

The Mobility Enterprise - Improving Auto Productivity

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ABSTRACT

The Mobility Enterprise is a particular version of a shared vehicle fleet, aimed at solving the problem of low automobile productivity. The automobile consumes a large portion of America's transportation energy supply. It also operates much of the time with unused capacity: vacant seats and empty cargo space. Since programs to fill those vacant seats—ride sharing and high occupancy vehicle incentives—have fallen so far short of their objectives, a new approach is warranted. The enterprise's central concept is matching vehicle attributes to travel needs. Generally, a household purchases vehicles for those few trips that require a large capacity, rather than for the majority of trips (usually to work) that have minimal vehicular needs. If a household could tailor its "immediate access" fleet to these frequent trips and still retain reasonable access to larger-capacity special purpose vehicles (SPV's), considerable economies could be achieved. The household is relieved of owning seldom-used excess capacity, and automobile productivity and efficiency are greatly improved. Having easy access to a shared fleet of SPV's also affords a household an increase in the quality and economy of its travel experiences. This paper describes a research project recently begun at Purdue that involves a comprehensive investigation of the Mobility Enterprise concept. Questions of institutional barriers, consumer response, and organization and management are discussed here as keys to the fate of the enterprise in the transportation climate of the foreseeable future.

INTRODUCTION

The Mobility Enterprise proposes a sharing among its participants of special purpose vehicles (large sedans, trucks, recreational vehicles, and so forth) in order to relax the multi-purpose requirements of the family car(s). Research recently begun at Purdue University is aimed at determining how this concept might become a practical reality.

After years of promoting public transit and car pooling to conserve energy, planners and analysts have begun to recognize that consumers prefer the convenience of the personal automobile. At the same time,

auto efficiency (fuel economy) has undergone significant improvement while auto productivity has remained disturbingly low. [1,2] Currently, the auto industry is engaged in a series of redesigns aimed at improving fuel economy. These measures involve a conversion to front-wheel drive, use of lighter weight materials, and a continuation of vehicle "downsizing." But these improvements will be achieved at an ever-increasing cost. [1,3,4]

There are undoubtedly a variety of measures for improving auto productivity. The enterprise concept is based on better matching one's trip requirements to the vehicle's characteristics. Three features of a mobility enterprise—retained auto autonomy, easy access to an expanded fleet, and reduced expenditures—are the keys to its success. They are interrelated. An enterprise member's minimum attribute vehicle (MAV) provides him, by definition, with the most economical means of accomplishing his most frequent trips. When a trip can be made using his own MAV, the member knows he can travel without delay. When a member's MAV is inappropriate for a desired trip, he must seek access to the appropriate special purpose vehicle. This process may involve delays, if the vehicle is garaged elsewhere. It may also involve some advance planning, paperwork, and out-of-pocket costs, depending on the procedures of the enterprise. There is even the possibility that the desired vehicle may not be immediately available because of a prior reservation. Such departures from guaranteed access and "instant gratification" are aspects of the mobility enterprise that must be offset by clear benefits. Such benefits appear to be possible, since the Enterprise can offer several improvements: (1) a wider range of vehicles available for temporary use by an individual; (2) a less complex set of criteria in buying a car; (3) trip and ownership economies that can be translated into more disposable income or increased mobility; and (4) a more efficient use of society's scarce or expensive resources.

SOME OBSERVATIONS

The capabilities of personally owned automobiles are significantly underutilized.

While approximately 80 percent of the trips in this country are taken in vehicles with more than four seats, only about 20% require a vehicle that large. [9] A car buyer typically considers the maximum number of people, pounds of cargo, or degree of performance he will have to utilize a certain (often very small) fraction of the time. The result is lengthy off-peak periods with underutilized capacity. The range requirements for a large percentage of tripmaking are also remarkably low. For example, a golf cart with a 30-mile range and

higher speed capability has attributes sufficient for about 70% of all trips made.

People prefer to drive themselves.

Ride sharing and public transit promotions have failed to generate a widespread willingness to give up the flexibility, accessibility, and personal autonomy associated with individually-owned vehicles. Taken together, these higher occupancy modes still account for only a small amount of the peak-hour travel. [2] The prospects for “seat filling,” therefore, appear less bright than promoting the better use of individually-owned vehicles. Taken together, these higher occupancy modes still account for only a small amount of the peak-hour travel. [2] The prospects for “seat filling,” therefore, appear less bright than promoting the better use of individually-owned vehicles.

Transportation expenditures will remain nearly constant.

The increases in the real costs of travel in the last eight years have meant a slightly greater proportion of a household’s disposable income being spent on transportation and a reduction in the amount of travel by a household. [5] Both trends represent a deterioration in mobility.

Fairly constant at 12% since 1950, the proportion of personal consumption expenditures (PCE) devoted to transportation rose steadily in the 1970’s from 11.9% to 13.6% [6]. Sudden gasoline price increases had the added effect of curtailing vehicle-miles traveled [7].

The Enterprise idea is a familiar one.

The idea of sharing the high-dollar-value item by rotating its use is not new to this country, as the recent increases in shared vacation real estate indicate. In the area of transportation, the renting of recreational vehicles has proliferated in response to rapidly rising purchase and operating costs. In these and similar cases, individuals have pooled their resources to acquire capabilities they couldn’t reasonably have as individuals. They have made commitments and sacrificed some autonomy to enlarge their options.

While a majority of the European experiments have been of the “drive it and leave it” variety (starting, predictably with bicycles), others more clearly resemble the plan envisioned here. Notable among eleven European projects are the “White Bicycle” program begun in the Netherlands in 1965 (which lasted two years) and the more recent “Paydrive” shared car rental scheme in the United Kingdom, which has been in operation since 1979. The bulk of these experiments were carried out with little or no government support, and the overall status of such enterprises in Europe is considered to be “fairly healthy” [10].

Different demographic groups have different trip-making needs and vehicle ownership patterns.

Travel needs differ for a variety of factors such as age and occupation, by household size and income level. Enterprises based in retirement communities, commercial centers, and high-rise residential zones will encounter different travel patterns. In fact, in some cases demographic homogeneity of membership may render the enterprise impractical. A mix of members may be necessary. The seasonal variations of travel patterns and special vehicle needs must also be anticipated, either in terms of membership mix or fleet makeup. Persons of different income levels will have different perceptions of their minimum attribute vehicle (described later) and may require significantly different services from the enterprise.

ENTERPRISE DESIGN CONCEPTS

In a successful mobility enterprise, membership should enhance rather than limit the quality of individual mobility. Certain basic structures suggest themselves:

Diversified Rental Fleets. Rental agencies add special purpose vehicles (mini-cars, RVs, and so forth) to their existing car/truck fleet to provide a full range of vehicles; offer streamlined discount reservation service to "enterprise card" holders.

Broker-Based Enterprise. Existing rental company or new organization offers an enterprise management package; it can be assembled by broker on subscription or sign-up basis; or "natural enterprises" (neighborhood or employee groups) can work out their own deals.

Enterprise-Controlled Broker Scheme. Broker carries out administrative, storage, and maintenance functions under guidelines set by the enterprise, the enterprise may meet monthly to review rules and operations; broker may have right to advise on rules, renegotiate agreement, or insist financial liability be restricted to enterprise members.

Pure Enterprise. Enterprise members (probably neighbors) carry out all functions internally through periodic meetings, rotating committees, and so forth.

Automobile Company Enterprise. Auto manufacturers working through their dealers may consider the possibility of selling *transportation* rather than just automobiles. Each auto agency could sell or lease the personal MAV to enterprise members. Then it could provide and manage the special purpose fleet.

These five basic structures are a starting point. They begin the process of formulating and testing the operation of a mobility enterprise. Within a given structure, a variety of schemes can be devised to address questions of enterprise size, membership qualifications, fleet composition, scheduling, the reservation system, fees, financing, maintenance, pickup or delivery, insurance and legal problems.

RESEARCH ISSUES

Research issues related to the Mobility Enterprise cover a broad range of disciplines: economics, management, law, sociology, operations research, engineering, design, and so forth. The issues described in the following sections require considerable interaction among the researchers in the various disciplines. The research needs and data requirements presented are at this point only suggestive in that in-depth research tasks are still being formulated. For this presentation, we consider four broad categories for research:

1. *Enterprise Membership—Attractions and Obstacles*

The demand for mobility enterprises with various alternate designs must be estimated. To do this, an understanding of consumer choice mechanisms is required. Two complementary strands of research activity—disaggregate demand modeling and investigations of social behavior—have produced results which can be of use.

The heart of the enterprise project is to evaluate travel choice by matching trip requirements (a set of attributes) to vehicle characteristics (a set of attributes). Thus, the cost, roominess, performance, range, and comfort of the various autos, when matched with necessary trip attributes, determine vehicle choice.

Research will focus on three related decisions—the form of car ownership, vehicle type choice, and vehicle usage. The car ownership decision (e.g., to rent or to buy) is postulated to be determined by the accessibility and cost characteristics of the vehicle and by the socioeconomic characteristics of the individual. Choice of vehicle type is conditioned by the attributes already mentioned (roominess, efficiency, and so forth), while vehicle usage is determined by the operating cost of the vehicle and current travel needs of the families.

In addition to economic considerations, a number of social and psychological variables may be significant in the recognition of potential barriers to a successful venture. What kinds of people are typically attracted to such enterprises? Is self-organization more of a middle-class phenomenon? Do the less affluent have a greater need for sharing special purpose vehicles? What kind of enterprise structure is most functional, and does function vary by type (food, agricultural, and so forth)? What is the best method for getting people to join the enterprise—word of mouth, media advertisement, or an appropriate combination of both? In fact, how much can be generalized from non-transport enterprises to mobility enterprises? Answers to these and other pertinent questions could be crucial to the outcome of the project.

Another concern is the cargo carrying capacity of the MAV which might be covered by an ancillary organization such as a commercial goods delivery system. A major obstacle to asking consumers to give up their large automobiles is their persistent need for consumer goods transport (e.g., groceries, small appliances, and small furnishings). In a sense, people now take their “cargo vans” with them everywhere they go. In the past, when mass transit was more widely used, merchant

delivery systems were commonplace. Demand for such services decreased, however, as personal mobility in large cars increased. An enterprise based on a merchant delivery scheme can be marketed not as an exercise in self-restraint but as liberating convenience. The participant becomes liberated from the expense and bother of maintaining a personal fleet and the burden of inefficient transportation of goods.

2. *Vehicle Characteristics and Fleet Operations*

The MAV Design(s): The MAV may be defined as that vehicle which would meet the highest percentage of the transportation requirements of the household. It may be already apparent that the selection of the MAV is traveler-specific, and the attributes of the MAV help determine how much access to the shared fleet would be necessary. There would not necessarily be a universal MAV—at least not in every detail. The configurations of the MAV will be of interest to the project's researchers and, ultimately, to the automobile industry. The central question here becomes: What are the characteristics of the minimal attribute vehicle ("MAV") and how do they vary with the socioeconomic characteristics of the families?

The Shared Vehicle Fleet: Given a fixed number of members, how many shared vehicles should be purchased? Bounds can easily be set—no more than enough to guarantee availability "on call" and no fewer than the number based on 100% utilization, i.e., "perfect" scheduling. The optimum number should be based on a comparison of the marginal cost of an additional vehicle with the value of the declining marginal increase in accessibility associated with that vehicle. The number of members is also important. It will be shown below that, given a fixed probability of use by each member in an interval of time and a fixed number of vehicles per member, the larger the number of members, the more accurately shared use can be predicted. This increased predictability allows a decrease in the shared car safety margin necessary to assure that a car is available, thus decreasing the cost of the enterprise to its members.

Types of Services: All of the possible types of services that can be offered by the proposed enterprise system should be explicitly identified. Hours of operation, methods of pickup and drop-off services, and so forth must be considered.

It will be necessary to develop a set of service functions and determine the demand for the level of each service. For example, the expected delay in getting a desired vehicle will depend on the number of customers predicted for this type of vehicle during a given time period. An appropriate relationship can be developed to represent delay as a function of volume. [8]

The Reservation System: How shall a reservation system work? Recent advances in mini-computers will probably allow the development of an interactive scheduling network that will permit reservations to be processed at fairly low costs. Nevertheless, the concept of a shared, prescheduled fleet, with each member having a terminal where he can check the current status of the idle fleet and make reservations, requires careful planning and experimentation.

The Pricing System: Another major issue, of course, will be how the

system should be priced. Will guaranteed access be allowed at a price? Will there be a "parking sticker" system with a different fee for differing likelihoods of access? Will people reserve and then not use a car? A penalty system based on the airlines' experience is a possibility. Should the reservation system be based on a first-come, first-served basis, rewarding planning, or should the system be based on a continuous auction of time slots, with the possibility that someone would be "bumped" at the last minute by someone willing to pay more? Should peak period users be charged a premium? If so, should the proceeds be used to subsidize off-peak users, or be used to purchase more cars, increasing peak period capacity? Efficiency and equity trade-offs will be involved in the final selection.

3. *Organization and Administration*

Any organizational structure suggested for a mobility enterprise can be evaluated in terms of how well it is suited to operational requirements and members' attitudes. Certain universal considerations apply.

Membership Mix: A basic issue is the diversity of enterprise member characteristics. The optimum amount of diversity is clearly an open question. It would be impractical to have the population so homogeneous that there would be peak load problems for particular vehicles. That is, if the enterprise consisted primarily of college professors, many members might want a recreational vehicle in order to go on vacation at semester's end. Some amount of diversity in the membership of the enterprise would be necessary to balance the loads over time. Conversely, too much diversity may result in missing some scale economies that would be present if there were fairly large usage of a particular type of vehicle.

Legal and Institutional Matters: With respect to societal reaction to the enterprise concept, in general or with respect to transportation, what have been the main legal, institutional, or other factors that have aided or impeded their development and use? What laws (e.g., auto licensing, insurance regulations, reserved parking spaces, tax legislation) will make it easier or harder for the enterprise to survive? If minimal attribute vehicles are a key to success, will it be necessary to get special legislation to allow them on the streets? In a more heterogeneous transport mode environment, how would traffic safety be assured?

4. *The Demonstration Project*

A large-scale demonstration will likely be necessary at some point to prove the concept. Before that, there is need for some small-scale experiments in scheduling, vehicle design, and consumer behavior. A simulation model [8] will help choose the best combination of strategies to employ in the actual demonstration project.

How big should a demonstration program be? It is fairly clear that many of the major benefits of the enterprise to the traveling public will be evident only when a large enough fraction of the traveling public has joined the enterprise. For instance, congestion benefits arising from a fleet of smaller vehicles will be felt only when those vehicles make up a significant percentage of the traffic stream. In addition, the safe operation of smaller vehicles will be enhanced when they comprise more than a small

fraction of the traffic stream. The demonstration should be sufficiently large to examine scale effects on fleet operations. At that same time, questions concerning "start-up" and "transition" that are difficult to model must be at least partially answered.

PRELIMINARY ECONOMIC ANALYSIS

1. *Economic Incentives*

To complement the simulation model [8], an analytical economic approach is being developed. This approach begins by quantifying the possible economic incentives to join a Mobility Enterprise, then seeking an effective user fee structure.

Consider an individual who has the option of either buying a standard all-purpose family vehicle or joining the enterprise, where he will obtain a MAV plus access to a fleet of shared vehicles. Let us consider a modest case, wherein the standard family vehicle will be a compact car costing \$8,100, with 25 mpg fuel economy, and would be driven 10,000 miles a year. The individual's MAV would cost, say, \$3,800 and get 45 mpg. Either car, if chosen, would be kept four years. If he joined the enterprise, assume the MAV would be useful for only 7,000 miles of the household's travel each year, leaving 3,000 miles of travel to be made by higher attribute vehicles. To simplify this first analysis, we'll assume the individual borrows the all-purpose car from a shared fleet to travel those 3,000 miles having special requirements.

Table 1 summarizes a comparison of two alternatives. Alternative I is the common practice of buying a General Attribute Vehicle (GAV). Alternative II estimates the costs associated with owning or leasing a MAV, while having access to a shared fleet of GAVs. The GAVs are used only for trips in which MAVs do not suffice, so their per-driver mileage is only 3000 annually. But since they are shared among several users, their utilization rate (miles per vehicle per year) should increase, decreasing per-mile costs. Table 1 is based on a ratio of 0.4 shared vehicles per enterprise member. The accuracy and impact of this ratio on the analysis and design is discussed later. Table 2 gives the assumptions used in the cost analysis. These, of course, are subject to modification and refinement as the research proceeds.

Table 1. Comparison of Auto Ownership Alternatives

Alternative	Vehicle Type and Price	Ownership Costs	Operating Costs	Miles Driven	Total Annual Cost
I	\$8100 GAV	\$1851	\$.18/mi	10,000	\$3656
	3800 MAV	626	.13/mi	7000	1512
II	8100 GAV	757	.18/mi	3000	1280
	(.4 veh./member)				
	Alt. II totals (per member)	---	---	10,000	2792

Table 2. Total Vehicle Expenses—Major Components

	GAV	MAV
Purchase price	\$8100	\$3800
Value after 4 years [11]	\$4133.69	\$3249.58
Average miles per year	10,000	7,000
Average mpg	25	45
Annual payments ²	\$2607.62	\$1223.33
Annualized present worth of resale	\$756.70	\$596.81
Annual gasoline (\$1.40/gal.)	\$560	\$217
Maintenance ¹	\$688.70	\$370.72
Insurance ¹	\$555.96	\$297.96
Total Annual Cost ³	\$3655.58	\$1512.20
Total 4-year Cost ³	\$14,622.32	\$6048.80

1 Maintenance and insurance costs for \$3000 vehicle are \$0.05/mile and \$250/year, respectively. These values increase linearly with purchase price.

2 Interest rate = .13

3 Includes depreciation

The difference between the \$3,656 yearly GAV cost and the \$2,792 enterprise cost is a measure of economic incentive to join the Mobility Enterprise. The notion of economic incentive assumes that an individual makes such a rational economic assessment. Mode choice in urban travel has traditionally defied pure economic rationality, but increased travel costs have caused some recent mode shifts to ride sharing, if not to transit. Furthermore, the level-of-service differences are so small in this MAV versus standard car comparison, especially when compared with the magnitude of the Total Cost disparity, that this analysis merits proceeding further.

A GAV-only household pays \$3,656 per year for its auto travel. Switching to a MAV for 7,000 miles results in total costs of \$1,512. The remaining amount, \$2,144, can be spent on the shared vehicle for the 3,000 miles for which the MAV is unsuited. If the household does not choose to use a shared GAV that much, its membership in the enterprise can enable it to decrease its total travel budget even further.

2. *Market Potential*

A survey instrument is presently being refined that has two objectives:

1. To determine what techniques the enterprise could use to effectively and equitably reduce temporal variations in shared vehicle demand.
2. To determine the optimal mix of attributes to look for in the enterprise's shared GAV, once the MAV's attributes have been established.

Demographic information will be cross tabulated with various data obtained from retrospective trip diaries. In addition, it will be

necessary to bracket a dollar saving per household which must be present in order to elicit any trip planning or postponement on the part of prospective members. Initial work has begun in the area of focus interview formulation as a necessary precursor to the actual survey instrument. Preliminary data should include not only the current trip demands of a wide cross section of family units, but also the degree of education with regard to the concept of vehicle sharing and MAVs that will be needed in order to obtain valid survey results. The concepts of a Mobility Enterprise will be foreign to many interview (and survey) participants, therefore education of the respondent is a necessary step in ensuring validity from these techniques. Once the survey instrument is refined, it is planned to be administered locally, regionally, and nationally.

SUMMARY

The goal of the Mobility Enterprise is to improve automobile productivity by matching individual trip requirements to vehicle characteristics. Within this framework, some specific objectives are to:

- Predict the membership of such an enterprise according to the probable public reaction vis-a-vis auto autonomy, access to an expanded fleet, and reduced expenditures;
- Consider basic enterprise service structures (e.g., diversified rental fleets, broker-based enterprises, and so forth);
- Research issues in the various disciplines (e.g., law, economics, sociology, operations research, and so forth) as they relate to the enterprise concept;
- Determine the user fee structures that achieve the best combination of efficiency and equity;
- Describe appropriate vehicle characteristics and designs; and
- Develop a large-scale demonstration model involving scheduling, vehicle description, and consumer behavior.

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