Mobility Enterprise: One Year Later

MICHAEL J. DOHERTY AND F.T. SPARROW

A mobility enterprise is a new transportation concept aimed at increasing the productivity of the automobile through use of mini or micro automobiles in conjunction with a shared fleet of intermediate and full-sized vehicles. The main objective of the enterprise is to provide a better matching of vehicle attributes to trip requirements and still maintain the personal freedom that appears to be so highly valued by the American driver. Although this concept was presented in detail in an earlier TRB Record (TRR 882), a view of the progress that has been made in taking the mobility enterprise from an innovative concept to an actual experiment is presented in this paper. The majority of the information deals with methods for observing consumer attitudes, designing the actual mobility enterprise, and measuring mini and micro automobile performance.

In January 1982 the Automotive Transportation Center at Purdue University unveiled an innovative transportation concept called the mobility enterprise (1). Briefly stated, the research examined the effects of mini and micro class automobiles and shared-vehicle fleets on the overall productivity of the personal automobile. This paper is designed to provide an update of the progress made during the last year and to discuss the experimental design and preliminary findings.

After years of promoting public transit and carpooling to conserve energy, it appears that the average consumer still prefers the convenience of the personal automobile. At the same time, although automobile efficiency (fuel economy) has undergone significant improvement, automobile productivity has remained disturbingly low (2,3). The concept presented here for improving productivity is based on a better matching of the trip requirements of an individual to the characteristics of the vehicle. Three interrelated features of a mobility enterprise--retained autonomy, easy access to an expanded fleet, and reduced expenditures--are the inferred keys to its success. An enterprise member's minimum attribute vehicle (a mini or micro automobile in these experiments) provides him, by definition, with the most economical means of accomplishing his most frequent trips. When a member's mini or micro automobile is inappropriate for a desired trip, he must seek access to an appropriate vehicle from the shared fleet. This process may involve delays, some advanced planning, paperwork, and out-of-pocket costs, depending on the procedures of the enterprise. A general description of the mobility enterprise that has been set up at Purdue University is as follows.

1. The following items are included in a set monthly fee: (a) an individually garaged mini or micro class vehicle that will satisfy most commuting and around-town driving, (b) access to a shared fleet of intermediate and full-sized vehicles for trips that the mini or micro vehicle would be unsuitable, (c) all insurance costs, (d) all maintenance costs, (e) all registration and licensing costs, and (f) taxes.
2. Gasoline costs are not covered in the monthly fee.
3. Cost per participating household for experiments is $165 per month.

The concept of a mobility enterprise requires careful examination of several behavioral parameters of the American as a driver. Judging from the underutilization of public transit systems and ridesharing programs, it appears that personal freedom and independence are highly valued attributes. If it is imperative that this independence be preserved, a key step in the design of proposed experiments must be an inventory of the current patterns of the U.S. driver and the use of his personal vehicle. The shape of the enterprise must come as close as possible to satisfying travel demands, with as little inconvenience as possible. However, because there may be some inconvenience (changes in travel behavior), it is important to gauge the value drivers place on the quality of travel provided by the shared fleet available through the enterprise. In other words, what would be the trade-offs between the current condition of automobile ownership and participation in a mobility enterprise?

Two key tools that have been used to acquire data pertaining to consumer acceptance and current travel behavior are the focus-group interview and a survey instrument (questionnaire). In addition to consumer and travel-behavior studies, a microprocessor-based data acquisition system, under development at Purdue University, will measure the stress on these small automotive engines when subjected to real-world missions. Such a system is necessary to determine the feasibility of using mini or micro automobiles for personal transportation in the United States.

FOCUS-GROUP INTERVIEWS

Focus-group interviews are predicated on the assumption that the mobility enterprise will be better understood and more efficiently designed when there are more data on how potential users, supporters, and detractors define its advantages and disadvantages and its significant and modifiable attributes (4). The content of each interview was analyzed for recurring themes. The attributes that account for decisions to join or not join the enterprise were schematized, and questions measuring the character and quality of these attributes were developed for the larger general survey instrument.

Focus-group interviews began in West Lafayette, Indiana, in March 1982. The length of the focus-group interviews varied from 1 to 1.5 hr. There were seven focus groups: one group of Purdue University faculty and staff, one group of Purdue University faculty and staff couples, one group of Purdue University faculty and staff as new car intenders (intention to buy a new car within 2 months), two groups of college students, and two groups of teenagers (one consisting of all male and one consisting of all female). A total of 62 individuals participated.

Data from the focus-group interviews were analyzed for issues raised, opinions expressed, and experiences reported and were then examined for recurrent significant themes. The focus-group interviews and subsequent analyses were based on the assumption that the study of consumer attitudes and interaction and the emphasis on analysis of themes should provide insight into the consumer decision-making process of automobile ownership, mini and micro vehicles, and the mobility enterprise (5,6). This in turn should improve the capability for planning and developing the mobility enterprise. The focus group interviews were divided into four content areas: (a) vehicle ownership and use, (b) the expense of owning and operating cars, (c) the mini or micro automobile, and (d) the mobility enterprise. The major findings in each of these content areas were as follows.

1. Vehicle ownership: Increasing costs are creating compromises concerning style; i.e., when purchasing a vehicle, people are settling for less car than they originally had planned to buy. Also, there was an overwhelming attitude that automobiles are synonomous with personal mobility and freedom.

2. Vehicle expenses associated with vehicle ownership: All groups knew that owning a car was expensive, but when probed they were relatively unaware of the actual cost. There was a strong belief that ownership costs would not get too high. Virtually all groups believed that some technological breakthrough would occur to keep automobiles affordable.

3. Mini and micro automobiles: Price (quoted as between $3,000 and $4,000) makes these cars attractive as a second car. Also, safety was dismissed as a realistic issue because the participants generally perceived drivers to be more important than automobiles with respect to safety.

4. Mobility enterprise: Generally, the shared-fleet concept was not well received, as most groups believed it was an infringement on their freedom of mobility; thus they tended to dwell on the negative aspects of sharing. But, continuous maintenance was almost universally viewed as the major point in favor of the mobility enterprise. Finally, the ability of membership for a trial period of time was seen as crucial.

Because this study uses a small population and is not truly representative, and because the findings are qualitative and subject to biases, the study should be viewed as exploratory in nature, thus making generalizations difficult. Nevertheless, it is anticipated that the validity of issues raised will be considerably strengthened as the hypotheses derived from the focus-group interviews are further explored by forthcoming surveys. Such has already been the case in two other papers (7,8).

SURVEY INSTRUMENT

The local survey was intended to help gather data pertaining to the acceptability of the mobility enterprise concept to a representative sample of households in the area where the first experiments were to be run. It also acted as a tool to compile an inventory of current vehicle use patterns in the sample area.

The Social Research Institute of Purdue University conducted the local survey. The sample size was 300 households. Tippecanoe County is a designated standard metropolitan statistical area (SMSA), and 80 percent of the sample was drawn from the urbanized area and 20 percent from the nonurbanized area. Within the urbanized area, four strata were selected based on socioeconomic status (SES): high, medium, low, plus a fourth category containing small blocks (four dwelling units or fewer). Three strata were selected from the nonurbanized area based on SES (high, medium, and low). The survey instrument was administered by personal interviews of 30 to 45 min each. Two additional subgroups of 30 households each were interviewed, which represented retirement communities and condominiums. General demographic information that characterize the sample population is given in Table 1. The attitudes of the respondents toward the mobility enterprise as a transportation mode are given in Table 2.

When the sample is broken down into two subgroups, one consisting of those interested in joining and the other consisting of those not interested (only two respondents were undecided), several intriguing differences with respect to age, automobile purchasing intentions, and the acceptability of small cars for everyday use are noted (see Table 3). In general, those interested in joining a mobility enterprise are younger, closer to making car purchase decisions, and find small cars more acceptable than those not interested in joining. Two other significant observations are that (a) no retirees were interested in joining, and (b) those who were interested in joining believed they would need to use a shared vehicle, on average, approximately 45 percent more often than those who were not interested (67 days per year versus 46 days per year).

The results presented here are merely preliminary findings. A more detailed report analyzing the local survey will be forthcoming. In addition, a national survey about the mobility enterprise con-

Table 1. General demographics of transportation survey.

Item	No. of Respondents
Total	360
Male	173
Female	187
Age (years)	
18-25	79
26-40	124
41-60	73
>61	83
Highest level of education	
Less than 12th grade	46
High school education	123
Some postsecondary	86
Four or more years postsecondary	102
Household income	
<$5,000	38
$5,000-$14,999	80
$15,000-$24,999	93
$25,000-$34,999	74
>$35,000	62

Table 2. Preliminary survey results from questionnaire.

Question	Positive Response (%)
Do you think the mobility enterprise is practical?	65.3
Do you think the mobility enterprise is complicated?	20.3
Would the mobility enterprise work for your household?	23.9
Would it be important to see others join the mobility enterprise before you would?	50.3
Would you be interested in joining the mobility enterprise?	14.3
Would you be willing to join the mobility enterprise for a trial period?	24.4
For your household, would owning your own car be better than being a member of the mobility enterprise?	88.3

Note: 360 respondents were asked these questions.

Table 3. Preliminary survey results.

Item	Willing to Join a Mobility Enterprise?	
	Yes (n = 51)	No (n = 309)
Mean age of respondent	31.6	44.6
Planning to purchase a vehicle within the next year (%)	37.2	11.0
Planning to purchase a used car within the next year (%)	62.8	30.7
A mini or micro automobile is acceptable as a vehicle for everyday use (%)	76.5	63.1
A subcompact is acceptable as a vehicle for everyday use (%)	96.1	72.5
It would be acceptable sharing a car with several other people (%)	88.2	63.6

cept will be conducted by J.D. Power & Associates of West Lake Village, California.

TRIP DIARIES

Although focus-group interviews and transportation surveys are helpful in identifying the inclination toward acceptance of a mobility enterprise concept and some of its critical attributes, another more direct measure of acceptance based on actual behavior was also needed. For this reason, the collection of trip diaries from potential experimental subjects began in August 1982. Thus nearly 6 months of actual travel behavior was collected before the initial experiments.

Because participation in the mobility enterprise involves changes in vehicle use, it is important to know whether the enterprise fits into the current travel behavior of the participants. Because the travel patterns of the participants both as a group and as a household are known up to this point, this data should prove to be extremely valuable. Significant changes in travel patterns caused by the accommodation of the operating system and restrictions of the mobility enterprise are detected with these data. A meaningful control group of trip diary participants who will not be enterprise members is being maintained for the duration of the experiments.

Trip diary results to date have revealed a remarkable degree of consistency for the test population from week to week. A summary of trip types and mileage for the first 12 weeks of the study is given in Table 4. The trip occupancy pattern for the population for the first 12 weeks is given in Table 5.

Table 4. Pretest trip diary results of trip type and mileage.

Trip Type	Trips per Week	Mean Mileage per Trip (one way)
Shopping (grocery and nongrocery)	2.66	4.97
Commuting (work or school)	5.19	7.64
Social-recreation	3.49	14.65
Personal business (errands, passenger ferry, and so on)	5.75	5.14
Return home	9.05	9.24

Note: 65.36 percent were multipurpose trips. Results cover a 12-week period.

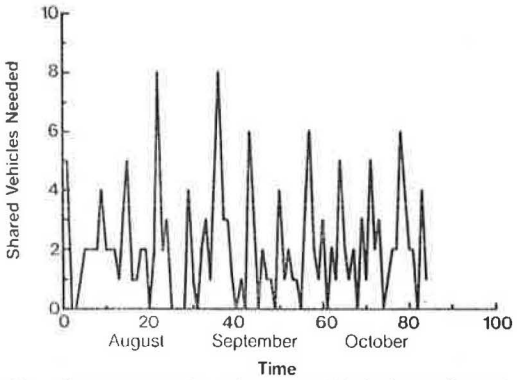
Table 5. Pretest trip diary results of trip occupancy.

Trip Type	Occupancy per Trip (%) by No. of Occupants	
	<2	>3
Shopping (grocery and nongrocery)	89.7	10.3
Commuting (work or school)	99.0	1.0
Social-recreation	79.1	20.9
Personal business (errands, passenger ferry, and so on)	91.2	8.8
All trips	91.1	8.9

Note: Results cover a 12-week period.

A final purpose for which the trip diary data may be useful is in the design of the shared fleet. One of the most critical design characteristics of a mobility enterprise is the size of the shared fleet for a given size of enterprise. How many cars would be too many? How many would be too few? For the purposes of the experiments currently being conducted, assume that a shared vehicle is required for a trip greater than 30 miles (one way) or transporting four or more occupants. By using these criteria, the expected use of shared vehicles for the first 12 weeks of the study is shown in Figure 1. Extrapolation of these data for a 20-member enterprise, run under the restrictions assumed here, appears to indicate that the enterprise is most efficient if it owns two vehicles in its shared fleet and uses an outside vendor for those times when additional vehicles would be needed. However, these questions must be more thoroughly examined during the actual experiment.

Figure 1. Hypothetical shared-fleet use.



Note: Data give expected need for shared vehicle for first 12 weeks of trip diary studies. These data are based on trip diary results from that time period for a hypothetical enterprise of 24 member households.

TECHNICAL DATA ACQUISITION SYSTEM

All mini and micro vehicles in the experiment are to be equipped with a data acquisition system (DAS) to collect information on the performance characteristics of these vehicles. The DAS has a standard configuration, with sensors mounted on the power plant that pass signals to the computer. The processor passes the data or processes it and sends the information to a digital recording device. Design specifications were developed to accommodate the harsh automotive environment. This work is not new; it is an extension of the basic work on internal combustion vehicles already performed for instrumentation of electric vehicles at Purdue University (9).

A mission use pattern will be developed through a series of plots, such as vehicle speed histograms (percentage of time spent in various velocity ranges), trip length histograms, number of trips per day versus day of the week, and so forth.

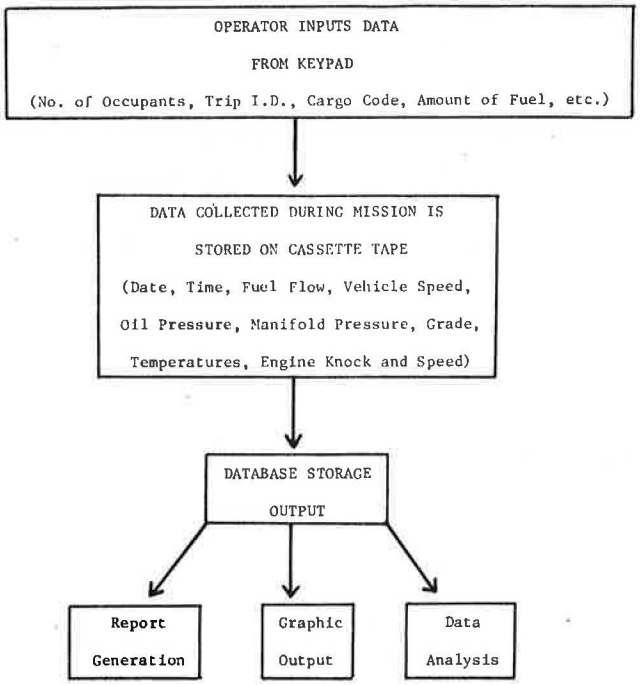
A mission severity index will be used to calculate the energy required for acceleration, constant speed, and idle periods. Data from engine fuel-consumption maps will also be used to characterize fuel consumption during a mission. A general schematic of this system is shown in Figure 2.

INITIAL EXPERIMENTS

The first mobility enterprise experiment became a reality on January 22, 1983. The enterprise initially consisted of seven participating households.

The basic service included an individually garaged mini or micro automobile and access to a shared fleet of one vehicle. Because of insurance restrictions resulting from the lack of safety data on the mini and micro automobiles, all such vehicles are prohibited from use on Interstate highways. All operating costs (excluding gasoline) are

Figure 2. Flowchart of DAS.



included in the monthly fee. In addition, each member receives approximately 10 coupons for use of the shared fleet. The coupons have a cash value of approximately $7.00. The basic rate for shared-fleet use varies according to peak or off-peak periods. The coupon exchange rate for shared vehicles is two coupons per weekday and three coupons per weekend day. Coupons may be accumulated for use at a later time, traded among members, or turned in at the end of the month for a credit toward their next month's bill. Maintenance of all vehicles and shared-fleet operations is administered through the Purdue University Transportation Services Department.

Trip diaries are being maintained for all vehicles in the mobility enterprise as well as in a control group of nonenterprise members. In April 1983 the mini and micro vehicles were equipped with the on-board DAS that measures various factors in engine performance. All test subjects are being closely monitored throughout the experiments.

SUMMARY

The purpose of this paper is to describe the progress that has been made in the past year in bringing the mobility enterprise from a hypothetical concept to a set of actual experiments designed to test its viability as a transportation mode. Many of the results presented here deal with research activities that must precede the actual experiments. The research emphasis to date has been in the area of consumer acceptance of the mobility enterprise concept, recruitment of experimental subjects, operational design of the Purdue University experiments, and methods for measuring mini and micro vehicle performance under U.S. driving conditions.

Thus far the data are encouraging because more than 20 percent of the random sample would be willing to try a mobility enterprise for a trial period and more than 10 percent said they would be willing to join such an organization. The data from the trip diaries appear to indicate that a mobility enterprise operation could satisfy a significant portion of the travel demands of the potential participants. This is particularly noteworthy because the data from the trip diary include August (a high vacation month) and September (Labor Day weekend). The focus-group interviews imply that there is no aversion to mini or micro automobiles (also indicated in the survey) and that continuous maintenance is a significant factor in favor of the mobility enterprise concept. The survey and focus groups have also indicated that the mobility enterprise, to be successful, must come close to the current state of automobile ownership. Other work currently under way deals with determining optimal shared-fleet size (10), which is crucial to the ultimate economic success of such a venture.

In addition to the data presented here, a great deal of the first year's effort has dealt with logistical considerations, such as obtaining waivers for importing the mini and micro automobiles, arranging insurance coverage and maintenance delivery systems, procuring vehicles for the shared fleet, and calculating costs to the participants. Although such efforts yield no experimental data, they are both time consuming and crucial to the performance of the actual experiments. Thus, because of the work described in this paper, the Purdue University mobility enterprise experiments were able to begin in January 1983.

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Person-Category Trip-Generation Model

JANUSZ SUPERNAK, ANTTI TALVITIE, AND ANTHONY DeJOHN

A person-category model of trip generation is presented as an alternative to household-based trip-generation models. In this model a homogeneous group of persons is used as an analysis unit. The final description of the person categories is not arbitrary but results from the multistage, multivariate analysis of many potentially significant variables. The variables age, employment status, and automobile availability were found to be the most significant descriptors of a person's mobility. The final version of the model is based on eight person categories. Both theoretical discussion and empirical findings favor the proposed version of the person-category model over household-based models because it is more practical at the forecast stage, requires significantly less data, has better behavioral background, and is more compatible with the entire system of individually oriented travel-demand models.

The development and evaluation of a person-category trip-generation model as an alternative to household-based models are discussed in this paper. The individual-level approach was chosen for the following reasons. First, a person-level trip-generation model is compatible with other components of the four-step travel-demand model system that is based on tripmakers rather than on households. Second, it is extremely difficult to devise a household-based cross-classification scheme that uses all important variables and has a manageable number of classes [e.g., a British household cross-classification model (1) has 108 categories]. Predicting representations in so many classes is difficult.

Third, the sample size for the person-category model can be much smaller (10 to 40 times) than for the household-category model. Fourth, demographic changes can be more easily accounted for in the person- rather than household-category model, and some demographic variables (such as age) are virtually nondefinable for households. Finally, person categories are easier to forecast to the future than the household categories, which require forecasts about household formation and family size. With the person categories these tasks are altogether avoided. More importantly, because the bulk of the trips will be made by people older than 18 years of age, the task of predicting the tripmaking population 15 to 20 years ahead is much easier.

There are of course some limitations that a person-category model may have. Foremost among these is the difficulty of introducing household-interaction effects and household money costs and money budgets into the model. On the other hand, it is not clear how vital these considerations are and how they can effectively be introduced even in a household-category model. The methodology of the development and testing of the person-category model was based on previous work from Europe (2–6), where the person level of data aggregation was found to be successful for travel-demand analysis.

DATA AND DEFINITIONS

Data

The data used in preparing this paper were from the Baltimore home interview survey conducted in 1977 by the FHWA and from Minneapolis-St. Paul home interview data collected in 1970. Before the analyses, data were superfically cleaned. Workday records were separated from weekend-day records, and some persons were excluded from the original sample. For example, if in the original file a significant inconsistency was found (e.g., number of cars in the family = 7 and number of drivers = 0), the person was excluded. Outliers were also excluded. If the number of trips done by a person was greater than 10 and if total time spent on traveling during the day exceeded 150 min, then this person was suspected to be a professional driver (or similar category) and was excluded from the sample.

Definitions

The following definitions are used in the analyses:

- N_i = trip rate, that is, the daily number of one-way trips made by (average) person in category i; and N_{qi} = trip rate to purpose q in category i;
- T_i = daily travel time; that is, the time (in minutes) spent by (average) person in category i on traveling during the day;
- Y_j = total number of trips made anywhere by the inhabitants of zone j (all categories together);
- L_j = number of zone j inhabitants; and
- α_{ij} = percentage of inhabitants of zone j belonging to category i.

Thus the following basic relationship is given:

$$Y_j = L_j \sum_i \alpha_{ij} N_i \quad (1)$$