Objective:

The objective of this project is to work in conjunction with the Volvo Motor Corporation to determine the optimal package of incentives for consumers to purchase a Nanocar given varying levels of infrastructure and monetary incentives. Through the use of an electronically administered stated preference survey, the Nanocar project aims to gauge consumer preferences for transportation infrastructure and policy change as a requirement for purchasing a new, small, environmentally friendly vehicle. The results of the survey will be presented to relevant decision makers, such as the automobile industry, city and county planners, and other stakeholders to determine the feasibility of implementing the incentives that consumers value most given levels of improved air quality and infrastructure change economics. This project will concentrate on the urban driving communities located in California and a general case study will be developed for the area. This case study will establish a foundation for the introduction of small, alternatively fueled vehicles in similar areas around the world and provoke new thoughts and discussions on the possibilities of alternative advanced transportation systems.

Significance:

The existing solutions to America’s urban automobile infrastructure problem are not working. The continued rise in population has been matched with a rise in individual automobile use. In contrast to this, the level of carpooling and use of transportation alternatives, such as mass transit, has witnessed a decline. Increased automobile use and the associated congestion have lead to a decrease in worker productivity and increased fiduciary loss by consumers. In addition, the environmental impacts of automobile use is significant in that automobiles are the source for most of the ground level ozone in metropolitan areas and also contribute to the rises in carbon dioxide levels in the atmosphere. Naturally, an increase in automobile use will exacerbate these problems. The established solutions to abate these problems have not changed commuter behavior as seen in the recent demographic and travel trends. In addition, current regulatory tools have moved towards curbing the environmental damage of vehicles, either through mandates to increase the production of environmentally friendly vehicles or through changes to infrastructure, such as the high occupancy vehicle (HOV) lanes found on many highways throughout the nation. A more proactive stance needs to be made by the automobile industry to work with regulatory agencies to search for a new solution that eases the burden on America’s urban roadways and environment. Instead of trying to alter commuter behavior by urging them to carpool or take mass transit, the focus should be redirected to make commuter preferences work for both the commuter and the environment instead of against them. The advent of an extremely compact, environmentally friendly automobile does just that. This solution allows consumers to maintain their preference of single occupancy driving while increasing space on the roadway, due to the decrease in automobile size, and alleviating the traditional burden placed on the environment by traditional gasoline-based vehicles.
Background Information:

Traffic and Commuting:
Metropolitan America faces a problem. Changing trends in demographics and travel characteristics have put an immense stress on urban American infrastructure, one that it cannot uphold indefinitely. The population of the United States has increased from 197 million in 1969 to 281 million in 2000, a positive change of 42% (U.S. Census, 2000). As population has increased, so has the amount of driving. The number of workers driving to work using private vehicles (driving alone and ridesharing) increased from 41.4 million in 1960 to 99.6 million in 1990, an increase of 141%. Trends in how the population commutes to work, however, are mixed. From 1980 to 1990, the number of people driving to work alone increased from 62 million to 84.2 million, a 35% increase, while all alternatives to driving alone declined with the exception of work at home (Ball, 1994). The number of workers carpooling to work decreased from 19.1 million in 1980 to 15.4 million in 1990, a decline of 19%. More specifically, declines were seen in each carpool class. Two person carpools saw a 9% decline from 1980 to 1990, while three-person carpools declined by 40% and four-person carpools declined 46% over the same time period. Public transportation usage has witnessed a decline as well. From 1960 to 1990, the number of workers using public transportation as their main means of commuting to work declined 7.8 million to 6.1 million, a negative change of 22%. In addition, the amount of workers choosing walking as their main means of commuting declined by 30%, from 6.4 million in 1960 to 4.5 million in 1990 (Ball, 1994). Compounded with these trends, the amount of total miles driven has more than doubled since 1970. This figure is expected to increase another 25% by 2010 (UCSUSA, 2000).

The trends shown in the data clearly point to the fact that more and more people are choosing to drive alone. The term that is typically associated with this mode of transportation is Single Occupancy Vehicles (SOVs). The increase in population, along with the rise of SOVs as the main means of transportation for most of the population has resulted in urban mobility becoming increasingly difficult. Studies have shown a dramatic increase in the amount of congestion prevalent in urban areas. Increased congestion leads to increased travel time, increased fuel consumption in stop-and-go traffic and lost productivity of people. (Texas Transportation Institute, 1999). The Texas Transportation Institute studied 68 urban areas to evaluate the state of travel conditions in the United States. In 1999, out of 68 urban areas studied, one-fifth experienced peak-period trips that take at least 30% more time due to congestion on a per trip basis. In addition, drivers in almost one third of the 68 urban areas experienced peak-period travel times that are 25% longer than the same off-peak trip. In more than one third of the urban areas studied, the average delay per driver is greater than one workweek per year in extra travel time. Moreover, another 14 areas had annual delays between 30 and 40 hours per driver. Increased congestion also means less fuel efficiency. Commuters in 35 urban areas purchased the equivalent to four extra tanks of fuel per year due to congestion. This is almost enough fuel to fill a 50-gallon drum over the course of one year. The Texas Transportation Institute estimated that the costs of delay and fuel were $500 or greater, per driver, in 40 of the 68 areas studied. The costs exceeded $1000 per driver in six areas with the most intense congestion problems (Texas Transportation Institute, 1999). In 2001, the Texas Transportation Institute updated their study and found that all areas showed more severe congestion that lasts a longer
amount of time and affects more of the transportation infrastructure. The study found that the congestion cost for the 68 areas in 1999 totaled $78 billion, which included the value of 4.5 billion hours of delay and 6.8 billion gallons of excess fuel consumed (Texas Transportation Institute, 2001). The updated research also found that the average annual delay per person, for all of the zones, increased from 11 hours in 1982 to 36 hours in 1999. In addition, the research estimated that to keep congestion from growing from 1998 to 1999, 1,800 new freeway lane-miles and 2,500 new lane-miles of streets had to have been built (Texas Transportation Institute, 2001). The study also found that building additional roadway is not the answer. The need for new roads currently exceeds the fiduciary limit of planning agencies and also exceeds the ability to muster environmental and public support. Neither the space, money, nor support is available to complete new roadway projects. The trends are visible and there is little evidence pointing to any decline in these statistics. More people than ever before are choosing to drive and commute to work alone. A large majority of the driving population consciously chooses to forego transportation alternatives that would either reduce their time spent in traffic or money spent on fuel or both.

Environment:
Automobiles, taken as a whole, have a significant impact on the environment. One of the most recognizable impacts is from automobile emissions. Automobiles emit sulfur oxides, $\text{SO}_x$, Nitrous Oxides, $\text{NO}_x$, Carbon Monoxide, $\text{CO}$, and Particulate matter.

Automobiles are a major source of ground level ozone in urban environments. Cumulatively, automobiles emit large amounts of nitrous oxide ($\text{NO}_x$), which is converted to ozone ($\text{O}_3$) when $\text{NO}_x$ is broken down by ultraviolet radiation. The reaction is

$$\text{NO}_x + \lambda (\text{ultraviolet radiation}) \rightarrow \text{N} + \text{O}$$

$$\text{O} + \text{O}_2 + \text{M} \rightarrow \text{O}_3 + \text{M}$$

Where M is a catalyst that is required for the reaction. In most cases, M is nitrogen. Ozone is an oxidant, which can cause severe problems to those with respiratory problems. It also creates irritating vapors and causes visibility reduction. Despite air pollution controls, at least 92 million Americans live in areas with chronic smog problems. The EPA predicts that by 2010 more than 93 million people will live in areas that violate health standards for urban smog and more than 55 million people will suffer from unhealthy levels of fine particle pollution. These conditions are not harmless. This type of pollution is serious to anyone with respiratory problems, children and senior citizens (UCSUSA, 2000). Although air pollution controls efforts have been in place since the 1970s, air pollution is expected to increase. The amount of pollutants that automobiles emit has been drastically reduced since the 1970s, the increase in automobile use and total miles driven has created a continued health hazard to the American population (UCSUSA, 2000).

Land-Use
At a time when urban population density has become a profound problem, space has come to be a very important issue. The dependency of the average commuter on their vehicle has caused an equally daunting automobile density problem. The number of vehicles on the road combined with the amount of space that they occupy has amounted to an unsustainable growth pattern. The average commuter vehicle is currently about 15 feet in length and 5.5 feet in width. When this number is multiplied over the driving population, the result is an obvious finding, which tells that a significant amount of space is dedicated to the
automobile. The use of a Nanocar would drastically reduce the amount of space taken up by the automobile when its use is multiplied over the entire population. As an example, if there were approximately 84.2 million people in 1990 commuting to work alone and they all switched to a Nanocar, there would be significantly smaller amount of space that is attributed to the use of a Nanocar versus the use of an average commuter vehicle. This is due to the smaller size of the Nanocar with a length of approximately 10.5 feet and a width of approximately 4 feet.

Average Commuter Vehicle:

\[ TotalArea = 15 \text{ feetlong} \times 5.5 \text{ feetwide} \times 8.42 \times 10^7 \text{ people} = 6.95 \times 10^9 \text{ feet}^2 \]

Nanocar:

\[ TotalArea = 10.5 \text{ feetlong} \times 4 \text{ feetwide} \times 8.42 \times 10^7 \text{ people} = 3.54 \times 10^9 \text{ feet}^2 \]

Therefore, if all single commuters as noted by studies in 1990 switched to commuting with a Nanocar, the total open area created would be:

\[ TotalOpenArea = (6.95 \times 10^{10} \text{ feet}^2) - (3.54 \times 10^9 \text{ feet}^2) = 6.60 \times 10^{10} \text{ feet}^2 \]

To put this area into perspective, the average NFL football field is 57,596.4 \text{ feet}^2. So if all the 1990 commuters switched from driving an average commuter vehicle to driving a Nanocar we would have enough room for approximately:

\[ TotalFootballFields = \frac{6.60 \times 10^{10} \text{ feet}^2}{\left(5.76 \times 10^{10} \text{ feet}^2 \right)} = 5.92 \times 10^4 \text{ FootballFields} ! \]

By saving a fraction of the space implied by the above numbers there would be plenty of new or unutilized space for many different land-uses such as community parks, shopping areas, wildlife habitat, and residential housing. Furthermore, this number does not account for the amount of land that is saved by smaller-sized parking spaces needed for the Nanocar. When parking is taken into account the total amount of surface area saved could possibly double. The Nanocar could provide a profound solution to the vehicle density problem creating more efficient land allocations for societal use.

Current Market Trends for Environmentally Friendly Vehicles:
The Nanocar is unlike any other vehicle currently on the market. It occupies two relatively new niches in the automotive industry: extremely compact size and ultra-low levels of emissions. The new niche that the Nanocar would fit into could be anything from a small compact vehicle to a motorcycle class vehicle. Since there are currently no vehicles on the US market that are comparable to the Nanocar, we need to look at the vehicles that either fit into the category of ultra-low emission vehicles (ULEV), super ultra low emission vehicles (SULEV) or zero emission vehicles (ZEV). In addition to this, we can also look at the
success of ultra compact vehicles ("KEI" vehicles, literally "light" vehicles) in Japan to begin understanding the potential market of the Nanocar in the US. In the United States, automobile manufacturers have begun including environmentally friendly vehicles, such as LEVs and ZEVs, into their line-up, especially in California. The American Council for Energy-Efficient Economy indicates that 23 out of 41 automobile manufacturers that sell their vehicles in the US produce ULEV or ZEV vehicles. This is due to a variety of factors: society's increased environmental awareness, the California Air Resources Board's mandate stating that 10 percent of automotive manufacturer's production be ZEV by 2003\(^1\), the continued reliance on fossil fuel use, fluctuating gas prices, tax rebates, and the pursuit for the most advanced technologies. Regardless of an automobile company's reasons for manufacturing an environmentally friendly car, hybrid vehicles have been reasonably successful in the market thus far (Appendix I). However, extremely compact cars have not been marketed or sold on a reasonable scale in the United States.

In terms of the sales figures for hybrid vehicles, data is available for two vehicles, the Toyota Prius (SULEV, ULEV class), and the Honda Insight (ULEV, LEV class). Toyota's Prius was first introduced into the US market in March 2000 and although Prius sales are exclusively through the online website, total sales have topped 8,500 units with 3,874 units already being sold in year 2001 alone. Sales of the Honda Insight in the US commenced earlier in December 1997. The Insight has sold a total of 5,491 units (as of May \(^{3}\), 2001) and compared to a four-month period between January and April of 2000, sales have doubled in the same period for 2001.

In contrast to this, the main ZEVs on the market are General Motor's EV1 and Toyota's RAV4 EV. As compared to the aforementioned hybrid vehicles, sales for the EV1 have been lackluster compared to hybrid vehicles in that only a total of 1,076 units have been sold since sales began in 1997. In addition, out of the seven versions of electric vehicles on the market in 2000, only two 2001 versions have been manufactured (Ford Ranger and RAV4 EV). This may be an indication that automobile manufacturers are switching to alternative environmentally friendly vehicles that utilize hybrid technology or are investing in developing fuel-cell technology. In addition, the lack of EV development maybe due to the fact that battery technology has not developed as quickly or has not had the breakthrough hoped for by the ARB.

Internationally, ultra-compact vehicles with low emissions or zero emissions have been sold in areas such as Western Europe and Scandinavia where environmental awareness is higher. The Swatch Car (developed by Swatch and Mercedes Benz) is examples of such cars. In Japan, ultra compact “Kei” vehicles (literally "light vehicles") have been on the market for many years, more because of the necessity of such vehicles for navigating through the congested, narrow roadways of urban Japan rather than for environmental reasons. Although these vehicles utilize fossil fuels as their energy source, several "Kei" vehicles on the market today have environmental benefits such as high fuel efficiency and low emissions. Furthermore, several vehicles fall under the category of "environmentally friendly" set by the Ministry of the Environment, which reduces registration taxes. Environmentally friendly vehicles such as the Toyota Prius have been on the market for a longer period in Japan, and because of this the number of Prius’ sold totaled over 40,000 units (as of November 2000)

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\(^1\) Note: The automobile industry successfully lobbied to extend the deadline
since sales began in December 1997. If Japan and Europe are good indicators of future global trends, the market for environmentally friendly vehicles in the US will definitely continue to increase in the future. However, the attractiveness of environmentally friendly vehicles in the US is highly dependent on regulatory mandates implemented by states as well as the number of incentives that manufacturers, developers and other regulatory agencies (e.g. Environmental Protection Agency) can offer to the consumer.

Political Arena:
California provides evidence for the extent of the environmental and economic problems that excessive CO\(_2\) emissions can generate. In the attempt to decrease CO\(_2\) emissions, policy makers have concentrated in the reduction of vehicle emissions. According to the California Air Resource Board, about half of all CO\(_2\) emissions are generated by personal vehicles. A program such as California's mandate for the sale of Zero Emission Vehicles (ZEV's) serve as a good example of the kind of legislation that has been created to deal with this problem. According to the original ZEV mandate, car companies must include at least 3% of ZEV's in their sales by 1998 and 10% by 2003 in the state of California with no specific requirements on the source of power used by these vehicles. In light of unforeseen delays in the implementation of the mandate, the time the mandate was scheduled to begin was postponed until March 2003. The problem with this mandate is that the introduction of expensive ZEVs will ultimately decrease the demand for these cars. This increase in price will likely result in potential consumers holding onto their vehicles for longer periods of time. These older, environmentally unfriendly vehicles produce high levels of emissions (Howard, 2000). The end result will be that the amount of reduction in emissions due to the ZEV mandate will be much lower than the increased emissions generated by the longer use of older vehicles.

Another program that is currently being implemented in California is the Transportation Equity Act for the 21st Century (TEA-21). The goal of this act is to improve highway safety, current transportation infrastructure, private and public modes of transportation, air quality through congestion mitigation, and increase research and development with the financial aid provided by the federal government. There are several concerns regarding the TEA-21. The first concern deals with the distribution of federal funds. The act does not specify the criteria for distribution of funds amongst its components. This becomes a problem as different components have varied needs for financial resources. Such resources would be optimally allocated in accordance with their performance. These can be derived with the use of a performance measurement tool and a standard such as cost-effectiveness criteria. The lack of such a standard is the second concern that the TEA-21 raises. A standard methodology for measuring and reporting air quality improvement and other public benefits generated by the act must be properly defined. If no standard methodology exists, the quality of the data and information provided in the annual reports is low. Inaccurate reporting is also a concern. Therefore, requirements for reporting must improve in order to increase the efficiency and insure the success of the TEA-21 in years to come.

Other ways in which policy makers have attempted to reduce emission levels from vehicles include the introduction of increased public transportation, toll roads, gasoline taxes, HOV lanes, and the implementation of a carpool service or rideshare programs. The goals of all the aforementioned programs are to reduce the amount of total vehicle miles traveled. This in turn will reduce the total amount of emissions produced by cars. While some programs
target different sectors of people’s driving needs, others such as the gasoline tax, penalize all sectors of people’s driving needs. In other words, some programs are more effective than others in reducing emission levels. For this reason it is critical that a cost benefit analysis be done in order to ensure that the cities’ limited resources are utilized in only the implementation of the most effective programs.

Survey Background (Behavioral):
There are several different techniques of surveying consumers in order to assess the demand for market goods such as the Nanocar. The most commonly used method applicable to our project is the Contingent Valuation Method. Contingent Valuation is a general term for a number of different survey methods that could be applied to our project, including stated preference and conjoint analysis. The stated preference method involves calculating the probability that a decision-maker will choose a particular alternative from a set of alternatives, given data sets provided by the researcher (Train, 1993). In essence, this method asks a respondent to make a choice among a finite set of alternatives. There are inherent problems with this method. The most damaging to the validity of the results is that respondents, which in this case are the consumer, do not always fully comprehend what they are being asked to value. This is particularly the case in the valuation of an environmental related product or good. The technique of using conjoint analysis entails asking a consumer to rank preferences for a simulated purchase given a set of alternatives. This is typically done by providing the respondent with a range of options and asking them to place these variables or options in accordance to their preference and then calculating the overall utility of each. Although this method of survey can be more statistically robust, it is harder to minimize the bias of the results as choosing the variables presented and correlating the answers across respondents can be complicated. In addition, the ranking scale used in conjoint analysis is not based on a utility theoretic foundation for economic valuation. The general problems with surveys that must be considered are: how to deal with non-respondents, how to make sure that questions and/ or variables are unbiased, how to ensure that the respondents completely understands what it is that they are being asked to value, how to deal with the “feel good factor”, especially in the case of an environmentally related good (i.e. overvaluing the good due to environmental consciousness), how to deal with biases inherent in the distribution technique, and how to incorporate errors so as to produce valid results.

Choice Theory:
In order to determine what buyers consider most important when making a purchase decision, we will be using a simple economic model to estimate the choices a respondent makes given a set number of options associated with the purchase of the Nanocar. The decision maker can be described by \( n \) and the set of alternatives that the decision maker can choose from as \( J_n \). This can be thought of as the choice set and is subscripted by \( n \) to represent the fact that different decision makers might face differing sets of alternatives. In addition, the alternatives that a decision maker faces differ in their characteristics. Some of the alternatives are observed and some are not.

The observed characteristics of alternative \( i \), as faced by decision maker \( n \), can be labeled as \( z_{in} \), for all \( i \) in \( J_n \). Again note that the variables are subscripted by \( n \) to denote the fact that different decision makers can face alternatives with differing characteristics.
The choice made by a decision maker depends on the characteristics of each of the alternatives in the choice set. It is expected that different decision makers can make different choices when facing the same alternative because the value that each decision maker puts on each characteristic is different. The observed characteristics of the decision maker can be noted as $s_n$. Therefore, the probability that the decision maker $n$ chooses alternative $i$ ($P_{in}$) from set $J_n$ depends on the observed characteristics of alternative $i$ compared with all other alternatives and on the observed characteristics of the decision maker. The parametric function of the general form

$$P_{in} = f(z_{in}, z_{jn}, s_{in}, B) \quad \text{Equation 1}$$

where $f$ is the function that relates the observed data to the choice probability. This function is specified up to some vector of parameters $B$. According to Train (1993), the general description of stated choice models is completely contained in this equation. All stated choice models have this general form; the specific models are derived by specifying $f$.

Utility Maximization and Choice Theory:

By combining the general specification of stated choice models to utility theory, three benefits clearly arise. The first is that a clear meaning of the choice probability emerges. Until utility theory is applied, the meaning of the choice probability, $P_{in}$ is not clear. The second is that utility theory offers a context for deriving various forms of $f$. As mentioned before, different stated choice models take shape because of variations in $f$, which is allowed by the theoretical underpinnings set in utility theory. Third, the literature on stated choice models use terms that only have meaning in the context of utility theory. Therefore, our analysis is based on these fundamental concepts.

Stated choice models can be derived from utility theory by making a “precise distinction between the behavior of the decision maker and the analysis of the researcher (Train, 1993).” In making the choice above (Equation 1), the decision maker derives a certain level of relative happiness or “utility.” In fact, each alternative would give the decision maker a level of utility, with some being higher or lower than others. The utility derived from alternative $i$ in $J_n$ can be labeled as $U_{in}$ and similarly for each other alternative in $J_n$. The utility depends on a number of factors including the characteristics of the alternative and the characteristics of the decision maker. All of the relevant characteristic of alternative $i$, as faced by person $n$, can be labeled $x_{in}$. All of the relevant characteristics of person $n$ can be labeled as $r_n$. Therefore, $x_{in}$ and $r_n$ should contain all relevant characteristics and the utility function that follows from these factors is

$$U_{in} = U(x_{in}, r_n) \quad \text{for all } i \in J_n \quad \text{Equation 2}$$

where $U$ is a function.

The decision maker will choose the alternative where he or she derives the greatest utility. This can be denoted as

$$U_{in} > U_{jn} \quad \text{for all } j \in J_n, j \neq i.$$
When equation 2 is substituted, \( n \) chooses \( i \) in \( J_n \) if and only if

\[
U(x_{in}, r_n) > U(x_{jn}, r_n), \text{ for all } j \text{ in } J_n, \text{ } j \neq i.
\]  

This finishes how a decision maker determines his or her choice. The decision maker chooses the alternative that provides the greatest utility.

Unfortunately, the researcher does not observe all of the relevant factors to and therefore cannot exactly know the utility function. The elements of the original utility equation must be subdivided into what the researcher observes and what the researcher does not observe. Therefore, the characteristics of the alternative \( (z_{im}) \) and the characteristics of the decision maker are divided into observed and unobserved characteristics. \( U(x_{im}, r_n) \) can be then broken down for each \( i \) in \( J_n \) into two sub-functions, one that is observed by the researcher and one that is unknown by the researcher. The known sub-function is that which is to be estimated up to a vector \( B \) and is labeled \( V(z_{im}, s_n, B) \). The unknown sub-function can be thought of as an error term with the label \( e_{im} \). The utility equation then becomes

\[
U_{in} = U(x_{im}, r_n) = V(z_{im}, s_n, B) + e_{im} \quad \text{Equation 4}
\]

The researcher, therefore, does not entirely know a decision maker’s total choice utility. However, the researcher does know a good deal about the observed characteristics and is able to make an educated guess as to the decision maker’s choice.

**Assumptions:**
In this project, it is assumed that the unobserved characteristics, \( e_{im} \), are independently and identically distributed (IID) in accordance with the extreme value distribution. With this distribution for the unobserved characteristics of utility, the probability that a decision maker will choose alternative \( I \) is

\[
P_{in} = \frac{e^{V_{in}}}{\sum_{j \neq i} e^{V_{jn}}}, \text{ for all } i \text{ in } J_n
\]

Since the distribution of the unobserved components are assumed to have zero mean, the observed components are then the expected or average utility. The unobserved component of utility is assumed to have a zero mean, as given by the extreme value distribution. Essentially, this assumption allows the known components to be representative of the entire utility as a whole. (Train, 1993)

The project also assumes what is known as the independence from irrelevant alternatives assumption (IIA). This assumption follows from the IID assumption and implies that the ratio of the choice probability for any two or more alternatives is unaffected by the addition or deletion of an alternative. This can also be thought of as the random components \( (e_{im}) \) are uncorrelated between choices and have the same variance. Although this assumption sometimes becomes tenuous when applied to real world situations, we believe that it is still acceptable for our project (Carson et al, 1994).
**Approach:**

In this section, the general approach to the problem will be presented. It is instrumental to our analysis that the Nanocar is still in the research and development stage and therefore the design and the engineering of the car is not finalized. This means that many attributes normally associated with a car such as the type of fuel used, aesthetic quality, etc. is not yet determined. However, for the purposes of the project, it is assumed that the Nanocar will use some type of environmentally friendly technology such as hybrid or fuel-cell technology. In our approach, we will be evaluating those aspects of the car and, more specifically, the infrastructure associated with it that makes it an attractive option to the consumer. The timeline presented by Volvo for the project is defined to be in the region of 10-20+ years and therefore many questions about future changes and future trends will not be addressed at this point in time.

To find the attributes that consumers value most, our group will establish multiple scenarios in which infrastructure and land use is varied in both type and extent. These attributes will be chosen according to initial consumer questioning and from the group’s own personal experiences regarding the effectiveness of existing infrastructure. The scenarios will then be presented to consumers via a survey format to gauge their reaction and preferences. By asking the consumers to choose from a selected list of scenarios, which feature infrastructure and monetary incentives associated with the Nanocar, a revealing picture of consumer preferences can be established. These preferences are, therefore, the principal factors that are considered when purchasing an automobile, such as the Nanocar, given the predetermined attributes. The survey will provide insights into determining the point at which consumers will want to switch from buying a gasoline-fueled automobile to purchasing a Nanocar. The results of the survey will be presented to decision makers to gauge their attitudes towards new solutions to the transportation infrastructure problem. Decision makers will also be surveyed as to the feasibility of implementing some of the attributes that are shown to be significant to the consumer. The specific tasks relating to the approach are given below.

**Specific Tasks and Subtasks Relating to the Approach:**

- Determining the Attributes (also see Appendix II)
  1. Initial consumer survey to determine attributes
  2. Define attributes
  3. Design survey
  4. Visualization of attributes
  5. Draft Survey
  6. Pretest
  7. Modifications
  8. Beta version on Survey Website
  9. Second Round of Modifications
  10. Survey Distribution
  11. Sample decision makers
  12. Follow Up
  13. Data Analysis
14. Results
15. Decision-maker feedback

As mentioned in the objectives, the main focus of this project is to analyze the most important (significant) incentives that can be provided to a consumer in order to purchase a Nanocar. Therefore, our research will focus on, the primary commute of a consumer, and the determination of the environmental benefits of implementing specific incentives. The main reason for directing attention onto the primary commute is that all consumer commutes are not homogenous; one person’s primary commute may entail going to work while another may be going to the grocery store. As mentioned before, the survey is to be electronically administered via the World Wide Web. Our survey population will be reached via active means; the purchasing or acquiring email lists and actively sending them the hyperlink to the survey. Although several biases are inherent with this technique, an analysis of non-respondents and a high number of respondents will hopefully return a representative sample of the driving population above 18 in California. Please note that the group’s goal is to have 1000 respondents to the survey.

Group Structure and Management (see Organizational Chart)

<table>
<thead>
<tr>
<th>Group Member</th>
<th>Position</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jota Shohtoku</td>
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<td><a href="mailto:jshohtoku@bren.ucsb.edu">jshohtoku@bren.ucsb.edu</a></td>
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<tr>
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<tr>
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<td>Data Manager</td>
<td><a href="mailto:jpeery@bren.ucsb.edu">jpeery@bren.ucsb.edu</a></td>
</tr>
</tbody>
</table>

Faculty Advisors:
Assistant Professor Cathie Ramus
Professor Jeff Dozier

Client Representatives:
Volvo Monitoring and Concept Center
Dr. Ichiro Sugioka (Aerodynamics and Advanced Researcher)

Meeting Structure

Date: Every Thursday
Time: 2:00-3:30
Location: Girvetz Hall 2310
Participants: All group members, advisors (when available)

General Structure of the Meeting:
Meetings will be held every Thursday to discuss individual research topics, obtain feedback from faculty advisors, and to proceed in the development of the project. In general, detailed agendas are prepared before the meeting in order to facilitate the meeting in an efficient manner. In addition, the minutes of the meeting will be recorded by the Chief Secretary. The basic outline of the meetings is as follows:
i) Present individual research and discuss further research topics
ii) Report on the status of contacts made
iii) Discuss the development of the project (topic dependant on timeline)
iv) Discuss feedback from faculty advisors and clients
v) Set meeting agenda and tasks for the following week
vi) Set individual deadlines and discuss upcoming deliverables
vii) Set additional meeting times if required

Duration of posts and responsibilities of group members

All members have an assigned position, which entails duties and responsibilities. As a general rule, team members must be aware of the fact that the group project remains a priority throughout the course of the master’s program and therefore the same level of effort is expected for the group project as any other 4-unit course. The following is a general description of these expectations:

Project Manager: The project manager’s responsibilities include writing the agenda for the following week based on the team’s suggestions in the previous week, weekly progress reports via e-mail to faculty advisors, communicating the presence of upcoming deadlines and ensuring that those deadlines are met, and maintaining energy and motivation during the course of the project.

Liaison: The liaison acts as the point man (or woman) to the clients (Volvo Monitoring and Concept Center) as well as external advisors. The person’s responsibilities will include setting up meetings with clients and external advisors as well as communicating any information from them to the rest of the team.

Accounts Manager: The accounts manager executes any budgetary functions concerning the project. This includes completing a budget, organizing invoices, and distributing the budget appropriately.

Webmaster: The Webmaster’s main responsibility is to oversee all web-based information and contents relating to the project. This includes regular updates to the group project homepage, ensuring appropriate permissions are set on files and folders, and managing all related e-information (e-mails, documents, etc.)

Chief Secretary: The Chief Secretary is responsible for recording the minutes of the meetings (including any ideas, comments, or suggestions pertinent to the project), outlining upcoming deadlines and informing the project manager of those deadlines, and administrative duties such as reserving rooms for meetings and obtaining parking permits for guests.

Data Manager: The data manager’s duties include filing and entering hard copy data and correspondence into assigned project folders, cooperating with the Webmaster to file data in the profile space, and managing all other data related issues.

Please note, these posts are appointed for the duration of the project. However, at anytime the group feels as though another team member could better serve a position, the group will make a decision in a democratic manner.
System to ensure deadlines are met

As mentioned before, in order to ensure that the deadlines are met the Project Manager will inform the rest of the team of the upcoming deadlines. Members can consult the meeting minutes, agendas, as well as the progress reports. If individual deadlines cannot be met, the team member(s) will inform the rest of the group prior to the meeting and suggest an extended deadline, which the other teammates must agree upon. These situations should be avoided whenever possible.

Conflict resolution process

Conflicts should be avoided whenever possible through clear communication of deadlines and expectations, equality in group discussions, positive criticism throughout the duration of the project. However, in the case where conflicts arise, an emergency meeting can be called by any team member to resolve issues in an amicable manner. Failing to attend these meetings will not be tolerated by the other group members. Furthermore, any decisions made in the group will be unanimous. In other words, discussions will be held until all conflicts or issues are resolved. In the event where a stalemate occurs, faculty advisors will be contacted for advice.

Process for documenting, cataloguing and archiving information

The data manager is responsible for handling all the data relating to the group project. The team members will pass any information (e-mails, research documents, deliverables, etc.) to the data manager with an attached note that outlines the date and the type of information being submitted. The information will then be catalogued by the data manager in one of the six categories. The categories are:

a. Agenda
b. Minutes
c. E-mails and other correspondence
d. Research documents
e. Drafts
f. Final Deliverables

The folder for the research documents and correspondence will be separated by quarter, while information in the other categories will be compiled in one file for the duration of the project. In addition, team members will be responsible for updating a references file (in Microsoft Excel), which will contain the title, author, date, publisher, source, and a brief description of any information obtained during individual research.

Guidelines for interacting with faculty advisors/ external advisors/ clients

It is the primary duty of the liaison to maintain an orderly flow of information between the team, advisors, and clients. This will alleviate information gaps that may arise from multiple person contact. Each team member will have the opportunity to interact with various professionals in the environmental, development, and manufacturing community will be conducted in a polite, courteous, and professional manner. Once initial contact is made and
a relationship established, that team member is responsible for any further contact that the group might have for the duration of the relationship.

Overall expectations of group members and faculty advisors

The team expects the faculty advisors to actively participate in group meetings and discussions. The faculty advisors are expected to contribute positive criticism and to provide general direction when appropriate. The information and direction provided by the faculty advisors is expected to be consistent with the information and direction provided by the faculty group project coordinator.

The team members are expected to sustain the group project as a high priority for the duration of the project. They are expected to be honest and supportive as well as exercise integrity and patience in their interactions with others and in their own work. Team members are expected to create a lively and enthusiastic environment in which ideas and opinions are given equal weight and consideration. In order to facilitate coordination and understanding the team is expected to strive to make what is implicit, explicit.

Stakeholders:

There are several stakeholders involved with this project in addition to the group members themselves. All the current stakeholders are listed below:

Direct Stakeholders:

Bren School Group Project Advisors:

- Dr. Cathie Ramus, Assistant Professor
- Dr. Jeff Dozier, Professor

Ford Think

Nanocar Group Members

- Claudia Anticona, Accounts Manager
- Jason Peery, Data Manager
- Jonathan Saben, Webmaster
- Jota Shohtoku, Project Manager
- Clarice Wilson, Chief Secretary

Volvo Stakeholders:

- Dr. Ichiro Sugioka, Aerodynamics and Advanced Researcher
- Mr. Micheal Ippoliti, Offer Development Manager
**Indirect Stakeholders:**
Air Resources Board
- Alan Lloyd, Chairperson

American Honda
- Robert Bienenfeld

California Electric Transportation Coalition
- Dave Modisette
- Julie Malinowski-Ball

California Natural Gas Vehicle Coalition
- Sean Turner, President

City of Peachtree
- Jim Williams, Developmental Services
- Betsy Tyler, Public Information Specialist

City of Santa Barbara

County of Santa Barbara
- Dev Vrat, Planning and Development

Georgia Power – Electric Transportation
- Steve Lawrence

The Irvine Company
- Donald Bren

Pathway Communities
- Tonja Holder

PG&E Stakeholders
Customer Research
- Christina Jennings, EV Research

New Energy Markets
- Norm Stone, Manager
- Jim Larson, Senior Program Manager

Technical and Ecological Services
- Samuel L. Altshuler, Diplomat AAEE/Unit Supervisor

Toyota Stakeholders:
- Bill Reinert, National Advanced Fuel Vehicles Manager
• Geoff Partain, Advanced-Fuel Vehicles Manager
• Dean Kato, Legal Counsel (Environment)

University of California at Santa Barbara
• Donald Bren School of Environmental Science and Management

Weststart - Calstart Stakeholders
• Chris Buntine, Senior Project Engineer
• Leeor Alpern, Project Manager
• Fred Silver, Senior Project Manager
• Susan Romeo, Marketing Director
• John Boesel, President
• Carolyn Riehn, Chief Administrative Officer and Director Participant Services
• Gregg Moscoe, Manager of Marketing and Communication

Deliverables:

Spring 2001:
April 18th, 2001: Management Plan – The management plan outlines the general managerial issues, such as roles, responsibilities, conflict resolution, meeting times, etc. that are to be adhered to throughout the duration of the project.

May 9th, 2001: Draft Proposal – The written draft proposal gives specific details about the objectives, significance, background, and approach the group project team will have for the project. In addition to this, the management plan, budget, timeline, stakeholders and deliverables are presented in writing.

By June 8th, 2001: Final Proposal – After being reviewed by the advisors and clients, the group project team will make modifications to the draft proposal. In addition, any new information, or approaches that are decided upon will be added to the final proposal.

By June 8th, 2001: External Review – The group project team will prepare a presentation that outlines the objectives of the project as well as the approach the group plans to take in tackling the problem. The reviewers will critique the approach so that the group project team can obtain objective criticism and feedback, as well as make any changes if necessary. The group project advisors, two other Bren School faculty members and two external stakeholders will attend the review.

By June 18th, 2001: Live Website - By the end of spring quarter 2001, the group project team will have an operational website hosted through the Bren server. The website will contain a homepage, a page describing the generalities of the project, links to clients and associated institutions and personal information.

Fall 2001:
October 2001: Public Presentation on Progress – The public presentation will be held at the beginning of the fall quarter. The 15-20 minute presentation will be a condensed version of
the group project, consisting of the clearly stated research question, importance of research, plan for executing research and expected results. In addition, the group project team will report on the current progress of the project.

**End of Fall Quarter: Written Progress Report** - In addition to the weekly updates via e-mail to advisors outside the US, the group will write a full report that summarizes that initiatives taken on project since the public presentation.

**Winter 2001:**
January 2002: First Draft of Report - The group project team will aim to complete the first draft of the final written report by this time. The first draft will contain all the contents of the final report, which are executive summary, discussion of objectives and significance, background information, discussion of methods, results, discussion of results, conclusions, recommendations for future research and references. The advisors will then review the first draft.

March 2002: Final Report - The final report will be a revision on the first draft; the contents of the report will be very similar to the first draft. In addition, the final report will adhere to the quality standards described in the Group Project Guidelines (available online at [http://www.bren.ucsb.edu](http://www.bren.ucsb.edu))

April 2002: Four Page Summary Paper - The four-page summary is a document that will summarize the main points of the project. The document will be aesthetically exciting, easy-to-read, and will also give a complete view of the project.

April 2002: Project Presentation Poster - The poster is a professional document that will give a visual display of the project. It will contain a summary of the entire project from the objectives to the recommendations.

April 2002: Group Project Presentation
## Milestones:

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<th>Task Name</th>
<th>Spread</th>
<th>Start</th>
<th>Finish</th>
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<tr>
<td>Primary Research</td>
<td>130 days</td>
<td>4/2/2001</td>
<td>9/28/2001</td>
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<td>Background Information</td>
<td>45 days</td>
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<td>Management Plan</td>
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<td>9/28/2001</td>
<td>10/12/2001</td>
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<td>First Draft Final Report</td>
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## Appendix I:
### Summary of Sales of Environmentally Friendly Vehicles vs. Petrol-Based Vehicles of Similar Size Category

<table>
<thead>
<tr>
<th>Car</th>
<th>United States Car Sales (% sales growth/month)</th>
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<tbody>
<tr>
<td></td>
<td>36639.00</td>
</tr>
<tr>
<td>Chevy EV1</td>
<td>28.00</td>
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<tr>
<td>Honda Insight</td>
<td>354.00</td>
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<tr>
<td>Toyota Prius</td>
<td>841.00</td>
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<tr>
<td>Honda Civic</td>
<td>20522.00</td>
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<tr>
<td>Ford Escort</td>
<td>9091.00</td>
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<tr>
<td>Acura Integra</td>
<td>2577.00</td>
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Appendix II

Define attributes → Design survey → Visualization of attributes → Draft survey → Pretest stage → Modifications

Results → Analysis → Data processing stage → Time lag & Follow-up

Share with decision-makers & re-question → Presentation of results and conclusions

Survey Distribution → Contact decision-makers
Appendix III

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## Appendix IV
### Budget

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<th>Funds</th>
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<tr>
<td>Funds from Bren</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$1,000</strong></td>
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<table>
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<tr>
<th>Fixed Expenses</th>
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<tbody>
<tr>
<td>Telephone*</td>
<td>$12</td>
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<tr>
<td>Estimated calls per month $15 for 9 months</td>
<td>$135</td>
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<tr>
<td>Photocopies</td>
<td>$93</td>
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<td>Copy Card</td>
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<tr>
<td>Printing*</td>
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<td>Software and accessories</td>
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<td>Presentation expenses</td>
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<td>Final poster production</td>
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<td>Administrative Supplies</td>
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<td>Business Cards</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>Net total</strong></td>
<td><strong>$70</strong></td>
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<table>
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<th>Internship Funds</th>
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<tr>
<td>Funds from Volvo</td>
<td>$10,000</td>
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<td>Funds from THINK</td>
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<td><strong>Subtotal</strong></td>
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<table>
<thead>
<tr>
<th>Internship Expenses ($2500 per month*)</th>
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<td>Jonathan Saben (2 months)</td>
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<td>Joe Shohtoku</td>
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<td>Jason Peery</td>
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<td><strong>Subtotal</strong></td>
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<table>
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<th>Other Expenses</th>
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<tr>
<td>Volvo Retreat Expense</td>
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<td><strong>Net Total</strong></td>
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*Additional services rendered will have a fixed cost of $625 per week