful?

______________________ (TV station name, channel, announcer)

That's all the question I have. Is there any other information you would like to tell us about your traffic information needs?

____

____

____

____

____

____

____

We appreciate you taking the time to help us learn more about what you want to see in the way of traffic information.

Motorist Information Survey

The Washington State Department of Transportation and the University of Washington are working together to improve the traffic information you receive before and during your travel on Seattle area freeways. To make traffic information more effective for you, we need to know about your commute and use of traffic information. Please fill out this questionnaire carefully, selecting the most appropriate answers for your situation. **Feel free to add short comments to the right of your answer if it requires explanation.** All responses are confidential.

A. Your Commute

1. In an average week, how many days do **you drive any portion of north bound I-5** to **work**?

   ❑ 7 ❑ 6 ❑ 5 ❑ 4 ❑ 3 ❑ 2 ❑ 1 ❑ 0

2. If you use I-5, where do you usually enter and exit I-5 when you commute?

   Northbound— Enter I-5: ______________________
   Exit I-5: ______________________

   Southbound— Enter I-5: ______________________
   Exit I-5: ______________________

3. Estimate your driving . . .

   Distance between home and work, excluding detours and errands: ________**miles**
   Time from **home to work**, excluding detours and errands: ________minutes
   Time from work to home, excluding detours and errands: ________**minutes**

4. How much **flexibility** is there in the time when you . . .

Leave home for work	**❑ A lot**	**❑ Some**	**❑ Very little**
Leave work for home	❑ A lot	❑ Some	❑ Very little
Arrive at work	**❑ A lot**	**❑ Some**	**❑ Very little**
Arrive at home	❑ A lot	❑ Some	❑ Very little

5. How much **stress** do you experience during your usual commute to and from work?

   ❑ A lot ❑ Some ❑ Very little

6. During your commute, how much importance do you place on . . .

Saving commute time	**❑ A lot**	**❑ Some**	**❑ Very little**
Reducing commute distance	❑ A lot	❑ Some	❑ Very little
Increasing commute safety	**❑ A lot**	**❑ Some**	**❑ Very little**
Increasing commute enjoyment	❑ A lot	❑ Some	❑ Very little

7. How many people (including yourself) usually are in the car when you commute?

   ❑ [illegible] more

B. Your Route Choices

1. How **familiar** are you with south/north routes that can be used as alternatives to I-5?

   ❑ Very ❑ Somewhat ❑ Not at all

2. How often do you modify or change the route you travel from . . .

Home to work	**❑ Frequently**	**❑ Sometimes**	**❑ Rarely**
Work to home	❑ Frequently	❑ Sometimes	❑ Rarely

More ☞

3. How often do the following factors affect your choice of commuting routes?

Comments:

	Frequently	Sometimes	Rarely
Traffic reports and messages	❑	❑	❑
Actual traffic congestion	❑	❑	❑
Time of day	❑	❑	❑
Weather conditions	❑	❑	❑
Time pressures	❑	❑	❑
Errands	❑	❑	❑

4. Where are you most likely to choose your commuting route? (**Check only one.**)
❑ Before leaving home or work ❑ While driving on city and county streets
❑ When approaching entrance ramps ❑ While driving on freeways

5. When you are commuting, what length of delay on a freeway would cause you to divert to . . .
An alternate route that you know ________minutes
An alternate route that you do not know ________minutes

C. Traffic Information

1. How much **help** do you get from traffic information delivered by . . .

	A lot	Some	Very little	Never used
Television	❑	❑	❑	❑
Electronic message sign over the freeway	❑	❑	❑	❑
Advisory radio indicated by freeway sign	❑	❑	❑	❑
Commercial radio station	❑	❑	❑	❑
Phone	❑	❑	❑	❑

2. When you are **on** the freeway, how often **does** traffic information **cause** you to divert to an alternate route?
❑ Frequently ❑ Sometimes ❑ Rarely ❑ Never receive information

3. **Before you drive**, how often does traffic information influence . . .

	Frequently	Sometimes	Rarely	Never receive
The time you leave	❑	❑	❑	❑
Your means of transportation (e.g., car, bus)	❑	❑	❑	❑
Your route choice	❑	❑	❑	❑

4. From which medium would you **prefer** to receive traffic information. . .

Before driving (**Check only one.**)
❑ TV ❑ Phone ❑ Commercial radio station ❑ CB Radio

While driving (**Check only one.**)
❑ Phone ❑ Electronic message sign over freeway ❑ CB Radio
❑ Commercial radio station ❑ Advisory radio indicated by flashing lights on freeway sign

5. At what point do you **prefer** to receive traffic information? (**Check only one.**)
❑ Before leaving home or work ❑ While driving on city and county streets
❑ When approaching entrance ramps ❑ While driving on freeways

6. If continual up-to-the-minute traffic information were available in the following ways, would you use them?

Traffic information delivered via phone hot line	❑ **Yes**	❑ **No**
Radio station dedicated to traffic information	❑ Yes	❑ No
Traffic information received by computer at home or work	❑ **Yes**	❑ **No**
Cable TV station dedicated to traffic information	❑ Yes	❑ No

7. Which of these services would you like to see developed **first**? (**Check only one.**)
   - ❑ Traffic information delivered via phone hot line
   - ❑ Radio station dedicated to traffic information
   - ❑ Traffic information received by computer at home or work
   - ❑ Cable TV station dedicated to traffic information

8. Which of the following are available to you? (Check <u>all</u> those items that are usually in working order.)

Phone:	❑ Home	❑ Office	❑ Car
Computer:	❑ Home	❑ Office	

Comments:

D. Lake Washington Bridge Users

If you use either SR-520 or I-90, please answer this section. Otherwise, skip to the next section (Section E).

1. In an average week, how many days do you use the following routes to commute **across or around** Lake Washington?

	7	6	5	4	3	2	1	0
I-90 Bridge	❑	❑	❑	❑	❑	❑	❑	❑
SR-520 Bridge	❑	❑	❑	❑	❑	❑	❑	❑
I-405 North	❑	❑	❑	❑	❑	❑	❑	❑
I-405 South	❑	❑	❑	❑	❑	❑	❑	❑

2. Which source of traffic information do you most prefer to use in selecting a bridge for commuting to work over Lake Washington? (Check only one.)
   - ❑ TV
   - ❑ Electronic message sign over the freeway
   - ❑ Advisory radio indicated by freeway sign
   - ❑ Commercial radio station
   - ❑ Phone
   - ❑ None

3. Where are your most likely to choose the bridge you use for commuting to work over Lake Washington? (**Check only one.**)

❑ Before leaving home or work	❑ While driving on city and county streets
❑ When approaching entrance ramps	❑ While driving on freeways

E. For Classification Purposes

1. What is your home Zip Code? ____________ What is your work Zip Code? ____________

2. Are you: ❑ Male ❑ Female

3. Are you: ❑ Married ❑ Unmarried

4. What is your age? ________

[illegible] ________

6. What is your annual income, before taxes, for yourself <u>and</u> for your entire household?

<u>Yourself:</u>	<u>Total Household:</u>
❑ No income	❑ No income
❑ Under $10,000	❑ Under $10,000
❑ 10,000-19,999	❑ 10,000-19,999
❑ 20,000-29,999	❑ 20,000-29,999
❑ 30,000-39,999	❑ 30,000-39,999
❑ 40,000-49,999	❑ 40,000-49,999
❑ 50,000-59,999	❑ 50,000-59,999
❑ 60,000-74,999	❑ 60,000-74,999
❑ 75,000-100,000	❑ 75,000-100,000
❑ Over 100,000	❑ Over 100,000

More [illegible]

7. Would you be willing to come to the University campus to take part in a follow-up interview about your use of traffic information. If so, please fill out the following. All information will be kept confidential.

Name: ______________________________

Address: ______________________________

City/Zip: ______________________________

Phone number at: Home ______________ Work ______________

Thank you very much for participating in this effort to improve Seattle traffic information.

Please fold with business reply matter on outside and staple/tape on line below.
Drop in a mail box. No stamp is necessary.

Motorist Information Survey

Washington State Department of Transportation

University of Washington

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

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PLANNING, RESEARCH AND PUBLIC TRANSPORTATION DIVISION
PUBLIC TRANSPORTATION OFFICE
TRANSPORTATION BUILDING KF-01
OLYMPIA WA 98504-9939

Motorist Information Survey

The Washington State Department of Transportation and the University of Washington are working together to improve the traffic information you receive before and during your travel on Seattle area freeways. To make traffic information more effective for you, we need to know about your commute and use of traffic information. Please fill out this questionnaire carefully, selecting the most appropriate answers for your situation. Feel free to add short comments to the right of your answer if it requires explanation. All responses are confidential.

A. Your Commute

1. In an average week, how many **days** do **you drive I-5** to or from **work** anywhere between Lynnwood and downtown Seattle?

❏ 7 ❏ 6 ❏ 5 ❏ 4 ❏ 3 ❏ 2 ❏ 1 ❏ 0

(If zero, please skip to Section C, next page.)

2. Please tell us where you usually enter and exit I-5 when you commute.

Southbound-- Enter I-5: ______________________
Exit I-5: ______________________
Northbound-- Enter I-5: ______________________
Exit I-5: ______________________

3. Estimate your driving . . .

Distance between home and work, excluding detours and errands: ________ miles
Time from **home to work**, excluding detours and errands: ________ minutes
Time from **work to home**, excluding detours and errands: ________ minutes

4. How much **flexibility** is there in the time when you . . .

Leave **home for work**	❏ A lot	❏ Some	❏ Very little
Leave **work for home**	❏ A lot	❏ Some	❏ Very little

5. How much **stress** do you experience during your usual commute to and from work?

❏ A lot ❏ Some ❏ Very little

6. During your commute, how much importance do you place in . . .

Saving commute time	❏ A lot	❏ Some	❏ Very little
Reducing commute distance	❏ A lot	❏ Some	❏ Very little
Increasing commute safety	❏ A lot	❏ Some	❏ Very little
Increasing commute enjoyment	❏ A lot	❏ Some	❏ Very little

7. How many people (including yourself) usually are in the car when you commute?

❏ 5 or more ❏ 4 ❏ 3 ❏ 2 ❏ 1

B. Your Route Choices

1. How **familiar** are you with north/south routes that can be used as alternatives to I-5?

❏ Very ❏ Somewhat ❏ Not at all

2. How often do you modify or change the route you travel from . . .

Home to work	❏ Frequently	❏ Sometimes	❏ Rarely
Work to home	❏ Frequently	❏ Sometimes	❏ Rarely

More ☞

3. How often do the following factors affect your choice of commuting routes?

Comments:

	Frequently	Sometimes	Rarely
Traffic reports and messages	❑	❑	❑
Actual traffic congestion	❑	❑	❑
Time of day	❑	❑	❑
Weather conditions	❑	❑	❑
Time pressures	❑	❑	❑

4. Where are you most likely to choose your commuting route? (Check one only.)

❑ At home or work ❑ On city streets ❑ Near entrance ramps ❑ On I-5

5. When you are commuting, what length of delay on I-5 would cause you to divert to . . .

An alternate route that you know ________ minutes

An alternate route that you do not know ________ minutes

C. Traffic Information

1. From which media have you ever received traffic information? (Check all that apply in each column.)

	Column A Before driving	Column B While driving
TV	❑	---
Electronic message sign over I-5	---	❑
Advisory radio indicated by flashing lights on highway sign	---	❑
Commercial radio station	❑	❑
Phone	❑	❑
CB Radio	❑	❑
None	❑	❑

2. From which medium would you prefer to receive traffic information? (Check one only **in each column.**)

	Column A Before driving	Column B While driving
TV	❑	---
Electronic message sign over I-5	---	❑
Advisory radio indicated by flashing lights on highway sign	---	❑
Commercial radio station	❑	❑
Phone	❑	❑
CB Radio	❑	❑

3. How much **help** do you get from traffic information delivered by . . .

	A lot	Some	Very little	Never used
TV	❑	❑	❑	❑
Electronic message sign over I-5	❑	❑	❑	❑
Advisory radio indicated by highway sign	❑	❑	❑	❑
Commercial radio station	❑	❑	❑	❑
Telephone highway construction hot line	❑	❑	❑	❑

4. **When you are on I-5**, how often does **traffic information** cause you to divert to an alternate route?

❑ Frequently ❑ Sometimes ❑ Rarely ❑ Never receive information

Comments:

5. **Before you drive**, how often does **traffic information** influence . . .

	Frequently	Sometimes	Rarely	Never receive
The time you leave	❑	❑	❑	❑
Your means of transportation (e.g., car, bus)	❑	❑	❑	❑
Your route choice	❑	❑	❑	❑

6. At what point do you **prefer** to receive traffic information? (Check one only.)

❑ Before driving ❑ On city streets ❑ Near entrance ramps ❑ On I-5

7. If continual up-to-the-minute traffic information were available in the following ways, would you use them?

Traffic information delivered via phone hot line	❑ Yes	❑ No
Radio station dedicated to traffic information	❑ Yes	❑ No
Traffic information delivered via computer	❑ Yes	❑ No
Cable TV station dedicated to traffic information	❑ Yes	❑ No

8. Which of these services would you like to see developed first? (Check one only.)

❑ Traffic information delivered via phone hot line

❑ Radio station dedicated to traffic information

❑ Traffic information delivered via computer

❑ Cable TV station dedicated to traffic information

9. Which of the following are available to you? (Check all those items that are usually in working order.)

Radio:	❑ Home	❑ Office	❑ Car
Phone:	❑ Home	❑ Office	❑ Car
TV:	❑ Home	❑ Office	
TV cable hook-up:	❑ Home	❑ Office	
Computer:	❑ Home	❑ Office	

D. For Classification Purposes

1. What is your home Zip Code? __________ Your work Zip Code? __________

2. Are you: ❑ Male ❑ Female

3. [illegible]r age? ❑ Under 31 ❑ 31-40 ❑ 41-50 ❑ 51-64 ❑ 65 and over

4. What is the annual income, before taxes, for your entire household?

	Total Household
No income	❑
Under $10,000	❑
10,000-19,999	❑
20,000-29,999	❑
30,000-39,999	❑
40,000-49,999	❑
50,000-59,999	❑
60,000-74,999	❑
75,000-100,000	❑
Over 100,000	❑

5. Would you be willing to take part in a follow-up interview about your use of traffic information? If so, please fill out the following. A more detailed discussion of your commute would help us improve your travel on Seattle freeways. All information will be kept confidential.

Name: ______________________________

Occupation: ______________________________

Address: ______________________________

Phone number at: Home ______________ Work ______________

Thank you very much for participating in this effort to improve Seattle traffic information.

Please fold with Business Reply mailer on outside and staple/tape on line below.
Drop in a mailbox. No stamp is necessary.

Motorist Information Survey

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University of Washington

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APPENDIX C: SCREEN DESIGN, PRELIMINARY FINDINGS

Before designing the screen for *Traffic Reporter*, we investigated previous studies as well as conducting our own surveys in order to understand the human factors aspects of screen design and to apply that understanding to *Traffic Reporter's* screen. This appendix describes the results of those studies. The areas discussed are (1) end user and task, (2) cognitive processes, (3) memory load and coding, (4) grouping, (5) continuity and closure, (6), color, (7) text, (8) graphics, and (9) icons.

End User and Task

The first, and perhaps most critical aspect of screen design, is to understand the end user and the task. End users must be involved in the design process from the inception of the project. In this study, the commuter's input is invaluable in determining and verifying screen usability. A screen may "look nice" and be easy for the designer and his peers to use, but a screen is ineffective if it does not convey the appropriate message to the intended users.

Cognitive Processes

Motorists' cognitive processes are complex but important to the development of effective traffic information screens. In terms of cognitive processes, Gould (1) provides a good summary of human cognitive abilities related to navigation systems. Perceptual coding occurs by higher centers in the cortex. A code may be defined as a stored representation or abstraction of an object. It is thought that the information is matched (mapped) with a neural code that was learned and stored in the cortex. This level of "understanding" of a stimulus is referred to as perception (2).

The task and nature of the stimulus both impact the complexity of the mapping that occurs, which in turn influences a user's response time and decision making. At the lowest level of complexity, simple detection is required. Higher levels of complexity involve multidimensional considerations and require identification and categorization of a stimulus. The traffic information screen designer should strive to minimize the mental re-coding of displayed information. This should result in faster responses, less errors, and less required learning. For example, when displaying time, a digital format should be used rather than presenting clocks with moving hands because less re-coding is required.

Memory Load and Coding

Working memory is also referred to as short-term memory by some authors. This memory only lasts approximately 15 seconds (3). The only way to retain information in working memory for a longer period of time is by rehearsal. Rehearsal requires directed attention. Even after rehearsal, information in working memory decays over time. Upon awakening, commuters are unlikely to be as alert and able to direct attention as they are later in the day. For these reasons, it is desirable to present traffic information within a 15 second period if possible.

The maximum number of items, or chunks of information, that can be retained in working memory without rehearsal is seven plus or minus two (4). As much as possible, items should be chunked for the user in a meaningful way to reduce the working memory load.

Working memory is transferred into long-term memory by processes of coding. The coding process involves attaching meaning to the information and relating/pairing this information to information already in long-term memory. The more relations that can be formed, the higher the probability that the information will be retained (5).

The choice of coding should be determined on a case by case basis using analytical techniques. The combination of analysis and simulation provides a powerful approach to designing a screen display (6).

Grouping

Visual information should be grouped in a manner that is meaningful to the motorist and provides structure to the task. The Gestalt theory of grouping information suggests that by applying several grouping concepts, it is possible for the human to be able to understand the material more rapidly and to do so subconsciously. For example, the divisions between paragraphs suggest that the text grouping is to be treated as a cohesive, related thought. A reader usually doesn't think of this consciously.

Continuity and Closure

The concepts of continuity and closure may require further explanation. An every-day example of continuity is the output of a dot-matrix printer. Each character on a page is composed of a series of dots. If viewed closely, it is possible to see each dot. But when the text is read, characters are perceived, not numerous tiny dots. The position of the dots has conveyed the continuity of a single character. When developing traffic information screens, the principle of continuity may be used when developing map segments, or when developing a progressive display of arrows intended to suggest direction of travel.

Closure is closely related to continuity but is concerned with outline forms. The closure concept states that only portions of a stimulus may be necessary to suggest a complete entity. An example would be the angled corners of a box. If only the corners are present, a person is usually able to imagine the entire object.

Color

Color is an extremely important consideration in the design of screens for the display of traffic information. Colors are powerful visual stimulants for humans. When a motorist sees a screen for the first time, the characteristic of the screen that is usually noted first is color (7, 8). Because of this, color can be used very effectively to focus a motorist's attention. Also, parallel mental processing of color is extremely efficient (9, 10, 11, 12). Parallel processing refers to the ability of the human to recognize and understand the code of color as well as a second code simultaneously. In addition, color adds a third dimension to an otherwise two-dimensional surface (13). But, inappropriate use of color can result in worse performance than if it were not used at all (14, 15).

The primary benefit of color in alphanumeric displays is to aid in rapid detection and grouping of information (16, 17, 18). Color is especially useful if the screen is already dense with information (16, 13) or the user is an inexperienced screen user (18, 13). Grouping of information with color is especially effective because areas with similar colors are recalled together (19). Other valid uses include marking out-of-tolerance, new or critical data, and de-emphasizing data (20, 21, 22).

It is very easy to use color inappropriately. In terms of tasks, color appears to be poor for identification, categorization (naming), and memorization of objects (18). Mental representations constructed for these tasks do not seem to require color. In terms of motorists, different groups may have different expectations for color meanings, and different abilities to perceive colors. Of all the coding methods, color is perhaps the most non-intuitive and so, the most misapplied. An appropriate acronym for use of color in displays would be CCC (Careful, Conservative and Consistent). All the following guidelines support this thinking.

Color should be used conservatively in the design of motorist information screens. Beginning from a monochromatic screen, it is wise to add only colors essential in aiding the motorist make a driving decision (23). The use of color to provide variety or to make a screen more "attractive" should be avoided. Large numbers of colors tend to lengthen search times and thus, should be minimized (18). Also, regions that are busy with color tend to be confused with other colorful regions (24). The display should work well without color first. In other words, it is poor design to try to compensate for a poorly formatted display with the addition of colors (25).

The designer must be conscious of the limitations motorists have in perceiving color. Motorists gender and age can impact the perception of color. Males constituted 51% of the commuting population in the area of our study. Also, approximately 8% of men have week or abnormal color perception (26, 27, 22, 28). The two most common forms of color vision deficiencies are the inability to discriminate red-green and blue-yellow (29). For this reason, it is important to use primary colors. But, saturated blue is difficult to focus on. This is especially true for older individuals (14). Note that 13.8% of the commuting population we studied is over 50 years of age. Saturated blue should be replaced with light blue except when used for background.

Consistency is extremely important for effective use of color. It is important to use color consistently both within a screen and between screens (14, 30). Within a screen, color codes should be defined, if not previously defined, and used consistently, giving only one meaning to a color (31, 7, 20, 32, 33). Colors that are close on the color spectrum should be avoided unless the intent is to show a close relationship (27, 18). Contrasting colors such as red, blue, green and white are good choices.

One barrier to good color screen design may be the preferences of motorists. The colors that users are comfortable with may be preferred to technically superior choices (18). It seems human nature to avoid change, even if the change would be for the better. During final screen testing, this aspect of human behavior should be weighed against initial design choices that are technically sound.

The ambient illumination of a motorists home television screen impacts their perception of color and cannot be controlled by the screen designer. High levels of ambient illumination reduce the perceived saturation and contrast, and so limit the number of colors that can be detected. This adds support to the design criteria of limiting the number of colors used and using saturated colors.

Text

When designing the textual components of traffic information screens, text shape, size, spacing, grouping, wording, and color should be considered. Extensive work has been done in the area of displaying text, so only a capsulated summary is provided here.

Shape of Letters and Numbers; Fonts

Three factors should be considered when selecting the shape of letters and numbers: stroke width, width-height ratio and style or font. The stroke width is the ratio of thickness of the stroke to the height of the character. The most readable characters have a ratio of 1:6 to 1:8.

The width-height ratio is the ratio of the width to height of the characters. The most commonly used ratio is 3:5 (3), others suggest 3:4 (34).

There are numerous fonts, but all are not equally readable. There is conflicting literature regarding readability of fonts. Tufte (35) found that Sans Serif font, with the sheriffs or little flourishes, resulted in poor readability. Cornog and Rose (36) found the most readable commonly available style of font to be Roman or Sans Serif, without sheriffs. In general, when designing motorist information screens, simple block letters should be used for maximum readability, while script or any similarly shaped characters be avoided.

Headings

Bold faced capital characters are preferable for headings, but regular lower case text is more legible for longer sections of text (37). Reading of passages in all caps tends to be slower and thus is poor design. If an arbitrary code of traffic information is displayed that is made up of more than one letter, then it is best to use all lower or upper case letters (38).

Text Size

Text size is as important as text shape. A motorist with 20/20 vision can discriminate a stroke width of 1 minute of arc. This translates to a character height of 0.14 inches (0.35cm) when viewed from a distance of 8 feet (2.4m). But, this is a minimum character size for a person with perfect vision and viewing printed material. The poorer display characteristics of most home televisions and large viewing distances calls for a character size of 0.5-1inch (1.3-2.5cm) in height. Many findings support this recommendation (39, 40, 41, 42, 43, 34).

Text Spacing

The spacing of text can influence its readability. Relatively densely packed text aids quick scanning and comprehension because it takes less ocular work (44, 45). But the appropriate level of packing is dependent on the screen's resolution as well as other factors such as brightness and color. In addition to proper spacing, text should be grouped appropriately.

Text Sequence

Sequences of alphanumeric text can be remembered more easily if they are grouped in sets of approximately seven characters (46). This is based on the seven plus or minus two rule mentioned earlier. Structured formatting has also been found superior to narrative in terms of speed of learning (47).

Text Grouping

Screen complexity matrices were developed by Tullis (48) as an objective and standard means of evaluating screen complexity. These measures result in several important guidelines for text grouping. First, clusters of text should be separated by no more than one space horizontally and should be on adjacent lines vertically. Second, screens are easier to read if they are low in density. Schneiderman (49) concluded that a well grouped screen is one with a low to moderate number of groups (6-15). Last, blocks that start in the same column tend to lower layout complexity.

Text Wording

In addition to choosing the most advantageous manner to group text, the message itself must be worded so that the motorist understands the message. Active statements are easier to understand than passive or negative ones (50). For example:

Accident ahead can be avoided by exiting 80th to Aurora.	Passtive
Accident ahead, continuing on I-5 is not advised.	Negative
Accident ahead, exit 80th to Aurora.	Active

Text written in the passive voice have less information and reduces response time (51). Negative statements do not explicitly state the desired action. This forces the motorist to first understand what they are not to do, before they can conclude the proper action.

Graphics

In addition to the careful use of color, graphics can be a very powerful communicative tool. Graphics increase the rate at which humans can extract, process, understand, and respond to relevant information. Vast amounts of information can be transferred quickly through graphics (52). This rapid transfer is possible because the data are presented in a form that permits rapid recognition of amounts, trends and relationships. A motorist's ability to grasp traffic information presented graphically is much more fundamental than the ability to work with data presented verbally or numerically (53).

Graphics are at their best when displaying large amounts of data with complex relationships. Prime uses for graphics are to:

(1) Reduce screen density.

(2) Map relationships between physical entities.

(3) Show complex relationships.

(4) Show trends.

(5) Display geographical data (maps).

(6) Show limits.

Graphics can be used to greatly reduce the volume of text required to describe data, especially when the relationships are complex. For example, a traffic map is much easier to understand then a long textual description. The relationships between physical entities are more quickly understood when presented graphically. Also, trends that are quite difficult to extract from tabular data should be displayed graphically. Line and bar graphs convey the information much more rapidly than data in tabular form (54, 55). Line graphs are typically more effective than bar graphs for displaying trends (56, 55). Line graphs are used extensively in Statistical Quality

Control to display limits of variables. The limit lines allow the user to determine the performance of the data by seeing how far the data points are within specified limits. This type of graph may be a useful alternative method of displaying travel time estimates. The limit lines would represent typical speeds based on historical data.

When constructing graphics, it is important to observe the seven plus or minus two rule mentioned earlier. The more complex the relationships, the more important it is to limit the number of relationships conveyed on a single screen through successive decomposition of the information. For example, this thinking may be applied when suggesting an alternate route by providing an exploded view of a map.

It is all too easy to construct misleading graphics. The designer should prevent distortions due to manipulation of scales by showing the zero base on charts. Although three-dimensional graphs are now widely available, they convey disproportionate size and so are best avoided in circumstances that require accurate interpolation (57, 35).

The physical location of graphics in relation to text in a traffic information screen is dependent on the relationship of the graphic to the text as well as the motorist's task. Again, many of the guidelines mentioned earlier can be applied. No single blanket rule exists for placement of text with graphics. The placement of the text in a vertical, horizontal or clockwise manner around a graph is not as critical as consistency and matching the motorist's expectations for the task of selecting a driving option (58).

Icons

Motorists frequently rely on physical analogies to construct a mental model, so the use of icons should exploit this tendency. Icons are referred to in the broad sense, meaning both miniature images of objects such as trash cans and file folders, or representations of actions such as cursors. The main benefit of using icons in traffic information screens would be to reduce screen density. The underlying reason icons speed the user's response is because icons do not require the re-coding that words do. Also, learning symbols is rapid and accurate, even by different cultures (59).

Considerable testing has been done to determine if there are shapes that have a universal meaning and so are candidates for icons. Unfortunately, the list of meanings that should be conveyed is much longer then the number of tested shapes, and so the designer is often forced to design icons. Dreyfus (60), provides a large collection of symbols that are commonly excepted to have "universal" meaning.

When forming an icon, it is important to provide the correct emphasis and de-emphasis. Emphasis should be given to the graphical features that distinguish the object from other objects, and all other features should be de-emphasized. For example, when developing the icon for a car, the side view outline of a typical car may be all that is required. The bulge of the cab and the proportions of the vehicle are likely characteristics that would separate this icon from that of a bus or motorcycle.

Traffic icons should be simple in terms of both structure and color. Icons should be composed of no more than two dimensions to aid in rapid interpretation (61). The addition of extra detail/information to an icon slows the mental processing of core, symbol information (62). In other words, there is a trade-off between the amount of detail in the symbol and the speed of manipulation. Insufficient detail results in an unrecognizable icon, while too much detail results in a slow response. If the task is to distinguish cars from buses and motorcycles, then a rectangle would likely be an example of insufficient detail, while a fully rendered quarter view of a vehicle would represent unnecessary detail. Filled figures are superior to outline figures (63), and closed figures should be used unless there is a reason for the outline to be discontinuous (64, 65).

In terms of color, traffic screen icons should be limited in hue and combinations of hue, saturation and brightness (66, 67). When using light colored symbols on a dark background, yellow-green is effective. Also, brightness and contrast of symbols seems to more important than it's color (43).

Abstract symbols are much more difficult to comprehend than are pictographs, which represent the intended message (68). Also, as is always the case, it is important to remain consistent in use, appearance, and location (23). Standards for evaluating symbols for public use have been developed by Zwaga and Esterby (69).

As attractive as icons are, they are limited in use. A verbal description should not be forced into iconic form. It may be best to leave a term in text form to avoid confusion or to use another means of representing the term (70).

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APPENDIX: D
Calculation Methodology

Velocity Calculation

One of the goals of this project is to calculate velocity of traffic at specific points in the I5 corridor. To this end a derivation of velocity from the data collected (as defined by TSMC personnel) is developed.

The classical relationship that is the basis for the velocity estimate is:

$$v = \frac{q}{k}$$

where

$v \equiv$ vehicle velocity in miles per hour

$q \equiv$ traffic flow in vehicles per hour

$k \equiv$ traffic density in vehicles per mile.

Volume to flow conversion:
The relationship between the first quantity measured by TSMC, labeled volume (Vol), and traffic flow is straightforward. Vol is actuations of a loop per unit time (five minutes in TSMC practice) and an actuation is considered by TSMC to be a vehicle passing over the loop. Therefor a constant of 12 (five minute intervals per hour) is the conversion:

$$q = 12 \times Vol.$$

Occupancy to density conversion:
The second value available from TSMC is called Occupancy (Occ) and is defined to be the time during which a loop is occupied divided by some total time (or fraction of the total time that a car is present) times 100. The conversion from Occupancy to flow is less straightforward.

The time in the region of the detector per vehicle is the sum of two components, the time for the front of a vehicle to pass over the detector's region of sensitivity (l_d) and the time for a vehicle of length l_v to exit the region. Time of Occupation of a loop is:

$$T_O = \int_{l_d} \frac{1}{v(x)} dx + \int_{l_v} \frac{1}{v(x)} dx.$$

The "total time" in a region of length D is:

$$T = \int_D \frac{1}{v(x)} dx + \int_{l_e} \frac{1}{v(x)} dx.$$

Occupancy as defined by TSMC is:

$$Occ = \frac{\int_{l_d} \frac{1}{v(x)} dx + \int_{l_v} \frac{1}{v(x)} dx}{\int_D \frac{1}{v(x)} dx + \int_{l_v} \frac{1}{v(x)} dx}.$$

where the "total distance " in the denominator is normalized to one mile. The velocity is assumed constant over the sensing region resulting in:

$$Occ = \frac{\frac{1}{v}(l_d + l_v)}{\frac{1}{v}(D + l_d)}$$

The relationship between traffic flow and occupancy is assumed to be:

$$k = g(Occ)$$

Using some assumptions a value for g is determined. Assuming:

$$\begin{aligned} v &= constant \\ l_d &= 8(feet) \\ l_v &= 16(feet) \\ D &= 5280(feet/mile). \end{aligned}$$

A value of $g = 2.2$ (vehicles per mile) can be obtained. This appears to be the mechanism used by TSMC.

Finally if the above is correct the vehicle velocity in terms of the TSMC data, on a per lane basis, is:

$$v = \frac{12(Vol)}{2.2(Occ)}$$

The data provided by TSMC, in the files provided to date, is a sum over the number of lanes (n_i) at each location. If this is the format of the real time data then the local velocity is:

$$v_i = \frac{12(Vol)}{2.2(Occ)n_i}$$

It is noteworthy that traffic conditions are not factored into this estimate. Traffic theory seems to indicate this may be an oversight; however, given the available data this may be the best assumption set for this initial implementation of this application.

This module of the RTMIS should be implemented in a manner that allows for future replacement with an estimation process that incorporates traffic density estimates in the velocity calculation.

Travel Time Derived from Traffic Velocity

The speed of a vehicle moving in a given direction (velocity) is assumed to change linearly between estimates made at the sensing stations.

$$v(x) = v_i + x\frac{v_{i+1} - v_i}{x_{i+1} - x_i}$$

The travel time (in the direction of traffic flow between any two stations located at x_i and x_{i+1} is:

$$\tau_{i+1} = \int_{x_i}^{x_{i+1}} \frac{1}{v(x)}dx.$$

Now define:

$$\Delta v = v_{i+1} - v_i$$

$$\Delta x = x_{i+1} - x_i$$

and the travel time is written:

$$\tau_{i+i} = \int_{x_i}^{xi+1} \frac{1}{v_i + x\frac{\Delta v}{\Delta x}}dx.$$

Integration results in:

$$\tau_{i+1} = \frac{\Delta x}{\Delta v} ln \left(x\frac{\Delta v}{\Delta x} + v_i \right) \Bigg|_{x_i}^{x_{i+1}}.$$

Applying the limits,

$$\tau_{i+1} = \frac{\Delta x}{\Delta v} \left\{ ln \left(x_{i+1} \left(\frac{\Delta v}{\Delta x} \right) + v_i \right) - ln \left(x_i \left(\frac{\Delta v}{\Delta x} \right) + v_i \right) \right\}.$$

Now apply a linear transformation so that each τ_{i+1} can be used for total trip time estimates.

$$x_i \rightarrow 0$$

$$x_{i+1} \rightarrow (x_{i+1} - x_i) = \Delta x$$

results in:

$$\tau_{i+1} = \frac{\Delta x}{\Delta v} ln\left(\frac{v_{i+1}}{v_i}\right).$$

This result while analytically correct, is difficult to implement numerically in the area where $v_i \approx v_{i+1}$ and $\Delta v \approx 0$. However, much of the operating envelope for this project is in this region. To overcome this difficulty expand the result as a (Taylor) power series:

$$\tau_{i+1} = 2\Delta x \left\{ \frac{1}{v_{i+1} + v_i} + \frac{(\Delta v)^2}{3}\left(\frac{1}{v_{i+1} + v_i}\right)^3 + \frac{(\Delta v)^4}{5}\left(\frac{1}{v_{i+1} + v_i}\right)^5 \ldots \right\}$$

It is noteworthy that this series expansion has none of the numeric difficulties inherent in the analytical result, particularly in the most likely region of operation for this project. Further because of the relationships of the powers to which the variables are raised these polynomials can be evaluated efficiently.

The number of terms used in this series will effect the accuracy of the resulting travel time estimate. The percentage error in the estimate is:

$$\epsilon(n, v_i, v_{i+1}) = \left(1 - \frac{\sum_{n=0}^{N} \frac{(\delta v)^{2n}}{2n+1}\left(\frac{1}{v_{i+1} + v_i}\right)^{2n+1}}{\frac{\Delta x}{\Delta v} ln\left(\frac{v_{i+1}}{v_i}\right)} \right) \times 100.$$

Some initial numerical experiments indicate that the use of three terms in the series provides a maximum error range between 3 and 4 percent. An additional five terms (total 8) reduces this only by one percent. These ranges are approximate since the error depends on several variables as well as the region over which it is being estimated (due to the poor numerical properties of $ln(x)$ when $x \rightarrow 1$ and $\frac{1}{\delta v}$ when $\delta v \rightarrow 0$).

This is the proposed mechanism to estimate the travel time between stations. The total travel time (T) between two sites will be the sum of all the travel time estimates (τ_{i+1}) for the stations between the sites.

$$T = \sum_i \tau_{i+1}$$

where

$$\tau_{i+1} \approx 2\Delta x \left\{ \frac{1}{v_{i+1} + v_i} + \frac{(\Delta v)^2}{3}\left(\frac{1}{v_{i+1} + v_i}\right)^3 + \frac{(\Delta v)^4}{5}\left(\frac{1}{v_{i+1} + v_i}\right)^5 \right\}.$$

In this way the time between any two sites, beginning and terminating at stations, can be calculated.

APPENDIX E: USABILITY FORMS

CONSENT FORM

UNIVERSITY OF WASHINGTON
CONSENT FORM

USABILITY TESTING OF REAL TIME TRAFFIC INFORMATION SYSTEM (TRAFFIC REPORTER)

Investigator: Jan H. Spyridakis
Department of Technical Communication
College of Engineering, FH-40
206/543-2567

Investigator's statement:

Purpose and Benefits

We are interested in determining user response to a real-time commuter information system known as "Traffic Reporter." "Traffic Reporter" can alter the way we currently receive traffic information.

Procedures

If you agree to participate in this study, you will be given a questionnaire to fill out which will ask general questions about your commute. You will receive an introduction and a demonstration of the commuter information system known as "Traffic Reporter." You will be given a short tutorial to acquaint you with the system. Finally, you will be given a set of tasks to perform on the system; these tasks will be interspersed with questions asking your opinions about the system. You will be asked to read all tasks and questions aloud, as well as to try to "talk through" your thought processes and actions while performing the tasks. Your response will be timed and tape-recorded.

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 associated 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 investigator will have access to the data and that data will be retained for three years. You may refuse to participate or may withdraw from the study at any time without penalty.

Margaret B. Cooney 1/9/91
Signature of Investigator Date

Spyridakis 1/9/91
Signature of Faculty Advisor Date

Subject'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 investigator listed above.

____
Signature of Subject Date

SUBJECT PROFILE QUESTIONNAIRE

SUBJECT PROFILE QUESTIONNAIRE

I. INFORMATION ABOUT YOUR COMMUTE

1. How often do you commute on I-5?
   ___ Less than 1 day a week ___ 1-2 days/wk ___ 3-4 days/wk ___ 5+ days/wk

2. a. What is the nearest I-5 ramp:
   To your home? ______________
   To your work? ______________

   b. Do you use these ramps for your commute? ____ Yes ____No

   c. If no, which entrance or exit ramps do you use?

   Northbound --- Enter I-5: ______________
   Exit I-5: ______________

   Southbound --- Enter I-5: ______________
   Exit I-5: ______________

3. At what time, or between what times, do you usually:
   Go to work? ____________________AM
   Leave work? ____________________PM

4. How often do you modify or change your route *to* work?
   ___ Rarely ___ Sometimes ___ Frequently

5. How often do you modify or change your route *from* work?
   ___ Rarely ___ Sometimes ___ Frequently

6. When do you choose your commuting route?
   ________ Before leaving home/work
   ________ While driving on city/county streets
   ________ While driving on freeways
   ________ Other (Please specify: ____________________)

7. Before you drive how often does traffic information influence:
   The time you go to work ___ Never ___ Rarely ___ Sometimes ___ Frequently
   The time you leave work ___ Never ___ Rarely ___ Sometimes ___ Frequently
   Your travel mode (e.g., car, bus) ___ Never ___ Rarely ___ Sometimes ___ Frequently
   Your route choice ___ Never ___ Rarely ___ Sometimes ___ Frequently

8. How familiar are you with alternate routes for your commute?
   ___ Not at all ___ Somewhat ___ Very

9. How familiar are you with alternate modes of transportation (e.g., bus, vanpool) for your commute?
   ___ Not at all ___ Somewhat ___ Very

10. a. Are you responsible for picking up/dropping off others:
On your way *to* work? ______ Yes ______ No
On your way *from* work? ______ Yes ______ No

b. If yes, do these responsibilities affect your:
Departure time? ______ Yes ______ No
Route choice? ______ Yes ______ No
Mode choice? ______ Yes ______ No

II. PERSONAL/ COMPUTER USE - *The information obtained in this part of the questionnaire is confidential, and will not in any way be linked to your name.*

1. a. Job title: ____________________

b. Number of years with present employer? ____________________

2. a. Do you have a computer at your desk at work?
___ Yes ___ No ___ Not at my desk, but there is one I can use anytime

b. If yes, how many days a week do you use a computer at work?
___ Less than 1 day a week ___ 1-2 days/wk ___ 3-4 days/wk ___ 5+ days/wk

3. a. Do you have a computer at home?
___ Yes ___ No

b. If yes, how many days a week do you use a computer at home?
___ Less than 1 day a week ___ 1-2 days/wk ___ 3-4 days/wk ___ 5+ days/wk

Thank you for completing this questionnaire. In a few minutes, we will have you evaluate the traffic system.

INTRODUCTION/ DEMO

Intro/Demo for "Traffic Reporter"

(Preface -- We NEED your input. We are using you to help test the system--you are not being tested. I am going to be reading aloud from this page so all subjects see/hear the same thing. I will be reading this out loud, so that all of our evaluators will hear the same thing.)

Intro: This program is a model of a system designed to assist commuters in making decisions about their commute before they even get in their cars. Specifically, Traffic Reporter helps you to decide whether to leave at different times or to choose different routes than normal. Currently "Traffic Reporter" only shows a limited portion of freeway and can only perform limited functions. As with all models, there are some areas that may still have a few problems.

Demo: I would like to briefly acquaint you with the screen, the mouse, and the functions of the system.

(The screen & Mouse Point to all these things as explained.)
First, let's look a little bit at the screen.
At the very top of the screen notice the **title** --Traffic Reporter: I-5. The portion of I-5 that the system currently maps extends from SW 236 at the north near Lynnwood, to Dearborn at the south in downtown. As you can see, "Traffic Reporter" represents I-5 as a schematic map on the main part of the screen. The left "roadway" represents Southbound, while the right represents Northbound. Currently, the system doesn't show either express or carpool lanes.

- Look at the **interstate signs** and arrows indicating the direction of travel. (Left side Southbound, right - North)
- Look at the **ramps,** which are labelled. Notice that most ramps have two labels--one for Northbound and one for Southbound.
- Look at the "road" which is segmented, each **segment** having a color.
- These **colors** are speed indicators (& they will change as the system updates). If you look at the lower left portion of the screen, you can see the legend for these colors. For example, if a segment of roadway is red, then the speed for that segment is 0-19 mph.
- Look at the **menus** at the top of the screen labelled File, Options, Data, Communications, and Help.

The only menu option that you will be using today is the Help menu, which I will show you how to use in just a little while.

- At the very bottom of the screen is a **line** that displays today's date and time, and a data time stamp. Notice that the time on "today's time" and the data time stamp show virtually the same time, because the information is "live" and represents continually updating freeway conditions. (We get this information from sensors in the roadways.) Notice that the "data time stamp" updates about once a minute. This

updated information is reflected in the changing colors (speeds) on the screen.
Before I demonstrate the system to you, let me first tell you a little bit about the **mouse**. With this system, you can perform four different functions. By using the mouse, you can access these functions and get more detailed information than is currently on the screen. Notice that the mouse itself has both a left and a right button. Each button serves a different purpose as you will see a little later when I demonstrate the system.

-Notice that as I move the mouse around on the desk, it moves a symbol called a cursor on the screen. If I move the mouse up, the cursor moves up; if I move it down or sideways, the cursor moves down or sideways. It only takes a little bit of movement from your hand on the mouse to make the cursor move around. Ordinarily the shape of the cursor is an arrow. The cursor's shape can also change to a magnifying glass, which allows you to get enlarged views of the freeway or an hour glass, which is the computer's way of asking you to wait a minute while it updates information.

(Demo)

Now I'm going to demonstrate the functions of the system to you. Before we start, do you have any questions?

By using the mouse, you can interact with the Traffic Reporter system. There are four functions that can be performed that I will now show you.

(1. Zoom)

The first function that I want to show you is the "zoom" or congestion function. It allows you to zoom in on areas of congestion to find out what exact speeds traffic is moving.

When I move the arrow cursor over the freeway, notice that its shape changes to a magnifying glass.

If I **click the left** mouse button **once** while I have the magnifying glass cursor *over a freeway segment*, a "zoom" box appears on the left of the screen.

-In this "zoom" box, notice that you get congestion information for the section of freeway that you chose. The numbers you see represent speeds in miles per hour for various freeway segments.

-By moving the mouse and clicking the left button again, you can keep zooming all around freeway sections. **[demo a couple of times]**, or you can click on the **OK** button with the left mouse button **[demo]** to close the box.

OK is a way of closing dialog boxes. You always use the left button and click once in order to close dialog boxes.

(2. Info between 2 points)

Let's imagine we want to find time and speed between an entrance ramp and an exit ramp.

Another function of the system is to get the average time and the average speed between two points on either northbound or southbound I-5

If I click *on a ramp label*, with the **left mouse button**,for example NE 85 southbound, and then click on another ramp label on the same side of the freeway--again with the left mouse button**, let's say Mercer,** a box appears on the upper right side of the screen that gives me trip information between these two points.

-At the top of the box, the system tells you the the direction of travel. [point to]

-The middle part of the box gives you four additional pieces of information: the originating or entrance ramp, the destination or exit ramp, average time (in minutes) for your trip, and the average speed (in mph) for your trip.

(Point to each, then Demo a couple of times)

-If you want to get information between two other points or if you want to close the Trip information box, **click OK** with the left mouse button.

There are two things you should try to keep in mind:

First - If you make a mistake in selecting your first ramp, just re-click that ramp and it will no longer be highlighted. If, however, you've mistakenly chosen your second ramp, you will have to close the dialog box and try again.

Second-You have to click on two ramps on the same side of the freeway. Traffic Reporter doesn't allow you to make U-Turns. If you happen to click on opposite sides of the freeway, i.e., NE 145 southbound and Northgate northbound, you will get an error message.

The two functions that I just demonstrated to you, "zoom" and clicking on an entrance and exit, are both accessed by clicking the left mouse button on different objects. The next two functions that I am going to show you involve *double clicking* <u>either</u> the left mouse button <u>or</u> <u>the</u> <u>right</u> mouse button. A double click is two clicks in rapid succession.

(3. Info to a destination)

Finally, let's imagine that you have a particular *exit* in mind, but want to know time and speed information from various *entrances*.

The fourth and final function of the system can do this for you. Let's say we want to get off of I-5 at Roanoke southbound. Traffic Reporter will show us time and speed information from all points north of Roanoke.

- **Double clicking the left** mouse button on a **ramp label, Roanoke SB,** will bring up a dialog box on the right of the screen that shows information from all possible entry points north of there:

a. The direction of travel to that ramp.
b. Average travel time from different entrance ramps.
c. Average speeds from different entrance ramps.

Double clicking the left mouse button on a northbound ramp label will give me the same type of information, i.e., **NB NE 175 ,**

You will still get:

a. The direction of travel to that ramp
b. Average speeds from different origins.
c. Average travel time from different origins.

(4. Info from an origin)

Now let's imagine that you want to find speed and time information for all possible exits--and--that you are getting on I-5 at a particular entrance.

Another feature of the system allows you to find the time and speed between your origin (entrance) ramp and all north or south bound exit ramps depending on your travel direction. For example, if I were going to get on the freeway at NE 175 and head downtown, I could find average travel speeds and times to all of the ramps south of NE 175.

- **Double clicking the <u>right</u>** mouse button on the ramp label NE 175 southbound will allow me to perform this function. When I do that, I will get a dialog box on the right of the screen that tells me:

a. The direction of travel from the chosen ramp,
b. Average travel time to different exit ramps.
c. Average speeds to different exit ramps.

This function, too, works the same for either north or south.
For example, if I were to get on the freeway heading north at NE 45, I could find times and speeds to all exits north of 45th by double clicking the right mouse button on the NE 45 ramp northbound.

The double clicking functions are similar to each other. With a <u>RIGHT</u> double-click you know which entrance you want to get <u>ON</u> at and you are looking for information about different exits. With a <u>LEFT</u> double-click, you know which exit you want to get <u>OFF</u> at and you are looking for information about different points of entry.

Right ON
Left OFF

The next thing that I am going to do is give you a short tutorial to allow you to become familiar with the system. At any time during the tutorial or during the tasks that you will be doing later, you can ask Traffic Reporter for help on the different mouse functions.

HELP

Looking at the menu at the top of the screen you will see an item marked Help.
All you need to do is point the cursor at help, click the left mouse button and a box will appear that explains the four functions you just saw. To close the "Help" box, click OK.

Remember, you are not being tested in any way. We need your input in order to evaluate and improve the system and quality of information.

TUTORIAL

Tutorial for "Traffic Reporter"

Now it is time for you to get comfortable with the traffic system. Below you will find "tasks" broken down by the four functions--zoom, trip information between two points, information to a specific exit ramp, and information from a specific entrance ramp that I just demonstrated for you.

In each section below, you will be performing two tasks. In the first task you will be presented with the question, then you will be given specific instructions telling you how to perform the task; for the second task you will only be presented with the question. If you get stuck, look back to the instructions in the first task. Please read all of the questions and talk through your actions and responses out loud as well as writing in your responses.

Mouse Play

Before you start on this tutorial, move the mouse around and watch the cursor change shapes. Please do not click any mouse buttons now.

Zoom

Task A. Zoom in around Northgate Way. Find the speed at Northgate Way on Southbound I-5.

Instructions:

1. Position the mouse so the cursor is over the freeway section at Northgate Way.

2. When the cursor becomes a magnifying-glass, click once on the left mouse button.

3. Notice that the zoom box has appeared on the left side of the screen. Look at the southbound (left-hand) section of the freeway at Northgate Way to see the speed.

   What is the speed at Northgate southbound? ________________

4. Click OK with the left mouse button to close the zoom box.

Task B. Zoom in around NE 175 to find the northbound speed.

What is the speed at NE 175 northbound? ____________

Information between two points

Task A. Find the *number of minutes* and *average speed* it takes to travel between NE 45 and NE 175 northbound.

Instructions:

1. Position the cursor arrow on the label NE 45/NE 50 on the northbound (righthand) side of the freeway. (Make sure the cursor's shape is an arrow.)

2. Click the left mouse button. (The label will become highlighted.)

3. Move the cursor to the NE 175 label making sure it's an arrow. Click the left mouse button. (Still on the northbound side of the freeway.)

4. Look in the dialog box to find the amount of time it will take you to travel between NE 45 and NE 175.

   Between NE 45 and NE 175, what is your travel time?__________

5. Look in the dialog box to find the average speed.

   Between NE 45 and NE 175, what is the average speed?________

6. Click OK to close the dialog box.

B. Find the number of minutes and average speed it will take to travel between NE 145 and Stewart southbound.

Time from NE 145 to Stewart? ______________________________

Average speed from NE 145 to Stewart?______________________

Information to a specific exit ramp

Task A. You are downtown and need to go to NE 145. You don't know whether to get on the freeway at Dearborn or James. To find this out, you will have to answer the following questions:

(a) How long will it take you and what is the average speed that you will travel from Dearborn?

(b) How long will it take you and what is the average speed that you will travel from James?

Instructions:

1. Position the arrow cursor on NE 145 northbound.

2. Double click with the left mouse button on NE 145 northbound.

3. Look at Dearborn in the dialog box and find out average time and speed.

   How long will it take from Dearborn to NE 145?________________

   What is your average speed from Dearborn to NE 145?__________

4. Look at James in the dialog box and find out what the average time and average speed will be to go from there.

   Average time from James to NE 145? ________________________

   What is the average speed from James to NE 145?______________

5. Click OK.

Task B. You are travelling south from the Lake City area and need to go to Union street downtown.

(a) What is the average time and average speed you will travel if you get on I-5 at NE 85?

(b) How long will it take you and what will your average speed be if you get on at NE 70/NE 65?

Average time from NE 85 to Union? ________________________

Average speed from NE 85 to Union? ________________________

Average time from NE 70/NE 65 to Union? ________________________

Average speed from NE 70/NE 65 to Union? ________________________

Information from a specific entrance ramp

Task A. You are leaving from NE 145 and heading southbound toward downtown. You want to know whether to get off the freeway at Stewart or Union. To make this decision, you will have to find out the following:

(a) How long will it take you and what will your average speed be to get to Union,

(b) What will your average travel time and speed be to Stewart?

Instructions:

1. Double click with the right mouse button on NE 145 southbound.

2. Look at Union in the dialog box and find out how many minutes it will take you and how fast you will be travelling to get there.

   How long will it take from NE 145 to Union? ________________

   Average speed from NE 145 to Union? ________________

3. Look at Stewart in the dialog box and find out what the average time and speed will be to get there.

   Average time from NE 145 to Stewart?________________

   Average speed from NE 145 to Stewart?________________

4. Close the dialog box.

Task B. You need to get on I-5 at James and travel north toward the Harvard/Roanoke area.

(a) How long will it take you and what is the average speed you will travel if you get off at Harvard?

(b) How long will it take you and what average speed will you travel if you get off at Roanoke?

Average time from James to Harvard? ________________

Average speed from James to Harvard? ________________

Average time from James to Roanoke?________________

Average speed from James to Roanoke?________________

TASKS FOR COMMUTER EVALUATORS

DATAKEEPER TASK LIST

TASKS FOR "TRAFFIC REPORTER" EVALUATORS

The following pages are broken down into two parts. The first part has two scenarios with four tasks in each scenario. The second part is an overview of the system. Please read all of the questions aloud and "talk through" all of your thoughts and actions. Some of the questions have scales of 1 to 5. Please answer all of the questions, and circle only ONE number in the scales. Also, please do not circle between numbers; choose a number that you think comes closest to your opinion. Please remember that because the information you are looking at is "live", it may not represent the scenarios described below; therefore, you will have to imagine yourself in the following scenarios.

PART ONE

SCENARIO I

You work downtown off of James Street. Your company has just installed "Traffic Reporter" and you find yourself 'testing' the program to see how it works for you under the different circumstances described below.

1. You have to go over to Bellevue sometime today.

   a. If you leave now, how many minutes will it take, and how fast will your average travel speed be between James and SR 520?

      Travel time from James to SR 520? ____________________

      Average speed from James to SR 520? ____________________

   b. If "Traffic Reporter" displayed the time from James to SR 520 as 45 minutes, and it was just as convenient for you to leave at any time during the day, how <u>likely</u> is it that you would delay your departure time or route?

Likelihood of changing departure time?

Not at all		Somewhat		Very
1	2	3	4	5

Likelihood of changing route?

Not at all		Somewhat		Very
1	2	3	4	5

   c. How understandable is the information in the trip information dialog box ?

Clarity of information in trip information dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

2. It is 5:00PM and you need to pick up your neighbor's child at school at NE 175 by 5:30. You have heard reports that the freeway has been tangled up all day due to an accident at James. You need to decide whether to get on the freeway at James, or at Olive.

   a. Zoom in around James - Olive northbound.

      What is the speed at James? ______________

      What is the speed at Olive? ______________

   b. Find your travel time to NE 175 from both James and Olive.

      Travel time from James to NE 175?__________

      Travel time from Olive to NE 175?__________

   c. Keeping in mind that you only have half an hour, if the travel time was 35 minutes from James but 15 minutes from Olive, how <u>likely</u> is it that you would drive to Olive to enter I-5?

Likelihood of changing route?

Not at all		Somewhat		Very
1	2	3	4	5

   d. Comments (why/why not?) ______________________________

   ____

   ____

3. You've spent a good deal of your day waiting. First you had to wait at the bank, then you were put on hold for what seemed like hours, and then you ended up playing telephone tag with an important client. You want to go home to NE 205, but if you get stuck in slow or stopped traffic you're afraid of what you might do.

   a. You want to find out what your average travel speed would be to NE 205 if you got on at either James or Mercer.

      Average speed from James to NE 205? ______________

      Average speed from Mercer to NE 205? ______________

4. You need to go to the University district. Different people have told you about the "best" exit to get off at. What will your travel time and speed be from James to Roanoke, and from James to NE 45/NE 50?

   Travel time from James to Roanoke?______________

   Average speed from James to Roanoke?______________

   Travel time from James to NE 45/ NE 50?______________

   Average speed from James to NE 45/ NE 50?______________

SCENARIO II

Northgate Way is the closest I-5 entrance ramp to your home. You use I-5 to commute southbound daily to the Seattle Center and you exit at Mercer Street.

1. Recently you've noticed a lot of congestion around NE 50/ NE 45.

   a. What is the exact speed traffic is moving at the NE 50/NE 45 exit?____________

   b. Did you use the "zoom" box to answer (a) above?____ Yes ____ No

   c. Would you find the information in the zoom box <u>useful</u> in planning your commute?

Usefulness of information in zoom box?

Not at all		Somewhat		Very
1	2	3	4	5

2. A new product is being demonstrated several times during the day in your office. The demonstration that you want to see starts in 25 minutes sharp (no latecomers) however, you are still at home and running a little late. You need to decide whether you should try to make it to this demonstration or go to another one at a more inconvenient time.

   a. Looking at the main screen, how <u>confident</u> would you be that you could tell whether you could make the demonstration on time? (Assume 5 minutes from Mercer to Seattle Center, and a parking space out front!)

Confidence in main screen information?

Not at all		Somewhat		Very
1	2	3	4	5

   b. How long will it take to go from Northgate Way to Mercer? ________

   c. How <u>useful</u> would you find this trip information before your commute?

Usefulness of information in trip information dialog box

Not at all		Somewhat		Very
1	2	3	4	5

d. How likely is it that you would change your route based on this type of information from "Traffic Reporter"?

Likelihood of changing route?

Not at all		Somewhat		Very
1	2	3	4	5

e. How likely is it that you would change your departure time based on this type of information?

Likelihood of changing departure time?

Not at all		Somewhat		Very
1	2	3	4	5

3. Northgate Mall has decided to have a mall-wide sale all this week starting at 8:30 AM. Sale prices are so good that traffic has been backing up in the Northgate area since 7:00 AM.

   a. It is now 8:00 AM and you need to be at work at the Seattle Center by 8:20. You need to decide whether to get on I-5 at Northgate or further south at NE 85.

      How long will it take to go from Northgate Way to Mercer?__________

      from NE 85 to Mercer?__________

      What will your average speed be from Northgate to Mercer?________

      from NE 85 to Mercer?__________

4. Your car has been acting up in the cold rainy weather. You need to take it to the Eastlake Garage off of Roanoke. The mechanic said he would check the car anytime, but you should drive at least 35 mph so the car won't keep stalling.

   a. What is the average speed you will travel from Northgate Way to Roanoke? ____

   b. You know that there is a bus you could catch at the Eastlake Garage to the Seattle Center in 35 minutes. You notice on "Traffic Reporter" that traffic is stopped at Roanoke and wonder what your average speed and time will be if you get off either at NE 70/NE 65 or NE 50/NE 45. (Assume green lights all the way after exiting I-5!)

      Average speed from Northgate to NE 70/NE 65? ________

      Time from Northgate to NE 70/NE 65? _________

      Average speed from Northgate to NE 50/NE 45? ________

      Time from Northgate to NE 50/NE 45? _________

PART TWO

OVERVIEW

If you had access to "Traffic Reporter" (and assuming you had the freedom to do so), how likely would you be to:

	Not at all		Somewhat		Very
Change your departure time?	1	2	3	4	5
Choose an alternate route?	1	2	3	4	5
Choose an alternate mode?	1	2	3	4	5

Are there features or information that you would like to see added to "Traffic Reporter"?

Are there any features in the system you would like to see changed or deleted?

On the next four pages are some questions about the "Traffic Reporter" program. While writing down your responses, please feel free to add any comments either orally or on this sheet. These questions are designed to help us evaluate the program and your reactions to it. Feel free to look at and play with the system if it helps you answer these questions. Please continue to read the questions and make your responses out loud. Two of these questions ask you to rank different choices. Please give each item a separate ranking number, and do not eliminate any of the choices.

1. On the main screen there are arrows at the six ramps listed below. Please describe what you think each arrow represents.

↓ SW 236 Southbound ______________________

↓ NE 130 Southbound ______________________

SW 236 ↑ Northbound ______________________

NE 130 ↑ Northbound ______________________

Roanoke \ Northbound ______________________

Roanoke / Northbound ______________________

2. How <u>understandable</u> do you find the information on the main screen?

Not at all		Somewhat		Very
1	2	3	4	5

3. How <u>understandable</u> is the color coding of the freeway segments?

Not at all		Somewhat		Very
1	2	3	4	5

4. How <u>appropriate</u> do you find the range of speeds?

Not at all		Somewhat		Very
1	2	3	4	5

5. How <u>useful</u> do you find the range of speeds?

Not at all		Somewhat		Very
1	2	3	4	5

6. How <u>understandable</u> is the information in the close-up (zoom) views?

Not at all		Somewhat		Very
1	2	3	4	5

7. How <u>understandable</u> is the information in the dialog boxes that display travel times?

Not at all		Somewhat		Very
1	2	3	4	5

8. How <u>easy</u> do you find the mouse actions to remember and use?

Not at all		Somewhat		Very
1	2	3	4	5

9. How <u>easy</u> is it to extract information from the display?

Not at all		Somewhat		Very
1	2	3	4	5

10. How <u>easy</u> is it to interact with the system?

Not at all		Somewhat		Very
1	2	3	4	5

11. How <u>useful</u> would you find "Traffic Reporter's" information before your commute?

Not at all		Somewhat		Very
1	2	3	4	5

12. How <u>often</u> would you access "Traffic Reporter" if it was readily available to you?

Not at all		Occasionally		Frequently
1	2	3	4	5

13. Please rank how you would prefer to receive traffic information from "Traffic Reporter". (Please use 1 for your most preferred choice.)

______ On a screen
______ Via radio
______ Variable Message Sign on freeway

14. If you were to see "Traffic Reporter" on a screen, would you prefer to view it and manipulate it yourself, or would you rather have it interpreted for you, i.e., a newscaster would interpret the information.

______ View and manipulate ______ Interpreted

15 a. Do you feel you would use "Traffic Reporter" if it was available to you?

_____Yes _____No

b. If you answered "Yes" to (a) above, please rank the following in the order that you think you would use them for receiving information from "Traffic Reporter." (1 = most preferred, 8 = least preferred.)

____ Computer at home
____ Computer at work
_____Cable TV (no interaction with mouse)
____ TV kiosk in a store, parking garage, office building, etc. (no interaction with mouse.)
____ Public computer kiosk in a store, parking garage, office building, etc. (interaction with mouse)
_____Commercial TV
____ Commercial Radio
____ Other (Please specify: ______________________)

16. Please rate the usefulness of "Traffic Reporter's" information **relative** to other traffic information you receive.

Not at all		Somewhat		Very
1	2	3	4	5

Thank you very much for your time, effort and input!

TASKS
(Datakeeper)

Subject # 14
Comp/Non-comp________
RC,TC,RTC_______
M/F ______

SCENARIO I (Northbound)

You work downtown off of James Street. Your company has just installed "Traffic Reporter" and you find yourself 'testing' the program to see how it works for you under the different circumstances described below.

1. You have to go over to Bellevue sometime today.
   a. If you leave now, how many minutes will it take, and how fast will your average travel speed be between James and SR 520?

[1 step]
Click on 2 ramps NB (right side)

2 RAMPS
Travel time from James to SR 520? ____________

Average speed from James to SR 520? __________

Start	Tries	Helps	Stop

   b. If "Traffic Reporter" displayed the time from James to SR 520 as 45 minutes, how likely is it that you would delay your departure time or route?

Likelihood of changing departure time?

Not at all		Somewhat		Very
1	2	3	4	5

Likelihood of changing route?

Not at all	Somewhat			Very
1	2	3	4	5

   c. How understandable is the information in the trip information dialog box ?

Clarity of information in trip information dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

2. It is 5:00PM and you need to pick up your neighbor's child at school at NE 175 by 5:30. You have heard reports that the freeway has been tangled up all day due to an accident at James. You need to decide whether to get on the freeway at James, or at Olive.

   a. ***Zoom*** in around James - Olive northbound.

[1 step]
Zoom NB (right side)

Start	Tries	Helps	Stop

ZOOM

What is the speed at James? __________

What is the speed at Olive? __________

   b. Find your travel time to NE 175 from both James and Olive.

[1 Step]
Double click left on NE 175 NB (right)

Start	Tries	Helps	Stop

CHOICES TO A DESTINATION

Travel time from James to NE 175? ________

Travel time from Olive to NE 175? ________

   c. Keeping in mind that you only have half an hour, if the travel time was 35 minutes from James but 15 minutes from Olive, how likely is it that you would drive to Olive to enter I-5?

Likelihood of changing route?

Not at all		Somewhat		Very
1	2	3	4	5

   d. Comments (why/why not?)

3. You've spent a good deal of your day waiting. First you had to wait at the bank, then you were put on hold for what seemed like hours, and then you ended up playing telephone tag with an important client. You want to go home to NE 205, but if you get stuck in slow or stopped traffic you're afraid of what you might do.

   a. You want to find out what your average travel speed would be to NE 205 if you got on at either James or Mercer.

[1 STEP]
Double click left on NE 205 NB

Start	Tries	Helps	Stop

CHOICES TO A DESTINATION

Average speed from James to NE 205? __________

Average speed from Mercer to NE 205? __________

4. You need to go to the University district. Different people have told you about the "best" exit to get off at. What will your travel time and speed be from James to Roanoke, and from James to NE 45/NE 50?

[1 STEP]
Double click right on James NB

Start	Tries	Helps	Stop

CHOICES FROM AN ENTRANCE

Travel time from James to Roanoke? __________

Average speed from James to Roanoke? __________

Travel time from James to NE 45/ NE 50? __________

Average speed from James t o NE 45/ NE 50? __________

SCENARIO II (Southbound)

Northgate Way is the closest I-5 entrance ramp to your home. You use I-5 to commute southbound daily to the Seattle Center and you exit at Mercer Street.

1. Recently you've noticed a lot of congestion around NE 50/ NE 45.
   a. What is the exact speed traffic is moving at the NE 50/NE 45 exit?

[1 STEP]
Zoom @ NE 50/NE 45 SB

Start	Tries	Helps	Stop

ZOOM
Speed at NE 50/NE 45 exit? ______________

   b. Did you use the "zoom" box to answer (a) above?
   ____ yes ____ no

   c. Would you find the information in the zoom box useful in planning your commute?

Usefulness of info. in zoom box?

Not at all		Somewhat		Very
1	2	3	4	5

2. A new product is being demonstrated several times during the day in your office. The demonstration that you want to see starts in 25 minutes sharp (no latecomers) however, you are still at home and running a little late. You need to decide whether you should try to make it to this demonstration or go to another one at a more inconvenient time.

   a. Looking at the main screen, how confident would you be that you could tell whether you could make the demonstration on time? (Assume 5 minutes from Mercer to Seattle Center, and a parking space out front!)

Confidence in main screen info?

Not at all		Somewhat		Very
1	2	3	4	5

   b. How long will it take to go from Northgate Way to Mercer? _________

[1 STEP]
2 ramps SB

Start	Tries	Helps	Stop

2 RAMPS
b. Time from Northgate Way to Mercer? ________

   c How useful would you find this information before your commute?

Usefulness of info. in dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

d. How likely is it that you would change your route based on this type of information from "Traffic Reporter"?

Likelihood of changing route?

Not at all		Somewhat		Very
1	2	3	4	5

e. How likely is it that you would change your departure time based on this type of information?

Likelihood of changing departure time?

Not at all		Somewhat		Very
1	2	3	4	5

3. Northgate Mall has decided to have a mall-wide sale all this week starting at 8:30 AM. Sale prices are so good that traffic has been backing up in the Northgate area since 7:00 AM.
   a. It is now 8:00 AM and you need to be at work at the Seattle Center by 8:20. You need to decide whether to get on I-5 at Northgate or further south at NE 85.

<u>CHOICES TO A DESTINATION</u>

How long to go from Northgate Way to Mercer? _____

from NE 85 to Mercer? _________

Speed from Northgate to Mercer? _____

from NE 85 to Mercer? _________

[1 STEP]
Double-click left on Mercer SB

Start	Tries	Helps	Stop

4. Your car has been acting up in the cold rainy weather. You need to take it to the Eastlake Garage off of Roanoke. The mechanic said he would check the car anytime, but you should drive at least 35 mph so the car won't keep stalling.

a. What is the average speed you will travel from Northgate Way to Roanoke?

<u>2 RAMPS</u>

a.Avg. speed from Northgate Way to Roanoke? ___

[1 STEP]
Click on 2 ramps SB

Start	Tries	Helps	Stop

-----b. on next page-----

b. You know that there is a bus you could catch at the Eastlake Garage to the Seattle Center in 35 minutes. You notice on "Traffic Reporter" that traffic is stopped at Roanoke and wonder what your average speed and time will be if you get off either at NE70/NE 65 or NE 50/NE 45. (Assume green lights all the way after exiting I-5!)

[1 STEP]
Double-click right on Northgate SB

CHOICES **FROM** AN ENTRANCE	**Start**	**Tries**	**Helps**	**Stop**
Average speed from Northgate to NE 70/NE 65? ______				
Time from Northgate to NE 70/NE 65? ________				
Average speed from Northgate to NE 50/NE 45? ______				
Time from Northgate to NE 50/NE 45? ________				

TASKS FOR MEDIA EVALUATORS

TASKS FOR "TRAFFIC REPORTER" EVALUATORS (Media)

The following pages are broken down into two parts. The first part has two scenarios--Northbound and Southbound. The second part is an overview of the system. Please read all of the questions aloud and "talk through" all of your thoughts and actions. Some of the questions have scales of 1 to 5. Please answer all of the questions, and circle only ONE number in the scales. Also, please do not circle between numbers; choose a number that you think comes closest to your opinion. Please remember that because the information you are looking at is "live", it may not represent the scenarios described below; therefore, you will have to imagine yourself in the following scenarios.

PART ONE

SCENARIO I- AM Commute

1. Recently you've noticed a lot of congestion around NE 50/ NE 45 on the southbound lanes of I-5.

   a. Zoom in around the NE 50/NE 45 exit to find out what exact speed traffic is moving. Speed? ______________

   b. Would you find the information in the zoom box <u>useful</u> in reporting traffic information?

Usefulness of information in zoom box?

Not at all		Somewhat		Very
1	2	3	4	5

2. a. Looking at the main screen, how <u>confident</u> would you be that you could give commuters an accurate account of the morning commute from Lynnwood to downtown?

Confidence in main screen information?

Not at all		Somewhat		Very
1	2	3	4	5

   b. How long will it take someone to go from Northgate Way to Mercer? ____________

c. How <u>useful</u> would you find this trip info dialog box in reporting traffic information?

Usefulness of information in trip info dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

3. Northgate Mall has decided to have a mall-wide sale all this week starting at 8:30 AM. Sale prices are so good that traffic has been backing up in the Northgate area since 7:00 AM. You want to give commuters living in the Northgate area time and speed information from two different on-ramps to downtown in order to help them make commuting choices.

   a. You decide to give information from Northgate and from NE 85.

      How long will it take to go from Northgate Way to Mercer?__________

      from NE 85 to Mercer?__________

      What will the average speed be from Northgate to Mercer?__________

      from NE 85 to Mercer?__________

4. You choose NE 205 as your "entrance of the hour" to give commuter information about.

   Average speed from NE 205 to James? ________

   Time from NE 205 to James? __________

   Average speed from NE 205 to Dearborn? ________

   Time from NE 205 to Dearborn? __________

   b. How useful do you find time and speed information (a) to an exit or (b) from an entrance ramp in reporting commuter conditions?

Usefulness of information to an exit ramp?

Not at all		Somewhat		Very
1	2	3	4	5

Usefulness of information from an entrance ramp?

Not at all		Somewhat		Very
1	2	3	4	5

c. **How often do you think that you would use the trip information features of Traffic Reporter?**

Frequency of using trip information features of TR?

Not at all		Somewhat		Very
1	2	3	4	5

d. **Under what circumstances might you use the trip information features?**
Comments?____

SCENARIO II - PM Commute

1. It's time to do the evening bridge check.

   a. You want to let commuters know the average time and speed from downtown to the 520 exit.

      Travel time from James to SR 520? __________________
      Average speed from James to SR 520? ________________

   b. You want to let commuters know the average time and speed from Mercer to the Dearborn/I-90 exit.

      Travel time from Mercer to Dearborn?_____________________
      Average speed form Mercer to Dearborn?__________________

   c. How understandable is the information in the trip information dialog box ?

Clarity of information in trip information dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

d. How useful do you think this type of information would be in helping commuters choose a bridge?

Usefulness of information in trip information dialog box?

Not at all		Somewhat		Very
1	2	3	4	5

e. How likely is it that you would go to another source for further information about the bridges?

Likelihood of going to another source of information?

Not at all		Somewhat		Very
1	2	3	4	5

f. If you would go to other sources of information, what would those sources be?

____

____

2. You want to give commuters speed and time information to help them make choices about their Northbound (homeward) commute.

   a. Zoom in around James - Olive northbound.

      What is the speed at James? ____________

      What is the speed at Olive? ____________

   b. Find travel times to NE 175 from James, Olive, and Mercer.

      Travel time from James to NE 175?____________

      Travel time from Olive to NE 175?____________

      Travel time from Mercer to NE 175?____________

c. **How often do you think you would give commuters this type of time information?**

Frequency of giving commute time information?

Not at all		Somewhat		Very
1	2	3	4	5

d. Comments: ____

____

____

3. The Huskies are playing in the playoffs at Hec Ed Pavillion. Traffic around the U-District has been building up all afternoon. You want to give drivers information on a couple of routes to the stadium. You decide to give them time and speed information from downtown to Roanoke and to NE 45/50.

Travel time from James to Roanoke?________________

Average speed from James to Roanoke?________________

Travel time from James to NE 45/ NE 50?________________

Average speed from James to NE 45/ NE 50?______________

PART TWO

OVERVIEW

If you had access to "Traffic Reporter" how likely would you be to use the following functions:

	Not at all		Somewhat		Very
Zoom ?	1	2	3	4	5
Information between 2 ramps?	1	2	3	4	5
Trip Info to an exit?	1	2	3	4	5
Trip Info from an entrance?	1	2	3	4	5

Are there features or information that you would like to see added to "Traffic Reporter"?

Are there any features in the system you would like to see changed or deleted?

On the next three pages are some questions about the "Traffic Reporter" program. While writing down your responses, please feel free to add any comments. These questions are designed to help us evaluate the program and your reactions to it. Feel free to look at and play with the system if it helps you answer these questions. Please continue to read the questions and make your responses out loud.

1. How understandable do you find the information on the main screen?

Not at all		Somewhat		Very
1	2	3	4	5

2. How <u>understandable</u> is the color coding of the freeway segments?

Not at all		Somewhat		Very
1	2	3	4	5

3. How <u>appropriate</u> do you find the range of speeds?

Not at all		Somewhat		Very
1	2	3	4	5

4. How <u>useful</u> do you find the range of speeds?

Not at all		Somewhat		Very
1	2	3	4	5

5. How <u>understandable</u> is the information in the close-up (zoom) views?

Not at all		Somewhat		Very
1	2	3	4	5

6. How <u>understandable</u> is the information in the dialog boxes that display travel times?

Not at all		Somewhat		Very
1	2	3	4	5

7. How <u>easy</u> do you find the mouse actions to remember and use?

Not at all		Somewhat		Very
1	2	3	4	5

8. How <u>easy</u> is it to extract information from the display?

Not at all		Somewhat		Very
1	2	3	4	5

9. How <u>easy</u> is it to interact with the system?

Not at all		Somewhat		Very
1	2	3	4	5

10. How <u>useful</u> would you find "Traffic Reporter's" information before reporting traffic information?

Not at all		Somewhat		Very
1	2	3	4	5

11. How <u>often</u> would you access "Traffic Reporter" if it was readily available to you?

Not at all		Occasionally		Frequently
1	2	3	4	5

12. What are your current sources of traffic information?______________________

____

____

13. What audience do you gather traffic information for?

______ Radio ______TV ______Radio & TV _____Other (Please specify)

____

____

14. **RADIO**: How appropriate do you find Traffic Reporter's information for interpreting to radio listeners (verbal translations)?

Not at all		Somewhat		Very
1	2	3	4	5

15. **TV**: How appropriate do you find Traffic Reporter's information for interpreting and presenting to TV viewers (visual translations)?

Not at all		Somewhat		Very
1	2	3	4	5

16. How timely and accurate do you find the information on Traffic Reporter versus other information you receive?

Timeliness of information relative to other traffic info?

Not at all		Somewhat		Very
1	2	3	4	5

Accuracy of information relative to other traffic info?

Not at all		Somewhat		Very
1	2	3	4	5

17. Do you think that Traffic Reporter will reduce the amount of time you spend on the phone with TSMC? Comments?

18. Do you think that Traffic Reporter will make it easier for you to dispatch traffic watchers? Comments?

19. Do you think that Traffic Reporter will make it easier to transmit timely and accurate information to commuters? Comments?

Thank you very much for your time, effort and input!

APPENDIX F: NEWSLETTERS

Commuter Information Systems

Understanding and Helping Puget Sound Commuters

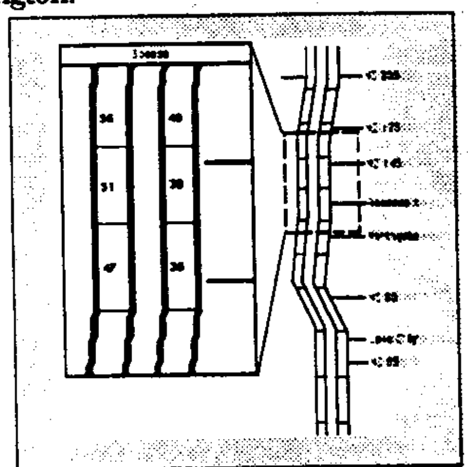
October 1990 A Newsletter for Transportation System Managers and Planners Number 1

Why Commuter Information Systems?

What *is* a commuter information system? It is a system that gathers on-road data and delivers the data in a form designed to impact commuter decisions—decisions on departure times, travel modes, and routes.

Why does a commuter information system make sense? It can provide *social, economic, and political benefits.* Existing transportation facilities can be used with greater efficiency, thereby reducing the pressure for high-cost solutions (such as new highways and railroads), conserving natural resources through decreased construction and pollution, decreasing commuter stress and lost time, and encouraging economic development in our cities. In addition, a commuter information system doesn't dictate what people can and cannot do; rather, it gives them the chance to make intelligent decisions based on their travel needs and awareness of the current status of traffic.

In future issues we'll discuss a real-time commuter information system being developed for the Puget Sound area at the University of Washington.



Possible screen for a commuter information system

UW Study Identifies Four Types of Commuters

A commuter information system can reduce traffic congestion by providing commuters with accurate and timely information about traffic conditions. For the system to be effective, however, we need to first understand commuter behavior and needs, and then deliver information tailored to those commuters likely to change aspects of their commute (departure time, travel mode, or route). In order to gather information on commuter behavior and needs, UW researchers surveyed 15,000 commuters as they exited I-5 downtown. Of this group, 6,000 responded, each providing information on 64 variables related to commuter behavior and needs. This survey identified four types of commuters: *pre-trip changers, route and time changers, route changers,* and *non-changers.*

PRE-TRIP CHANGERS (16%)

- Will change departure time.
- Will change route before departure but not during commute.
- Will change travel mode before departure.

ROUTE & TIME CHANGERS (40%)

- Will change departure time.
- Will change route before or during commute.
- Will not change travel mode.

ROUTE CHANGERS (21%)

- Will not change departure time.
- Will change route before or during commute.
- Will not change travel mode.

NON-CHANGERS (23%)

- Will not change departure time.
- Will not change route before or during commute.
- Will not change travel mode.

The best strategy for delivering information to commuters is to focus on those types most likely to change their travel behavior based on particular traffic information. For example, if we want people to change their travel mode, we should speak to pre-trip changers. It's neither feasible nor desirable to design a system to impact all motorists simultaneously. Significant improvements can be achieved by impacting a relatively small percentage of drivers, while an identical change in too high a percentage would just move the problem to another portion of the transportation system. Studies show that if one of every ten single-occupancy vehicles were removed from the traffic stream on urban freeways during peak periods, delays would be reduced by 48%.

Providing information to commuters is not the only solution to the problem of traffic congestion, but combining a commuter-oriented information strategy with today's communications technology can work over the long term: people exposed to effective and reliable information will change.

More about UW Study

The Washington State Department of Transportation (WSDOT) through the *Washington State Transportation Center* (TRAC), and the US Department of Transportation (USDOT) through *Transportation Northwest* (TransNow), are funding research at the University of Washington to design and develop a real-time commuter information system to help alleviate traffic congestion in the Puget Sound area. This project is a major component of Washington State's *Freeway and Arterial Management Effort* (FAME).

The UW research team is led by Mark Haselkorn (Technical Communication), Woodrow Barfield (Industrial Engineering), Jan Spyridakis (Technical Communication), Loveday Conquest (Quantitative Science), and Dan Dailey (Electrical Engineering). For more information about research publications to date (listed below) contact the editor of this newsletter.

Selected Project Titles

Analysis of Washington State Traffic System Management Center: Information and Screen Design. Master's Thesis. (Bruce Gray) UW, 50 pp.

Improving Motorist Information Systems: Towards a User-Based Motorist Information System for the Puget Sound Area. Technical Report, 144 pp; Final Report, 34 pp.

Information Requirements for Real-Time Motorist Information Systems. *Proceedings of the First Vehicle Navigation and Information Systems Conference*, 4 pp.

Integrating Commuter Information Needs in the Design of a Motorist Information System. *Transportation Research: General* (forthcoming).

Motorist Behavior and the Design of Motorist Information Systems. *TRB* (forthcoming).

Surveying Commuter Behavior as a Basis for Designing Motorist Information Systems. *Proceedings of the First Vehicle Navigation and Information Systems Conference*, 7 pp.

Surveying Commuter Behavior: Designing Motorist Information Systems. *Transportation Research: General* (forthcoming).

The Design of a Graphics-Based Traffic Information System Based on User Requirements. *Proceedings of the 34th Annual Meeting of the Society for Human Factors* (forthcoming).

Understanding Commuter Behavior for the Design of Motorist Information Systems. *TRB* No. P890800, 5 pp.

What Are Others Doing?

As a regular feature we'll let you know what's happening elsewhere in the field of commuter information systems. Future articles will describe efforts in other cities, such as New York and Chicago, and in other countries, such as Germany and Great Britain. (Next newsletter: *Pathfinder* in Los Angeles).

About this Newsletter

This issue of *Commuter Information Systems* is the first of six monthly newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. The next issue will focus on the development of an information delivery system for the Puget Sound area. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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Commuter Information Systems

Understanding and Helping Puget Sound Commuters

November 1990 A Newsletter for Transportation System Managers and Planners Number 2

In This Issue

In the last issue of this newsletter, we explained what a commuter information system is, how it impacts commuters, and how it can provide social, economic, and political benefits to communities. In this issue, we focus on a real-time commuter information system being developed for the Puget Sound area: *Traffic Reporter.*

Also in the last issue, we reported on four types of commuters who travel from the north on I-5 into downtown Seattle. In this issue we extend our analysis of Puget Sound commuters to those who travel from the south on I-5 into downtown Seattle. (The design of *Traffic Reporter* is based in part on our knowledge of these commuter types.)

Finally, we discuss *Pathfinder*, a similar commuter information project under development in Los Angeles.

From Freeway Data to Commuter Information

Traffic Reporter, a real-time commuter information system being developed for the Puget Sound area, begins with data collected as vehicles travel over detectors embedded in the pavement of freeway lanes. Detectors are spread along I-5, I-405, I-90, and SR-520 at approximately half-mile intervals.

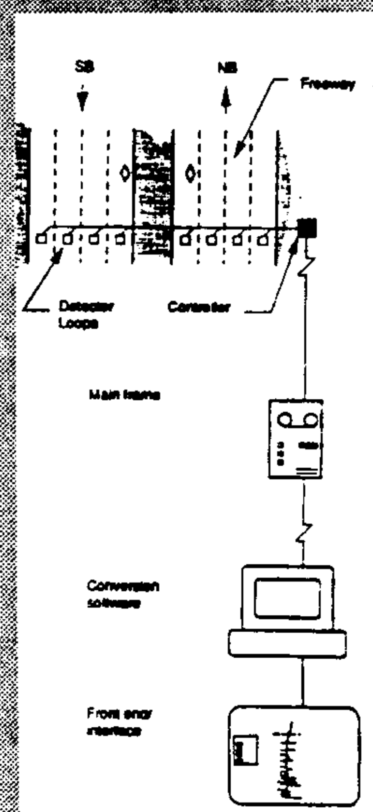
Next, a microprocessor accumulates the detector data for one second and sends two numbers to a central mainframe: (1) the number of cars that have passed over the detector in the last second and (2) the fraction of a second that a car was present over the detector.

The next stage takes place at WSDOT's Traffic Systems Management Center (TSMC). There, a mainframe accumulates the one-second microprocessor data and produces one-minute summaries of these data for all the detectors throughout the freeway system. These summaries are then transmitted to a personal computer on which the final two stages of processing occur. These final two stages are what actually convert freeway data into useful commuter information.

The fourth stage takes place on a personal computer currently in the Department of Technical Communication at the University of Washington. This computer receives summary data from 66 locations northbound and southbound between the King/Snohomish County line and Dearborn Street. Data are transmitted over conventional phone lines using a modem. From these data, the mean travel speed at each station is estimated. This estimation depends upon a number of assumptions (such as the average vehicle length) that are currently being tested to improve this estimation process. Once the speed at each station is available, the estimated travel time between any two stations can be calculated. These calculations of travel speed, time, and congestion can now be presented in a form designed to meet the needs of commuters.

Finally, *Traffic Reporter* presents up-to-the-minute travel speed, time, and congestion information through an interactive graphical screen. The design of this screen is based on extensive survey and analysis of potential users. These users—TSMC engineers, radio and television traffic reporters, and actual commuters—will be able to use *Traffic Reporter* to explore both specific trip information and general freeway conditions.

The next issue of this newsletter will describe how commuters can use *Traffic Reporter's* graphical user interface to make commuting decisions.



Overview of Stages of Data Collection

More on Commuter Types

An extensive survey of commuters who travel from the north on I-5 into downtown Seattle (reported in the last issue of this newsletter) identified four commuter types. To determine if these types were consistent in the Puget Sound population, a second survey was conducted on commuters traveling from the south on I-5 into downtown Seattle (5000 surveyed, 40% responded). The responses of commuters in the second survey confirmed that commuters from the south can be grouped into the same four types, with the percentages compared as follows:

Comparison of Commuter Types

	Survey 1 From N.	Survey 2 From S.
Pre-trip changers	16%	15%
Route & time changers	40%	45%
Route changers	21%	17%
Non-changers	23%	23%

It appears that the commuter types described in our first newsletter are representative of the Puget Sound area in general. To confirm this hypothesis, a third analysis will be made of commuters traveling east/west. Findings from this analysis will be reported in the next issue of this newsletter.

What Others Are Doing: *Pathfinder*, Los Angeles

Pathfinder, an experimental commuter information project jointly sponsored by the U.S. Department of Transportation, Caltrans, and General Motors, is being conducted in Los Angeles on a 14-mile stretch of the Santa Monica Freeway. The purpose of the experiment is to determine if up-to-date traffic information provided by state-of-the-art technologies will influence commuter behavior and alleviate traffic congestion.

The objectives and data collection methods of *Pathfinder* are similar to *Traffic Reporter*. Both systems aim to monitor traffic conditions by using information provided by detectors in the freeway and relaying these data to motorists. However, *Pathfinder* differs from *Traffic Reporter* in its manner of presenting traffic data. The original plan for *Pathfinder* was to display congestion information on dashboard computers installed in 24 cars (General Motors' contribution), allowing motorists to select the "best" route. However, hazards of motorists' monitoring the screen and traffic simultaneously have lead to an alternative now being investigated—the use of voice messages to deliver the data.

Another idea being explored is whether *Pathfinder* could provide commuters with directional information, either by a computer-generated map inside the car or by voice messages, to reach their destination. Research (including that done by the *Traffic Reporter* team on Puget Sound commuters) shows that the more familiar people are with alternative routes, the more likely they are to take them when faced with congestion. This feature would also be particularly helpful to tourists and new residents.

Next issue: *Autoguide*, United Kingdom.

About this Newsletter

This issue of *Commuter Information Systems* is the second of six monthly newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. The next issue will focus on the design of a screen for delivering real-time information to Puget Sound motorists/commuters. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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Commuter Information Systems

Understanding and Helping Puget Sound Commuters

TRAC TRANSNOW

December 1990 A Newsletter for Transportation System Managers and Planners Number 3

In This Issue

In the last issue of this newsletter, we introduced *Traffic Reporter*, a real-time commuter information system being developed for the Puget Sound area. In this issue, we focus on the development of an interactive screen display of this traffic information that can be delivered via personal computer, public kiosk, or TV. Also, we discuss *Autoguide*, a commuter information system in the United Kingdom.

Development of an Interactive Screen

Traffic Reporter presents up-to-the-minute information on travel speed, time, and congestion via an interactive screen. The design of the screen is based on the needs and behaviors of commuters. In the future, this screen can be accessed directly by commuters, or used by traffic reporters to enhance their reports via radio and TV.

The central feature of the screen is a graphical representation of a selected portion of I-5, showing all entry and exit ramps both north and south. The screen also includes a legend showing four speed ranges. At the bottom of the screen is a status bar showing the current date, current time, and time the displayed information was gathered. The system described below is updated every minute.

Here's how it works. First, you see an overview of all traffic speeds on the selected portion of I-5. These speeds are indicated in ranges, that is, the area between each station is colored according to a range of speed: green for 50+ mph, yellow for 35-49 mph, purple for 20-34 mph, and red for 0-19 mph.

Do you want more specific speed information? Move the cursor over the freeway, and the cursor becomes a magnifying glass. Then just click the mouse button and zoom in on that particular section of I-5. The magnified version is displayed to the left of the freeway map, showing mean speed rates of stations instead of broad speed ranges.

Do you want traffic data on a specific trip? Simply click the mouse at any two ramps. A box to the right of the freeway map will show estimated speed and travel time between those two ramps.

Do you want to select the best exit or entry ramp for a given trip? To select an exit ramp, just double-click the right button on the mouse at your origin ramp. A table will appear showing estimated rates of speed and travel time to all possible exit ramps currently displayed. To select an entry ramp, just double-click the left button on the mouse at your destination ramp. The same table will appear, this time showing estimated rates of speed and travel time to your destination ramp from all possible entry ramps currently displayed.

Finally, there are three features of interest mainly to traffic managers. First, *Traffic Reporter* can provide graphical, up-to-the-minute data on volume (number of cars passing over each sensor) and occupancy (percentage of time cars are over each sensor). Second, *Traffic Reporter* can indicate by color code (blue) a malfunctioning station. Third, *Traffic Reporter* can store commute data and play the data back, creating a record of freeway activity for historical and statistical analyses.

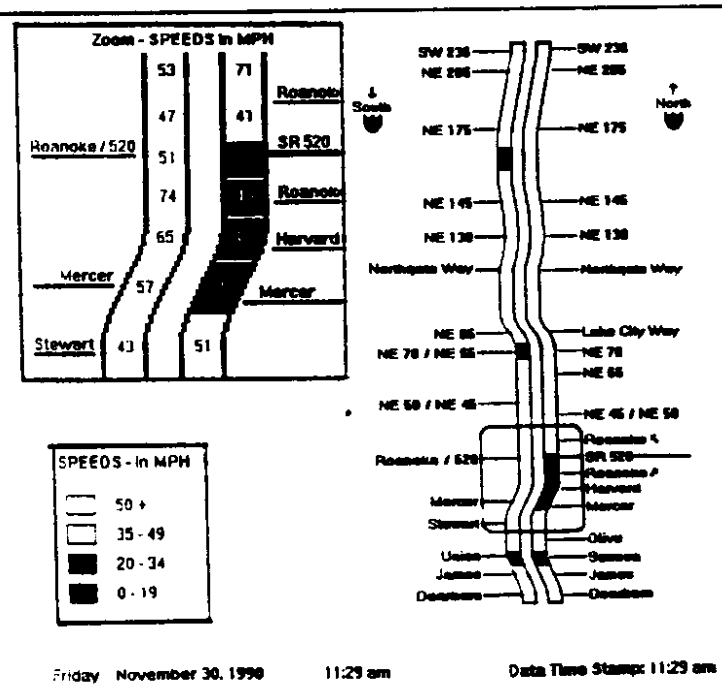

Figure 1. Screen representing I-5 between King/Snohomish County border and downtown Seattle.

What Others Are Doing: *Autoguide*, UK

Autoguide is an experimental route guidance system sponsored by the United Kingdom's Department of Transport. *Autoguide* is an infrared based system consisting of a network of roadside beacons, a central computer, and two-way communication units. The communication units transmit traffic data to cars equipped with dashboard computers and hand-held remote control units. Currently, a pilot project is being conducted in London, but by the mid-1990s it is expected that this system will be implemented throughout the United Kingdom—possibly throughout Europe.

This is how *Autoguide* works. At the start of a journey, the driver enters his or her destination into the dashboard computer. Then the computer displays the best route along with direction, distance, and travel time to the destination. As the vehicle passes a beacon site along the road, up-to-the minute data are transmitted to the vehicle and displayed on the computer screen.

Besides the display showing the best route, direction, and distance, other displays guide the driver on winding roads, alert the driver to turn, indicate appropriate lanes, and indicate when the driver nears the destination. In addition, audio messages often accompany visual messages so that the driver does not have to keep looking at the display. Examples of displays are shown in Figure 2.

Research has shown that drivers—even those traveling on familiar routes—often choose poor routes, thereby losing time and money. The aim of *Autoguide* is to save drivers ten percent or more of these losses by guiding them to their destinations. London, where traffic has increased by about 40% since 1970, is a prime example of how *Autoguide* can save time and money.

Next newsletter: overhead message systems, Chicago.

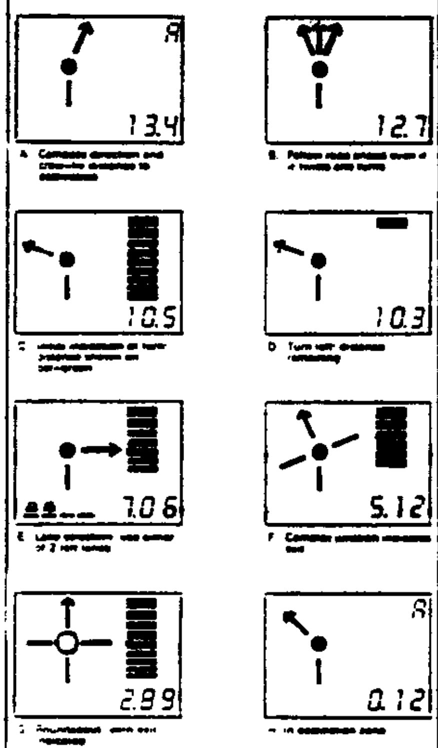

Figure 2. Examples of displays.

About this Newsletter

This issue of *Commuter Information Systems* is the third of six monthly newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. Copies of this or previous issues may be obtained from the editor. The next issue will focus on the usability testing of the screen for delivering real-time information to Puget Sound motorists/commuters. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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Commuter Information Systems

Understanding and Helping Puget Sound Commuters

January 1991 A Newsletter for Transportation System Managers and Planners Number 4

In This Issue

In the last issue of this newsletter, we described how *Traffic Reporter* presents real-time commuter information via a graphical screen. We discussed how traffic reporters, traffic managers, and commuters will access this information directly.

In this issue we focus on the design philosophy of *Traffic Reporter*. We also present some results from an east/west on-road traffic survey. Finally we discuss a changeable message system used in Chicago.

Commuter Response: The Ultimate Goal

In past issues of this newsletter, we introduced *Traffic Reporter*, a commuter information system for the Puget Sound area. Thus far, we have focused on the technological aspects of *Traffic Reporter*. This article focuses on the design philosophy of *Traffic Reporter*.

While modern technology is needed to develop and operate *Traffic Reporter*, *Traffic Reporter's* data gathering and message displays cannot alone improve traffic flow. This can be accomplished only if these messages cause motorists to modify their commuting behavior. Therefore, changing commuter behavior is the basic philosophy guiding the design of *Traffic Reporter*, and such a change can only be achieved by first understanding the behavior and information needs of commuters. Achieving this understanding is a communications problem, which is why technical communicators are leading the design and development of this commuter information system. In fact, the first step in designing *Traffic Reporter* involved getting out on the road and studying the behavior and information needs of commuters.

To further appreciate the importance of this approach, consider that a commuter information system is a type of control system. Control systems consist of a loop of at least three components: an environment, a stimulus, and a response. In some control systems, such as for controlling guided missiles, the response is automatic. However, many control systems require a human in the response loop. With *Traffic Reporter*, human response is the key component of system response, and this human response is extremely complex. (The information loop for *Traffic Reporter* is illustrated in Figure 1.)

Each development phase of *Traffic Reporter* has been driven by an understanding of the behavior of commuters and our ability to impact that behavior. At this time, the final stage, usability testing, is underway. The purpose of this stage is to confirm that *Traffic Reporter* meets the ultimate goal: changing commuter behavior. In the next issue we'll discuss usability testing.

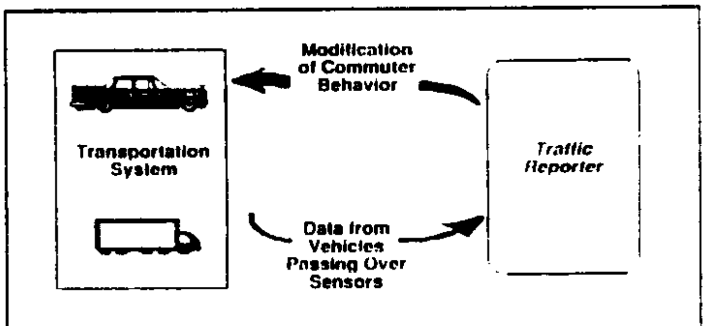

Figure 1. A Real-Time Commuter Information System Loop

Commuter Types and Geographical Differences

Two extensive surveys of motorists traveling into downtown Seattle (reported in the first two issues of this newsletter) identified four commuter types. From these surveys, commuters were broken down into three geographical groups: north, south, and east/west. To determine how the four commuter types were impacted by geographical differences, data were extracted from these surveys. These data are compared in Table 1.

Table 1. Comparison of Commuter Types (in percentages)

	North to Downtown	South to Downtown	East to West
Pre-trip changers	16	15	12
Route & Time Changers	40	45	47
Route Changers	21	17	15
Non-Changers	23	23	26

The commuter types were relatively stable across geographical differences. The only noticeable differences were that east/west commuters are slightly more flexible about the time they leave but slightly less flexible about route and mode of transportation. Those differences may be because these commuters have more flexibility with their time but less flexibility in their route or mode of transportation.

What Others Are Doing: Changeable Message Signs, Chicago

Since 1988, the Illinois Department of Transportation (IDOT) has been operating a changeable message sign (CMS) system on the Chicago network of expressways. The current signs were installed as part of the Dan Ryan Bridge Rehabilitation Project. CMS improves traffic flow and safety by providing real-time traffic advisory messages to motorists. These advisory messages help motorists make traffic decisions in advance of congestion or other traffic incidents.

The CMS system is comprised of 12 signs made of electromagnetically controlled, reflective disks. The typical sign has three 20-character lines providing 18-inch high yellow text on a black background. On weekdays, the signs are remotely controlled by the Traffic Systems Center (TSC) in Oak Park. When necessary at night and on weekends, the signs are remotely controlled by the Communications Center in Schaumburg.

Here is how information is generated. Traffic sensors embedded in the center lane at half-mile points accumulate data on lane occupancy. These data are then sent to a central computer. The computer in turn sends recommended messages to TSC technicians who then send the chosen message to the CMS master controller.

The signs can display a variety of messages, but the policy is to display messages only of traffic-related situations. Most of the messages relate to three traffic situations. First, the majority of messages relate to traffic congestion: location and extent of backups. Second, construction, maintenance, and emergency repairs also produce a heavy demand for messages, especially early warnings of start dates. Third, messages alert motorists to traffic incidents, such as accidents or blocking vehicles—particularly those incidents that necessitate detours. When quieter times prevail, the signs remain blank or carry site-specific messages, such as "reduced speed zone ahead."

Plans are being made to expand the existing CMS system. By early 1992, ten more signs will be added as part of the Kennedy Expressway Rehabilitation Project.

About this Newsletter

This issue of *Commuter Information Systems* is the fourth of six monthly newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. Copies of this or previous issues may be obtained from the editor. The next issue will focus on usability testing of *Traffic Reporter*. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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Commuter Information Systems

Understanding and Helping Puget Sound Commuters

February 1991 | A Newsletter for Transportation System Managers and Planners | Number 5

In This Issue

Our last issue of this newsletter discussed the design philosophy of *Traffic Reporter*, stressing that the ultimate goal is commuter response. We pointed out that the key component in designing *Traffic Reporter* was to first understand commuter behavior and information needs. Another crucial component is confirmation that *Traffic Reporter* meets the ultimate goal. This is accomplished by iteratively conducting a series of usability tests. In this issue we discuss this testing process.

We also discuss *InfoBang*, an experiment being conducted in Houston.

Usability Testing

The ultimate goal of *Traffic Reporter* is to influence commuter behavior by delivering appropriately designed real-time information. We took the first steps towards this goal by studying the behavior and traffic information needs of Puget Sound commuters. Based on this understanding, we designed *Traffic Reporter*. Now, we need to know if *Traffic Reporter* works: Is it useful? Is it effective? Most importantly, does it influence commuter behavior? Currently, we are answering these questions through usability testing, where commuters formally evaluate the system in terms of their needs and desires. In this issue, we (1) explain why usability testing is a critical task, (2) briefly describe the testing process, and (3) discuss future usability testing in this project. In the next issue, we will present initial results.

Why Do Usability Testing?

Traffic Reporter is a type of control system where human response is the crucial component. Thus, while output from *Traffic Reporter* is traffic information, control of the transportation system depends on how commuters respond to that information. Usability testing is a key element in achieving the desired response. Usability testing is also an ongoing process to ensure that modifications and enhancements to the system are designed with commuters' traffic needs and desires in mind.

Testing Process

We have selected three groups of *Traffic Reporter* users: commuters, traffic reporters, and traffic engineers. We are conducting formal usability tests on the commuters and traffic reporters and soliciting less formal input from the traffic engineers.

1. Commuters are seen as the primary users. We have chosen only subjects who travel from south Lynnwood into downtown Seattle because that is the only part of the freeway system that *Traffic Reporter* currently serves. Our selection of 24 subjects was made randomly and represents our targeted commuter types: *pre-trip changers, route changers*, and *route and time changers*. (See October issue for explanation of commuter types.)

To help us gauge commuter response to *Traffic Reporter*, we give subjects a short introduction to and demonstration of *Traffic Reporter*. The subjects then do a short tutorial that explains how to use the system. We next give subjects a series of tasks designed to test the usability of the system under various scenarios. Finally, we ask questions about the design and ease of use of the interface and solicit comments and suggestions from the subjects.

2. Traffic reporters are seen as secondary users. Through traffic reporters, information from *Traffic Reporter* will be passed on to commuters in TV and radio traffic reports. Therefore, we want to find out what information traffic reporters would like to receive. We also want to know if they think *Traffic Reporter* will improve the quality of traffic information they would pass on to commuters.

3. Traffic engineers are primarily personnel at the Traffic Systems Management Center who will use *Traffic Reporter* in its current form as one of several traffic information tools. Traffic engineers report traffic information to the media and public, detect incidents and report them to the State Patrol, and control ramp meters and variable message signs.

Future Testing

In the next phase of our traffic study, we plan to expand and enhance *Traffic Reporter*, and each major expansion or enhancement requires more usability testing. For example, we plan to add the high occupancy vehicle lanes and express lanes to *Traffic Reporter's* screen. This addition will result in *Traffic Reporter* displaying far more information both in the overview of freeway conditions, as well as in selected specific-trip information. How will we know if displaying this increased amount of information results in increased usefulness? The answer is usability testing. Until we are confident that *Traffic Reporter* meets the information needs of commuters, usability testing will be an ongoing part of system design.

What Others Are Doing: *InfoBang*, Houston

Want to find out about traffic conditions before you leave work, without turning on a radio, TV, or computer? Try *InfoBang*. *InfoBang* is an experimental motorist information project jointly sponsored by the U.S. Department of Transportation and the Texas State Department of Highways and Public Transportation. The purpose of the experiment is to provide real-time traffic information for pre-trip planning by using computer display terminals (Figure 1) located on the parking levels of ten buildings in Greenway Plaza (which serves 12,000 employees).

InfoBang provides accurate and timely information for Greenway employees on freeway construction, accidents, and disabled vehicles so that the employees can make decisions concerning travel routes to other areas of the city. Like *Traffic Reporter*, *InfoBang* addresses the need to provide traffic information to motorists at the work place before their commute, thus allowing motorists to make choices concerning their trips.

InfoBang works like this. Various commercial, state, local, and individual sources provide traffic information on accidents, congestion, disabled vehicles, and freeway construction to a commercial traffic advisory service. The advisory service compiles the traffic information on a mainframe computer, which sends messages to a file server in Greenway Plaza. The file server then sends the messages to the ten terminals in Greenway Plaza. The messages on the terminals are updated approximately every five minutes, and the contents of the messages are checked every 15 minutes for accuracy.

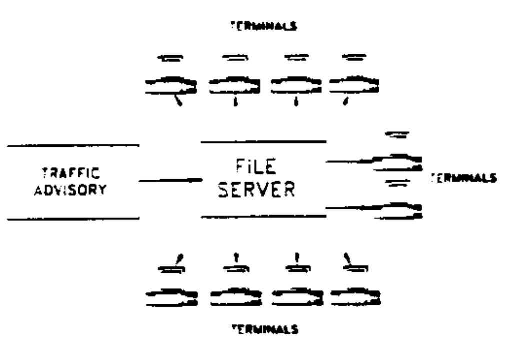

Figure 1. Location of terminals (shaded boxes) in Greenway Plaza.

InfoBang began in September 1990 and will continue for two years, with a possible extension for another two years. The Texas Transportation Institute is currently evaluating the information system in three ways: (1) public acceptance and utilization, (2) system reliability and accuracy, and (3) cost effectiveness. If evaluations show that *InfoBang* is successful according to those criteria, it may be implemented in other areas of the city.

About this Newsletter

This issue of *Commuter Information Systems* is the fifth of six monthly newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. Copies of this or previous issues may be obtained from the editor. The next issue will present usability testing results and focus on the future of *Traffic Reporter*. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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Commuter Information Systems

Understanding and Helping Puget Sound Commuters

April 1991 | A Newsletter for Transportation System Managers and Planners | Number 6

In This Issue

In this issue of *Commuter Information Systems*, we feature plans for *Traffic Reporter's* expansion and enhancement in the next phase of its development.

In our last issue of this newsletter, we described tests we have been conducting to evaluate *Traffic Reporter's* usability and effectiveness. In this issue, we report on preliminary results of those tests.

Finally, we discuss *INFORM*, a real-time commuter information system being used on Long Island.

Future of *Traffic Reporter*

As we have described in previous issues of this newsletter, *Traffic Reporter* is a PC-based, interactive, graphical commuter information system being developed for the Seattle area. The goal of *Traffic Reporter* is to influence commuter behavior and decision making by providing up-to-the-minute traffic information on Seattle-area freeways and delivering this information directly to commuters. In its current state, *Traffic Reporter* does provide graphical, up-to-the-minute traffic information on a PC; however, it covers only the northern corridor of I-5 from downtown Seattle to Lynnwood (about a 15-mile stretch) and is not yet directly delivered to commuters.

In the next phase of *Traffic Reporter's* development, we will expand *Traffic Reporter's* geographical coverage, complete its implementation, deliver it directly to commuters, and enhance it by adding more features. Specifically, we plan to accomplish the following:

1. Expand *Traffic Reporter* to cover more of I-5 and to include other Seattle-area freeways.
2. Separate out express and HOV lanes from regular freeway lanes.
3. Improve the conversion and accuracy of sensor data.
4. Investigate adding features such as a predictive mode.
5. Deliver *Traffic Reporter* directly to commuters via TV and radio reporters.
6. Develop a touch-screen version of *Traffic Reporter* for direct delivery to commuters via kiosks.
7. Explore delivering *Traffic Reporter* via other methods, such as dedicated cable TV, PCs at homes and places of business, and in-car delivery.
8. Use *Traffic Reporter* to record data for monitoring traffic patterns and establishing norms of freeway performance.
9. Continue to evaluate *Traffic Reporter's* usability and effectiveness.

We will report on the results of this additional work in Volume 2 of this newsletter. We anticipate the first issue to be ready by December 1991.

Usability Testing: Preliminary Results

In the last issue of this newsletter, we described usability testing of *Traffic Reporter*. We discussed why we conduct usability tests, who we test, and how we conduct these tests. While we are still conducting these tests, we can present some preliminary results.

Thus far, we have tested 13 commuters. These commuters had responded to our on-road survey and indicated flexibility in some aspect of their commute behavior. We designed the test to elicit information about the following issues: (1) interface design, (2) screen interactivity, (3) desired delivery method, and (4) potential change in commute behavior.

Overall, the subjects revealed that *Traffic Reporter* is a usable and effective real-time commuter information system. Following are specific responses to the above issues, as well as suggestions for future changes to the system.

Interface design. The subjects felt that the interface design was easy to understand. However, they suggested (1) using a color other than purple for the 20-34 speed range; (2) removing the arrows indicating freeway ramps that have access in only one direction; (3) adding a flashing icon to indicate when traffic has stopped; (4) adding information about incidents, particularly about the type of incident, lanes affected, and anticipated length of delay; (5) adding traffic information about major arterials; (6) adding a mechanism that would allow commuters to check on the validity of their decisions after their commute; and (7) ensuring accuracy of displayed information.

Screen interactivity. The subjects felt that the screen was easy to interact with. However, many of the subjects were confused by the number of mouse actions; these subjects recommended deleting at least the mouse actions that require double clicking the mouse button.

Desired delivery method. In general, subjects indicated that their preference for delivery of traffic information would depend on where they are when they need the information. If they are at home or at work, subjects prefer delivery by computer because the *Traffic Reporter* screen provides instant visualization of the traffic situation, and the screen can be tailored to individual commutes. If they are already in their cars, subjects prefer delivery by radio because of the time lapse between seeing the screen before departing and actually entering the freeway.

Potential change in commuter behavior. Since the ultimate goal of *Traffic Reporter* is to influence commuter behavior, this issue was the most critical. Therefore, we were pleased by the subjects' reports that they would change some aspect of their commute when presented with up-to-the minute traffic information delivered by *Traffic Reporter*.

In keeping with our desire to design a screen that meets the needs and desires of users, whenever possible we will use these suggestions in future implementations of *Traffic Reporter*. Furthermore, as we continue to develop *Traffic Reporter*, we will continue usability testing on the system.

What Others Are Doing: *INFORM*, Long Island

INFORM is part of a New York State Department of Transportation project designed to improve traffic flow on Long Island. Like *Traffic Reporter*, the *INFORM* system aims to achieve that goal by delivering real-time traffic information that will help motorists make informed commuting decisions in their choice of departure time and travel route. Also, like *Traffic Reporter*, *INFORM* gathers data on traffic volume and speed from sensors imbedded in freeways. It then sends those data to a central location (Fig. 1) where the data are converted to up-to-the-minute traffic information. This information is then delivered via telephone lines to 74 variable message signs along the two major Long Island freeways. In addition, state police and local traffic agencies have access to *INFORM*.

Businesses and other public agencies can subscribe for $200 a year (plus the cost of dedicated phone lines and computers) to *INFORM* to receive speed information through the *Visual Traffic Information Project* (the latest phase in the *INFORM* system). For example, the Fortunoff Company, a large store on Long Island, installed a computer with graphical display in its lobby. The 1,350 employees and 7,000 customers who visit Fortunoff each day can check the display for traffic information before they leave the building. Eventually, employees will be able to call for traffic information before they leave their homes for work.

Fig. 1 *INFORM* display at the Traffic Management Center on Long Island

Correction

In the February issue of this newsletter, we misspelled the word *InfoBanq*. *Infobanq* ends with a "q," not with a "g."

About this Newsletter

This is the final issue of Volume 1 (1990-91) of *Commuter Information Systems*. This volume has consisted of six newsletters intended to update interested parties on research in commuter behavior and the interpretation and delivery of transportation data. Volume 2 (1991-92) will have two issues and will report on *Traffic Reporter*'s development in the next phase of this project. We anticipate the first issue will be ready by December 1991. Copies of this or previous issues may be obtained from the editor. Opinions expressed in this newsletter do not necessarily imply endorsement by the University of Washington or the Department of Transportation.

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