

**REDUCING VEHICLE TRIPS AND
VEHICLE MILES OF TRAVEL
THROUGH CUSTOMIZED TRAVEL OPTIONS**

**Final Report
Results of Survey and Conclusions**

Prepared for:

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Executive Summary

This project was designed to implement a new application to help reduce total vehicle trips and vehicle miles of travel by encouraging the use of trip-chaining and substitution for all types of trips. CUTR provided employees of a local YMCA with travel diaries and implemented a three-stage research design:

1. Collect baseline travel data
2. Provide experimental group with customized travel suggestions, while not providing this information to control group
3. Collect travel data after providing the suggestions

A total of 75 individuals in 39 households participated in the research. An analysis of covariance was conducted on the average contributed vehicle miles of travel and contributed vehicle trips, using the second week's results as the dependent variable. The provision of suggestions had a statistically significant effect on vehicle miles and trips contributed. Overall, this experiment showed that the provision of travel information will reduce vehicle miles of travel. Further research should be conducted to indicate the extent to which such information needs to be customized.

Background

Most efforts to mitigate the impact of traffic congestion have focused on commuter traffic. Commuter traffic generally contributes the largest share of trip purposes in the morning peak period (estimated at 53 percent) but only 28 percent of all trips. Lessons learned from encouraging commuters to shift their mode of travel, time of day, frequency, and route of travel should be applied to the non-commuter market. Focusing on noncommute trips may be particularly important in reducing vehicle miles of travel. Otherwise, the benefits of reducing vehicle use from commute-related changes may be negated by long distance noncommute trips.

The genesis of this project was a paper authored by Geoffrey Rose and Liz Ampt, entitled "Reducing Car Travel Through an 'Individual Action' Programme." In their experiment,

Rose and Ampt followed a procedure of measuring travel behavior, providing suggestions for travel changes based on the contents of diaries, and re-measuring travel activity following provision of suggestions. This procedure was essentially the same as was followed in the current project. The main difference was that the current project included a control group, the Rose & Ampt project did not.

Objectives

This project was designed to implement a new application to help reduce total vehicle trips and vehicle miles of travel by encouraging the use of trip-chaining and substitution for all types of trips. The aim was to encourage individuals to occasionally choose a mix of travel choices over time to satisfy their travel needs rather than only choose the single occupant vehicle. The analysis of the data was intended to determine whether the provision of the customized travel options caused a change in the number of vehicle trips or vehicle miles generated for the period under study.

In addition, the research was designed to:

- allow transit and TDM professionals to understand how to apply TDM concepts to noncommute trips to reduce vehicle miles of travel and vehicle trips.
- establish and implement a process for evaluating opportunities for reducing vehicle trips and vehicle miles of travel through customized travel options.
- provide an evaluation of the potential for automating the process (artificial intelligence, neural networks) and delivery mechanisms (surveys, Internet) for providing personalized transportation “audits.”
- provide material for integration into the TDM training courses offered by CUTR under contract to FDOT.

Review of Travel/Activity Diary Design

In the course of conducting this review, CUTR examined a number of project reports for travel studies, publications and conference summaries, and the content of Requests for Proposals related to travel studies. Of particular use was a recent NCHRP publication, “Methods for Household Travel Surveys” (NCHRP Synthesis 236).

The synthesis first reviews a number of related but not directly relevant survey approaches, including the decennial census, the Nationwide Personal Transportation Survey, the American Travel Survey, and various other methodologies such as intercepts and on-board surveys.

Typical travel surveys contain information about trips taken, including purpose, breakdown of stages, start and end times, number of passengers in the vehicle, costs involved (usually parking costs) and whether or not a household vehicle was used for the trip. On the demographic side, gender, age, labor force status, profession, work hours, status of driving privileges, education level, ethnic origin, and relationships of people in the household are recorded. For the household, information is collected regarding number of persons, income, number of vehicles, type of dwelling, length of tenure in household, prior residence, and number of workers in the home. Finally, the make, model, production year, and odometer readings for household vehicles are recorded. (NCHRP #236, p. 17)

Usually, a travel or activity survey takes the form of a diary. The synthesis notes that while the intention is that survey respondents will take the diary with them as they travel, it is “generally thought” that respondents do not do this – rather, they fill out the diary at the end of the day. There was no information cited for this position. (NCHRP #236, p. 19)

In the mid- to late 1980’s, travel diaries assumed a fairly standardized form. Typically the diary takes the form of a list, with columns arranged for trip start time, origin,

destination, arrival time, mode, and other related information as necessary (fare, parking cost, and so forth). The simplest form of this type of diary is demonstrated in the 1981 MTC survey conducted in the San Francisco area. A 1990 travel study did not show any significant changes to the survey form. Each form is personalized to ensure that the correct respondent data is merged with the travel data. Respondent data (age, occupation, gender, and so forth) is recorded on a separate form. (CTPS RFP Appendices)

The 1985 Kitsap County survey (as published by the Puget Sound Council of Governments) also used the list approach, but provided categories for trip purposes and a category termed “land use” to describe the destination. As noted in the write-up, the form is fairly easy to use but its initial impression is intimidating because of the large volume of pre-printed material. A subsequent form greatly simplified the approach, listing categories labeled “then where?” “why?”, “how?” driver or rider classification, number of passengers, and start and end times for the trip. The increased use of open-ended response categories makes for greater expense in coding responses, and may (contrary to the opinion expressed in the write-up) make the survey more difficult for the respondent since they are required to generate descriptions and trip purposes on their own rather than classify them. Also, data quality may suffer from this approach. (Puget Sound report, p. A-4)

Various enhancements to the form can be made to make the format somewhat more user-friendly. The 1988 Metropolitan Washington Council of Governments survey, as well as the Bay Area survey, provides category listings for mode use, trip purpose, and AM and PM designation. A 1988 survey conducted by the Delaware Valley Regional Planning Commission essentially duplicates this format. (CTPS RFP Appendices)

The CATS survey from 1988 uses a columnar format rather than a top-to-bottom list of trips. The user-friendliness of the form is enhanced by the use of more checkboxes rather than requiring the survey respondent to either write out an answer or look up a response number from a category list. This format requires a substantially larger form to record

the same number of trips, since only 3-4 trips can be recorded on a single side of paper. (CATS report Appendix B)

More recent advances in travel analysis base reporting and modeling on activities performed rather than on mere origin-destination patterns. While this project does not have a modeling focus, there may be some advantages in the area of improved reporting by adopting a more activity-based survey form design. The NCHRP synthesis on travel surveys (#236) documents this trend: “The trip diary is already largely being replaced by an activity diary, and it seems probable that the activity diary may be replaced in the future by a form of time-use diary...”(p.37) In an activity diary, activities are recorded and the travel to reach the site of those activities is recorded separately. In a time-use diary, travel is treated as another type of activity and a response where time was used for travel results in a number of questions being asked to specify the details of the travel undertaken. (NCHRP #236, pp. 21-22)

Many surveys utilize the concept of a “memory jogger”, which provides a quick, shorthand way of recording activities or travel. These notes are then used to complete the larger instrument. Experience has shown that the details recorded in the memory jogger do not always match the results recorded in the larger, more detailed instrument. Other studies showed that in some cases either the memory jogger or the instrument was filled out, but not both. Some experiments have shown that improved data quality results from the use of a more complete diary instrument as compared to a memory-jogger style of survey form. (NCHRP #236, pp. 22-23)

CUTR’s 1997 travel diary for telecommuting used a columnar-type form which was a more convenient size for the respondent (a 2 ½” • 7 ½” booklet). A single trip record was recorded on each page. Check-off categories were provided for each question (start and end points by category, trip purpose, mode) with the exception of time and distance. For a five or seven-day trip recording project, this booklet would probably have become rather bulky and inefficient, particularly since more exact descriptions of origins and destinations were required.

The current survey project had the following requirements in form design:

- Transportability – it was most desirable that the form be carried with respondents during the survey period. This assumes, however, that respondents actually will fill it out as the day goes by, which has been questioned by the NCHRP report.
- Understandability – some of the respondents might have 11th or 12th grade level education, so the form must be designed that is simple for them to understand and fill out.
- Information about exact location of origins and destinations – since the purpose was to provide information on potential alternatives, an exact description of time and place was required, as well as distance estimates.
- Mode choice information– for calculation of potential VMT and emission savings, and to ensure that suggested alternatives achieve the goal of trip & mileage reduction.

The final form was designed to address all of these issues. It consisted of a cover page and subsequent identical sheets, to record up to ten activities in any given day. An example of these sheets is provided as Appendix A.

Additional information was required in order to customize the diaries with home and work addresses. A form was developed to collect the information needed to prepare the diaries, including home and work (or school addresses), availability of alternatives (bus, bicycle, etc.) and so forth. The form that was used to collect this information is presented as Appendix B.

Sample Selection

The most logical and procedurally sound option would have been to recruit randomly from Tampa Bay area households via a Random-Digit-Dial approach. However, participation would probably have been very low based on the level of effort that would be required of the respondents, and expensive incentives would have had to be provided. The project budget had been designed with the idea of using an existing group that would not require large incentives to participate, so this option was not feasible. Additionally, timely diary pick-up would have been difficult or extremely expensive (i.e., requiring overnight postage for each respondent for each day they participated. See the section on Initial Data Collection for more details on this requirement.)

The original plan was to conduct this project in conjunction with the American Lung Associations “Airwise” project designed to educate 7th and 8th grade children on the benefits of environmentally friendly activities. Students would be recruited to complete the travel diaries as part of a class project. In addition, the other members of their households would have to keep the travel diaries for successful completion of the project.

Attempts to contact teachers of science classes for that age range of students were completely unsuccessful. An incentive was offered to each class to defray costs of supplies and other materials but no responses were received from any of the teachers. It was finally concluded that the educational curriculum was probably not flexible enough to include this activity.

The second group targeted to participate also came from within the school system. Instead of utilizing students, this approach targeted Parent Teacher Associations (PTA), Booster clubs and other support groups. Again, CUTR offered to make a \$500 cash incentive available to each group that was willing to participate. The hope was that these groups, typically focused on fundraising, would welcome an opportunity to receive funds for participating. In this particular instance, it became evident that these groups met too

infrequently to allow oversight and supervision, thus raising concerns about the amount and quality of information that could be collected.

A third group was pursued from within both the public and private school systems. This attempt focused on student service organizations. The hope was that these student service groups could participate in exchange for community service hours/credits in addition to a \$500 cash contribution to the organization. Although there was tentative interest from a number of the private school organizations, most would not be able to participate until the following school term, which in this case was too late into the project. The main obstacle in this particular instance was that the project would have to be reviewed and approved by an in-house committee at each of the schools. Even though these committees were expressing a willingness to approve the project, the current approved list of projects could not be added to or altered until the following school term.

The project team then reviewed other options for recruiting households that would be less expensive than recruiting from the general public. It was determined that the best option would be to contact either special interest groups whose interests would coincide with the objectives of the project (for example, environmental groups) or to contact groups that had fundraising needs. In return for their participation, CUTR would provide some form of remuneration.

The YMCA of Tampa Bay was contacted as a potential participant. The plan would be to have YMCA employees participate in the experiment. The YMCA has six locations in Tampa, which are spread out over a wide area. Furthermore, the employees visit their work locations virtually every day, so arranging for pick-up and drop-off of the travel diaries would be greatly simplified.

The YMCA did agree to participate in exchange for a fee of \$50 per household that completed the surveys.

Data Collection Plan

The plan was to:

1. collect initial data;
2. generate the travel diaries for a one-week recording period;
3. collect a week's worth travel diary data;
4. generate and deliver suggestions for changes in travel behavior;
5. collect a second week's worth of travel diary data; and,
6. measure change from first week's travel to second week's travel.

Initial Data Collection and First Week of Diaries

An initial YMCA employee meeting was held in which the procedures were reviewed and initial questionnaires were distributed. The respondents were randomly separated into "experimental" and "control" groups, with about 40 total households in each group. Customized diaries were prepared for each household. Only household members who had drivers' licenses were asked to participate in the experiment. Both from the standpoint of validity of responses from younger participants and because trip reduction measures are generally aimed at vehicle drivers, it was determined that this approach would be optimal.

The diaries were collected over a one-week period. Respondents were requested to turn the diaries in to their workplace each day. This was done to foster daily participation (rather than waiting until the last day of the survey period to fill out all the surveys) and to facilitate rapid processing of the travel diaries. The cooperation rate was about 50%. About 75% of the diaries that were turned in were collected by CUTR employees the day that the diaries were turned in. The remaining diaries were collected at the end of the week. These were then entered into a Microsoft Access database for use described in the next section.

Suggestion Generation

The team provided the “experimental” group of households with customized information about travel options (e.g., inform them about transit service for the trip or suggest the use of biking or walking for short trips). Experimental households were encouraged to mix the use of modes and link trips.

The “control” group of households were not given this customized information. The control group was used to measure changes in contributed vehicle miles of travel (VMT). Though statistical validity was desired, the primary purpose of this project was to test the concept of encouraging use of transit, ridesharing, biking, walking, and telecommuting for various trip purposes based on data collected at the individual level.

The suggestions were developed by implementing a query system in the relational database. These queries and the resulting suggestions were developed as follows:

Alternate location suggestions:

All trips that were over 10 miles long, were taken by one of the following modes:

- drive a vehicle
- passenger in a vehicle
- motorcycle
- taxi

were done for one of following purposes:

- shopping
- personal business
- eat out
- other

and did not include destinations of home, school or work were identified. The days with trips meeting these criteria were analyzed individually to see if the alternate location suggestion was logical.

Bicycle suggestions:

All trips that were more than 1 mile and less than 3 miles in length, taken by one of the following modes:

- drive a vehicle with no passengers
- passenger in a vehicle
- motorcycle
- taxi

and not taken for the purpose of picking up or dropping off someone, were identified. The days with trips meeting these criteria were analyzed individually to see if the bicycle suggestion was logical.

Walk suggestions:

All trips that were equal to or less than one mile in length, taken by one of the following modes:

- drive a vehicle
- passenger in a vehicle
- motorcycle
- taxi

and not taken for the purpose of picking up or dropping off someone, were identified. The days with trips meeting these criteria were analyzed individually to see if the walk suggestion was logical.

Eliminate trips through technology suggestions:

Survey respondents who had internet access were identified. Their shopping trips, taken by one of the following modes:

- drive a car
- motorcycle
- taxi

were identified. The days with these types of shopping trips and the destination locations were analyzed. If the shopping was done in a location where the items for sale could be purchased over the internet, then internet shopping was suggested.

Transit suggestions:

The household locations and the individuals' primary work or school locations were plotted on a map. These locations were compared with direct bus routes and park 'n ride locations. Individuals with bus service less than six blocks from home and primary work or school locations or park 'n ride service less than 2 miles from home were identified. A query was implemented to identify all days when these individuals went directly from home to work, then directly back home again, using one of these modes:

- drive a car
- passenger in a car
- motorcycle
- taxi

If, at least once during the week, they showed the above travel pattern and met the above criteria, the transit suggestion was given.

Trip chaining suggestions:

Days were identified for individuals who went to "home" at least three times or to any other location at least two times. These days were analyzed, paying particular attention to the modes taken, to identify whether the individual could have combined some of these trips into one long outing rather than multiple short outings.

Combine trips outside the household suggestions:

A query was implemented to compare individuals' home zip codes and work locations. If two individuals had the same zip code, the same work location, and their homes were less than 1.5 miles apart, their daily travel patterns were analyzed together, paying particular attention to their work hours, usual mode taken, and usual stops on the way to or from work to determine whether they could reasonably carpool to work.

Combine trips within the household suggestions:

Households with members traveling to the same non-home, non-work location more than once on a single day, using one of the following modes:

- drive a car
- motorcycle
- taxi

were identified. All trips on that particular day, taken by each household member were analyzed to see if it was logical to suggest that they could have traveled to that location together, rather than traveling separately.

Combine trips across days suggestion:

Individuals traveling to duplicate non-home, non-work locations on separate days for the purpose of shopping or personal business were identified. All of the individuals' trips on those days were analyzed to identify whether it was logical to suggest that they could have gone to that location only once.

Suggestion Format

As each experimental group survey respondent was identified for a certain type of suggestion, a specific suggestion was drafted. Most suggestions included the date and location of the trip, the mode used, and a suggestion on how travel behavior could be changed to reduce vehicle miles traveled and/or vehicle trips taken. For recurring suggestions, such as those regarding the mode taken to work, the date was omitted. The completed travel diaries were returned to the experimental group participants, enabling them to refer back to their travel behaviors on the day in which the suggestion was made.

TRIP REDUCTION SUGGESTIONS

Your previous travel diaries have been analyzed and some suggestions have been generated to help you reduce the number of trips you make and/or the number of miles you drive. This would help cut down on the wear and tear on your vehicle and be good for the environment as well.

For your convenience, your previous activity diaries are enclosed in a separate envelope. You may want to refer to them as you review the trip reduction suggestions we've provided.

Trip reduction suggestions for:

Participant's Name

On 1/22/99 you drove from work to Alafia Elementary school to home to Wal Mart to home again. Perhaps you could have stopped at Wal Mart on the way home rather than making a special trip.

On 1/23/99, both you and your husband drove to Kash 'n' Karry at separate times. Perhaps you could have combined these trips.

On 1/24/99, you drove to Wal Mart, which is only about 1 mile from your home. If you are not purchasing too much to carry, perhaps you could walk rather than drive.

On 1/24/99 you drove to both Wal Mart and Target in separate trips. Perhaps you could have combined these trips into one outing.

Figure 1: Trip Reduction Suggestions

A review of the suggestions indicated that over 80 percent of the suggestions generated had to do with reduction in non-work-commute travel. The size of the sample did not allow for a thorough analysis of the source of trip reductions, however.

Included with the individual suggestions for each experimental group participant was the following list of commute alternatives and some of the benefits of reducing trips and miles traveled, drawn from direct mail materials developed by Bay Area Commuter Services of Tampa, Florida, and a new employee packet, also developed by Bay Area Commuter Services.

COMMUTE ALTERNATIVES

Are you tired of sitting in traffic, spending too much money on gas, car repairs and insurance? Cut your commuting costs in half. Reduce pollution. Decrease traffic congestion and enjoy a stress-free ride...consider a commute alternative.

CARPOOL

Sign up for a rideshare program and receive a personalized list of people who live and work near you. We'll give you tips on how to form a carpool and then its up to you.

VANPOOL

If your commute is lengthy...vanpooling may be the way for you. A vanpool is a group of 8 - 15 people sharing the ride to work. We'll provide you with a list of potential vanpoolers and even help you get started. Vanpoolers pay a low monthly fee. The driver rides free and also gets personal use of the van.

BUS

Riding the bus is a great alternative to riding alone. Call HARTline (254-4278) in Hillsborough County or PSTA (530-9911) in Pinellas County for route and schedule information. Their rates are affordable and you can sit back and relax.

BICYCLE

Florida has great weather year 'round so why not enjoy the great outdoors on your way to work. The expense of bicycling is nothing compared to driving alone. For those days of unexpected rain, you can load your bike on a bus and get home with HARTline's **BIKES ON BUSES** program. Many buses have racks so that your bike can accompany you or, take advantage of the bike lockers and racks located at many of the PSTA bus stops.

WALK

If you live close to work, why not walk? Sometimes it takes less time to walk to work than it does to drive and it's great exercise.

TELECOMMUTE

How would you like to go to work and not even leave your house? Try telecommuting. This modern commute alternative is catching on and there are many benefits and cost savings. In many cases the equipment to facilitate this alternative is a minimal investment.

ALTERNATIVE WORK SCHEDULES

4-DAY WORK WEEK

Would you like to work four days a week every week? Many companies and employees are favorable to four day work weeks. This alternative will cut fuel consumption and traffic by as much as 20%.

FLEXIBLE HOURS

This alternative allows you the option of varying the time you begin and end work. Make work fit your individual time and commuting schedule. This allows you to avoid rush hour traffic and the associated stress!

Figure 2: Commute Alternatives Suggestions – Bay Area Commuter Services

CUT THE COST OF COMMUTING!

Riding alone to and from work everyday can be pretty boring and expensive.

The cost of gas and, in some cases,



parking can eat at your paycheck. Why not save your money for more important things by carpooling, vanpooling, biking, riding the bus or walking to work? Say, for example, that you spend about \$20 per week on gas for your car. If you carpool regularly with just one other person you will spend half of what you used to on gas. Ride with three other people and you'll buy one quarter of the gas you used to! Imagine spending



\$5 or \$10 a week on gas instead of \$20 or \$30. You not only save on gas, you'll put fewer miles on your car and limit wear and tear.

REDUCE POLLUTION!

Here's a hair raising fact:

If you drive 10,000 miles in your car this year, you'll be pumping about 350 pounds of pollution into the air.



You may not be able to see it, but every time you breathe in you can feel it. Ridesharing can make a big difference, whether you do it every day or once a week. So be cool! Do the "environmentally correct" thing by improving the quality of the air we all breathe... share a ride!



Figure 3: Benefits of Alternative Commutes – Bay Area Commuter Services

These suggestions were only provided to those household that had completed a full week or very close to a full week of travel diaries. This reduced the useable sample to about 50 households. New diaries were prepared for these households and delivered together with the suggestions at the second YMCA employee meeting. At that meeting employees were requested to complete the second set of diaries.

Second week of Travel diaries

A total of 39 households that had completed the initial diaries also completed the second set of diaries. As previously, these diaries were collected at the YMCA locations and picked up at the end of the second week by CUTR employees. The second set of data was key-entered into the database to provide comparative data to that collected from the first week of diaries.

Results

Once the travel diary data was entered into the database, a query was implemented to sum the miles traveled and the trips taken per mode, per individual for both the first and second set of diaries. The modes included:

- Drive alone
- Drive with every combination of numbers of household members and non-household members
- Passenger with every combination of numbers of household members and non-household members
- Motorcycle
- City Bus
- Campus Bus/Shuttle
- Taxi
- Bicycle
- Other

These totals were then divided by the number of completed diaries during each week. This was done to adjust for situations where not all respondents filled out diaries every day of either week. The difference in the weighted miles traveled and trips taken between the first week and the second week was then calculated.

The original intent of this project was to provide quantitative proof that the provision of customized travel suggestions did impact vehicle trips and miles of travel. Due to lower than anticipated participation rates, this objective was not fully met, but the experiment did show statistically significant effects in several areas.

A total of 75 individuals in 39 households, drawn from the employees of the YMCA as described earlier, were recruited and participated in this project. Travel diaries were filled out in two non-consecutive, one-week periods, and suggestions for reductions in trips made were provided to forty individuals in twenty-one of the households (the “experimental” group). The other thirty-five individuals in eighteen households (the “control” group) did not receive any suggestions for reducing trips.

The results represent contributed vehicle miles of travel and vehicle trips before and after application of the treatment (i.e., provision of the suggestion). Contributed vehicle miles and vehicle trips are calculated by dividing the trips and/or miles by the number of passengers in the vehicle. For use of non-Privately-Operated-Vehicle (POV) modes, vehicle miles and vehicle trips were calculated as zero. The measure essentially describes the portion of the vehicle trip generated by the individual. Thus a person in a 4-person carpool is seen as contributing only $\frac{1}{2}$ as many trips as a person in a 2-person carpool, and $\frac{1}{4}$ as many trips as an SOV operator.

Descriptive Statistics

Descriptive statistics of the results are summarized in the table on the next page. There were some marked changes from the first period to the second and examination of the table shows that the experimental group appeared to have a higher rate of trip making in the initial period (5.53 trips per day versus 4.30), which resulted in higher contributed vehicle trips per day (4.53 to 3.14).

Descriptive Statistics of Project Results

<u>Statistic</u>	Total (N=75)		Control (N=35)		Experimental (N=40)	
	<u>Mean</u>	<u>Std. Dev.</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Mean</u>	<u>Std. Dev.</u>
Average miles per day – period 1	37.6	24.3	36.2	23.5	38.8	25.2
Average miles per day – period 2	50.5	93.7	45.4	55.6	54.9	118.0
Average trips per day – period 1	4.95	1.77	4.30	1.52	5.53	1.78
Average trips per day – period 2	4.28	1.53	4.14	1.51	4.40	1.55
Average vehicle miles contributed per day – period 1	27.2	19.7	26.2	17.5	28.2	21.6
Average vehicle miles contributed per day – period 2	29.6	23.1	29.9	20.5	29.4	25.4
Average vehicle trips contributed per day – period 1	3.88	1.58	3.14	1.46	4.53	1.40
Average vehicle trips contributed per day – period 2	3.31	1.32	3.20	1.44	3.40	1.21

Table 1. Descriptive Statistics of Project Results

Due to large differences between the groups on initial measures, particularly in the area of contributed vehicle trips, the results are best analyzed using an analysis of covariance to predict vehicle miles of travel (or vehicle trips) in the second period from the first, including a term for membership in the group which received the suggestions. An analysis limited to testing differences in mean changes might lead to erroneous conclusions as described in Lord (pp.37-9). Briefly, Lord explains, this occurs because “the analysis of observed gains results in a built-in bias in favor of whatever treatments

happen to be assigned to initially low-scoring groups.” This can be a significant issue when group sizes are small, as was the case in this experiment.

Analysis of Covariance: Contributed Vehicle Miles of Travel

In the course of the analysis five observations were found to be unduly influential in the regression and were removed. This analysis was done through the process of calculating and examining the deleted studentized residuals, where essentially the effect that the observation has on the resulting regression equation is calculated by removing it and re-estimating the equation. A value of 3 was used as a cutoff, although commonly values as low as 2 are used for this decision rule. A summary of the observations deleted is presented below:

Description of Observations Deleted from Contributed VMT Regression

<u>Group</u>	<u>Daily Vehicle Miles contributed</u>	
	<u>Period 1</u>	<u>Period 2</u>
Experimental	27.9	110.8
Control	52.5	13.2
Control	67.8	40.9
Control	32.9	72.9
Control	38.9	71.4

Table 2. Description of Observations Deleted from Contributed VMT Regression

The descriptive statistics for the remaining households are presented in Table 3 below:

Descriptive Statistics of Project Results – Five Observations Deleted

<u>Statistic</u>	Total (N=70)		Control (N=31)		Experimental (N=39)	
	<u>Mean</u>	<u>Std. Dev.</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Mean</u>	<u>Std. Dev.</u>
Average miles per day – period 1	36.2	23.3	32.5	20.1	39.1	25.5
Average miles per day – period 2	49.2	96.6	43.8	58.6	53.4	119.1
Average trips per day – period 1	4.99	1.80	4.30	1.57	5.54	1.80
Average trips per day – period 2	4.31	1.54	4.20	1.53	4.39	1.56
Average vehicle miles contributed per day – period 1	26.0	19.4	23.4	15.9	28.2	21.8
Average vehicle miles contributed per day – period 2	27.3	20.3	27.3	18.4	27.3	22.0
Average vehicle trips contributed per day – period 1	3.90	1.60	3.11	1.48	4.54	1.41
Average vehicle trips contributed per day – period 2	3.33	1.31	3.26	1.42	3.38	1.23

Table 3. Descriptive Statistics of Project Results – Five Observations Deleted

The analysis of covariance using second-period vehicle miles of travel as the dependent variable was done using as predictors contributed vehicle miles in the initial period, as well as a term for control/experimental group membership and interactions between that term and the covariate.

The F test for the significance of the interaction had a value of 0.83, which is not significant at 2 and 67 degrees of freedom.

The analysis continued without the interaction term and obtained the following results:

Regression of Contributed Vehicle Miles of Travel in second period

<u>Parameter</u>	<u>Standardized estimate</u>	<u>Standard Error</u>	<u>T value</u>
Intercept	0.0	1.53	0
Vehicle Miles Contributed Period 1	0.94	0.05	20.5
Experimental Group Term	-2.36	0.93	-2.54

N=70 R-squared = .858

Table 4. Regression of Contribution of Vehicle Miles of Travel in second period

When the deleted observations are included, particularly the observation where the experimental group member increased their travel by 82 miles per day, the significance of the group term disappears ($t=-.67, p > .50$). However, this is clearly an outlying observation. The deletion of the that single observation results in a t value of $-1.7, p < .10$. The deletion of the four other observations from the control group observations does not substantially change the value of the group term coefficient, but does reduce the variability of the parameter estimate. The t value for the provision of suggestions coefficient to the group of 70 observations is significant at $p<.01$, indicating that the suggestions did have significant impact on vehicle miles of travel. This means that households in the experimental group (i.e., those that were provided with suggestions) did in fact contribute less vehicle miles after being provided suggestions than did the group which did not receive the suggestions.

Analysis of Covariance: Contributed Vehicle Trips

The same analysis was conducted using vehicle trips taken in the second period as the dependent variable. In this case no observations were found to be overly influential. The F test for the interactions had a value of 1.51, which is not significant at 2 and 71 degrees of freedom.

The analysis continued without the interaction terms and obtained the following results:

Regression of Contributed Vehicle Trips in second period

<u>Parameter</u>	<u>Standardized estimate</u>	<u>Standard Error</u>	<u>T value</u>
Intercept	0.0	0.28	0.0
Vehicle Trips Contributed Period 1	0.72	0.07	10.40
Experimental Group Term	-0.40	0.11	-3.68

N=75 R-squared = .592

Table 5. Regression of Vehicle Trips in second period

The tests for significance of the treatment (providing customized suggestions) were conclusive for reduction in contributed vehicle miles of travel and contributed vehicle trips.

In order to more fully test the efficacy of the program, and particularly to more closely estimate the actual parameter value for the purposes of estimating cost-effectiveness, it will be necessary to budget for a larger sample size and to make data entry more automated to ensure ability to respond with rapid, timely suggestions.

A Related Experiment by Tertoolen, et al

In an experiment related to the current project, Tertoolen, van Kreveld and Verstraten provided varying levels of information to different groups of commuters, including a control group. In the experiment, 350 drivers in the Gouda, Netherlands area were chosen at random for participation. Respondents were assigned to one of four conditions – control, receiving information about environmental impacts of car use, receiving information about financial impacts of car use, receiving both types of information and receiving neither. Each of these groups was asked to record their travel over an eight week period. A control group was also established where no monitoring of travel was done.

On a pre-test questionnaire, the subjects responded to a question about whether they would be prepared to reduce their mileage for a period of eight weeks. The response to this question was used as a controlling factor in subsequent analyses.

In general, the findings were that mileage was lowest in the initial two-week period following the pre-test questionnaire. Mileage in subsequent periods was consistently higher.

The analysis makes several questionable points. First, there is a clear within-subjects difference between period 1 mileage and subsequent periods. This is attributed to “seasonal differences.” A preferred experimental design would not have asked respondents about reducing car use immediately prior to baseline measurements, since that suggestion may have influenced initial travel choices.

Next, the following result can be obtained through transformation of the data reported in the experiment:

<u>Condition</u>	<u>Mileage in Period 2</u> - mileage in Period 1	<u>Mileage in Period 3</u> - mileage in Period 1	<u>Mileage in Period 4</u> - mileage in Period 1
E	45	36	42
C	50	26	60
EC	12	18	-14
N	63	73	68

Table 6: Transformation of results from Tertoolen, et al, article

E = environmental information provided, C = cost information provided,

EC = environmental and cost information provided, N = no information provided

This data is interpreted by the authors as showing that the distribution of information had *no effect* on respondents. We disagree with this analysis. As noted earlier, analysis of mean changes can be misleading. However, it seems highly unlikely that this would be the case. Re-analysis of the authors' data may provide different conclusions than those reached in the publication. It certainly seems as if the information distribution caused some reduction in the differences between Period 1 (the "baseline" period) and subsequent periods.

Our conclusion is that this experiment in all likelihood replicates the findings of our own experiment in that travel suggestions appeared to caused some change in behavior in the desired direction (i.e. reduction of vehicle miles of travel) compared to a group of commuters that were not provided with the travel suggestions.

Qualitative follow-up with survey respondents

Following the completion of the project, a “debriefing” meeting was held with twelve (12) of the staff participants. The meeting was structured to provide responses in the specific areas of general emotional response to the project (loved it, hated it, etc.), positives and negatives about the project, and suggestions for improvements. A discussion guide is included as Appendix C.

The following items represent comments made by those attending the meeting and reflect their thoughts, comments and ideas about the project and their households’ experiences while participating. General comments about the project included:

- Knowing the purpose of the study up front may have encouraged better participation. CUTR purposely did not provide this information to avoid having that information affect respondent behaviors.
- Collection of diaries only once or twice during the week might have resulted in employees who forgot to return diaries not quitting or dropping out.
- It was difficult to convince family members to participate, and, in most cases, the staff member had to serve as a recorder for the household.
- Many participants found it easier to fill out the diary all at once at the end of the day rather than throughout the day during each trip.
- Alternating starting dates would have made it easier for more part-time and traveling participants to complete a full set of diaries (i.e. seven days of consecutive collection over a 10-14 day period).
- A website capable of receiving diary information might have been easier to use than a written instrument.

Comments related specifically to the diary instrument or the use of it included:

- There was no way to indicate out-of-town travel.
- There was confusion over how to record travel between adjacent facilities. Did .1 or .2 miles constitute just one destination or separate destinations?

- Some participants ran out of entry pages.
 - Make the diary sturdier i.e. use a heavier stock paper for the backing.
 - Have more destinations available for check-off in the second set of diaries.
- Other comments related to the actual procedure included:
- Some of the suggestions seemed odd and did not take into account specific circumstances such as neighborhood travel conditions, time of day, etc.
 - A disclaimer before suggestions might indicate that “suggestions do not take into account individual and family circumstances that were affecting the situation.”
 - Some suggestions seemed too personal.
 - Individual/household incentives were nice, but did not necessarily influence participation.
 - Some participants expressed initial concern over safety and privacy. Completing diaries for such a long, set period of time was perceived as possibly making it too easy to determine patterns of the households.
 - Most participants stayed involved due to loyalty to YMCA and because of the established relationship between some CUTR staff members and the YMCA organization.
 - Participants felt that similar projects could be done on a broader regional scale if a good relationship and trust are established with the participating entity (such as home- owners association, civic club, etc.).

Clearly one of the resounding sentiments from the group was that targeting groups wherein members had a high affinity for one another would be most likely to lead to the successful implementation of a similar project.

Some of the positive results that participants reported as a direct result of participating in the project included:

- Participation helped them realize exactly how many miles they actually drive. Some quotes were: “Now I can honestly report to my insurance carrier how much I actually drive,” “I am really glad that gas is cheap,” “I realized that I had just

driven 10.2 miles, one way, for lunch,” “It really made us think about our travel patterns as a family.”

- Discussing the project became a regular family event each night and brought the family together around the table for more than just eating. It created family time together.
- One participant shared that their household had three vehicles, one for each licensed driver. Prior to participating in the project, each of the drivers took their own vehicle to the same church, at the same time, three or four times a week. During the study they followed the suggestion to all share a ride in one vehicle. Following that experience they have been riding together on a regular basis and have committed to doing so for the long term.

Implications for Future Research

There is the first research conducted that demonstrates a statistically significant difference between the travel behavior of people who receive travel reduction suggestions and those who do not receive such suggestions. However, it has yet to be determined if the provision of “generic” suggestions (such as “share a ride”, “ride the bus,” etc.) has less impact on travel patterns than provision of customized suggestions based on household or individual travel behavior.

Efficient methods of collecting such data and providing travel suggestions have not been developed. This will be necessary before a large-scale implementation of this procedure can be attempted. The success of the relational database and query system in providing the suggestions is, however, very encouraging in this regard.

As the use of GPS-based locational systems increases and the prices and sizes of units designed to tap into GPS systems falls, the possibility of using such devices to record travel patterns is becoming a reality. This would enable time and location to be recorded without any effort on the part of the respondent. Travel mode, however, would still have to be recorded. This might be possible with the touch of a single button, indicating mode

and perhaps number of passengers. However, a more automated system would be preferable.

On the whole, the provision of travel suggestions achieved the desired result, namely, the reduction of vehicle miles of travel among those who received the suggestions compared to those who did not. The results for the impact on vehicle trips were directional, and sample size was not sufficient to allow for the conclusion that this result would be replicable in the general population. However, results are very encouraging.

It is possible that a GPS-based system, in conjunction with or in addition to an Internet-based system of recording travel modes and providing feedback, would be implementable on a much larger scale. CUTR recommends that thorough testing of such a system be completed on a sample large enough to allow for statistical validity and for projections to larger populations. The current study provides reasonable confidence that a system of this nature would produce positive results. It is impossible to say at the present time whether the system would produce enough reduction in travel to merit the cost of implementation. Further research of the type described above is needed in order to draw that conclusion.

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Appendix A: Activity/Travel Diary Design

Appendix B: Activity/Travel Diary Instructions

Appendix C: Initial Data Questionnaire

Appendix D: Discussion Group Guide