Research Report – UCD-ITS-RR-96-06

# An Organizational Approach to Understanding the Incorporation of Innovative Technologies into the Fleet Vehicle Market with Direct Application to Alternative Fuel Vehicles

June 1996

Kevin A. Nesbitt

Institute of Transportation Studies ◦ University of California, Davis
One Shields Avenue ◦ Davis, California 95616
PHONE (530) 752-6548 ◦ FAX (530) 752-6572
www.its.ucdavis.edu

# An Organizational Approach to Understanding the Incorporation of Innovative Technologies into the Fleet Vehicle Market With Direct Application to Alternative Fuel Vehicles

**UCD-ITS-RR-96-6**

**1996**

Ph.D. Dissertation
by

Kevin Abolt Nesbitt

Institute of Transportation Studies
One Shields Avenue
University of California, Davis
Davis, California 95616
Tel. 530/752-4909 Fax 530/752-6572
http:\\its.ucdavis.edu
e-mail: itspublications@ucdavis.edu

An Organizational Approach to Understanding the Incorporation of Innovative Technologies into the Fleet Vehicle Market with Direct Application to Alternative Fuel Vehicles

By

KEVIN ABOLT NESBITT
B.S. (North Carolina State University) 1985
M.S. (University of California) 1990

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Civil Engineering

in the

OFFICE OF GRADUATE STUDIES

of the

UNIVERSITY OF CALIFORNIA

DAVIS

Approved: [signature]
[signature]
[signature]

Committee in Charge

1996

Kevin Abolt Nesbitt
June 1996
Engineering

# An Organizational Approach to Understanding the Incorporation of Innovative Technologies into the Fleet Vehicle Market with Direct Application to Alternative Fuel Vehicles

## Abstract

Businesses, utility companies, and government agencies have long been targeted as the ideal initial market for alternative fuel vehicles (AFVs) because they purchase approximately one quarter of all light-duty vehicles sold in the U.S. each year and account for a large share of the total vehicle miles traveled in urban areas with poor air quality. Fleet vehicles that operate on pre-determined routes and that are centrally refueled are especially conducive to those AFVs which have limited driving ranges and little or no public fuel distribution network. Although fleets provide a promising market for AFVs, sales have been slow and few. One explanation is that policymakers do not understand how fleet and vehicle decisions are made.

Because of the importance of the decision in terms of people affected, resources demanded and precedents set, the purchase of an AFV by a fleet will not be a routine acquisition. Possible organizational implications of an AFV purchase (infrastructure installation requirements, corporate image benefits, etc.) will lead to a wide variety of individuals participating in the decision. This research represents the first comprehensive analysis of the fleet vehicle purchase decision within an organizational context.

Several types of information and data regarding the fleet decision process were collected. Seven focus groups were conducted with 59 fleet operators, 35 one-on-one interviews were conducted with fleet decisionmakers representing 22 organizations, and a

sophisticated multi-part statewide survey was administered to over 2700 organizations in California. Analysis of the data reveals four distinct decision-making structures which are used to form a typology of fleets. In order to operationalize the typology, a discriminant analysis was conducted and logit model developed to classify fleets into the typology categories. The classification model incorporates variables of fleet attributes that act as proxies for decision-making behavior. These attributes can be retrieved from public records.

The four fleet types are analyzed with respect to how each will likely respond to existing and proposed AFV policies and implementation strategies. Recommendations are made for formulating new AFV marketing strategies tailored specifically to the needs and decision behavior of each fleet type.

Daniel Sperling

# Acknowledgments

I am extremely grateful to several organizations and individuals for their support during the course of my dissertation research. First, I wish to express a sincere appreciation to my advisor, Professor Dan Sperling, whose support and guidance over the last four years made this dissertation possible. I am also very grateful to the two other members of my dissertation committee, Professors Pat Mokhtarian and Ryuichi Kitamura, whose insights and suggestions were invaluable to this research effort. I would like to acknowledge Professor Tom Golob at the Institute of Transportation Studies-Irvine for his help in administering the statewide surveys and Dr. Ken Kurani, a friend and colleague, whose overall guidance and help with the focus groups is greatly appreciated.

I am deeply grateful to my family and friends for their support and encouragement throughout my education. My wife, Elaine, deserves special mention for her enduring patience, constant encouragement, and selfless support.

I am grateful to the California Institute for Energy Efficiency for funding this research and to the University of California Transportation Center for additional financial assistance provided through a dissertation grant.

None of the above individuals or organizations are in any way responsible for any errors or shortcomings in this dissertation. I am solely responsible for the results of this dissertation and for any errors contained therein.

# Table of Contents

# Introduction and Study Overview

## 1.1 Background Information

Petroleum's dominance of the transportation energy market is slowly being challenged by the steady development of alternative fuel technologies such as ethanol, methanol, natural gas, hydrogen and electric vehicles. All of these contending fuels can be derived from domestic resources (many from renewable feedstocks) and have the potential to reduce emissions relative to gasoline-powered vehicles. However, each fuel is favored by a different set of values and circumstances and the associated vehicle technologies are at different stages of development.

Businesses, utility companies, and government agencies have long been targeted as an ideal initial market for these alternative fuel vehicles (AFVs) because, collectively, they purchase approximately one quarter of all light-duty vehicles sold in the U.S. each year (Bobit annual; MVMA annual). Such a large number of vehicles purchased by relatively few buyers presents a tantalizing market prospect for alternative fuel vehicles. Furthermore, the average fleet vehicle is driven over twice as far as the average household vehicle each year and most of that travel is in urban areas with poor air quality (Davis 1995; DOE 1993; FHWA 1992; Miau et al. 1992). Therefore, it is reasoned that near-term AFV air quality benefits could be realized sooner by supplanting these high mileage fleet vehicles with less-polluting AFVs. In addition, many fleet vehicles are refueled where they are parked overnight. It is argued that such an arrangement is conducive to using AFVs because of fuel availability advantages and the opportunity to refuel over a period of several hours (as is necessary for electric vehicles and natural gas vehicles that use slow-fill technology) (EPA 1993; GRI 1993; Miau et al. 1992).

Indeed, public and private fleets do represent a promising entry-level market for alternative fuel vehicles. Recently, legislators and policymakers have bolstered efforts to capture this latent AFV market by passing regulatory mandates which decree public and private organizations to incorporate cleaner vehicles into their fleets. These mandates have been implemented at the federal, state, and local levels.

At the federal level, the 1990 Clean Air Act Amendments (CAAA; public law 101-549) and the Energy Policy Act (EPACT; public law 102-486) direct fleets to purchase "clean fuel vehicles" and alternative fuel vehicles, respectively. The CAAA targets fleets with 10 or more vehicles which are "capable of central refueling" and operate in non-attainment areas (approximately 21 areas in 19 states). It stipulates that 30% of light-duty vehicle purchases by these fleets be clean fuel vehicles starting in 1998; this requirement ramps up to 70% by the year 2000. In 1991 an executive order made purchase requirements for federal fleets even more stringent. It requires the "maximum number of AFV purchases practical" with targets of 25% of all new acquisitions in 1996, 33% in 1997, and 50% in 1998.

The 1992 Energy Policy Act also calls for the purchase of clean vehicles but with a different goal of reducing U.S. dependence on foreign oil supplies. For this reason, the act stipulates the purchase of alternative fuel vehicles that operate on fuel that is "substantially not petroleum and [that] would yield substantial energy security benefits". The EPACT establishes minimum AFV purchase requirements for federal and state government fleets and fleets belonging to companies that make alternative fuels (e.g., utility companies). Only fleets operating in large metropolitan areas (populations of at least 250,000) with 20 or more light-duty vehicles capable of central refueling are covered under the EPACT (the law applies only to vehicle operators who own at least 50 vehicles in the U.S.).

The EPACT requires that 10% of state fleet acquisitions be AFVs in 1996 increasing to 75% by the year 2000. Alternative fuel manufacturers start at 30% in 1996 increasing to 90% by 1999, and federal fleets start at 25% in 1996 increasing to 75% by 1999. The goal of the act is to replace 10% of the petroleum currently used by light-duty vehicles by the year 2000 and 30% by 2010. The Department of Energy (DOE) has rulemaking authority to impose additional AFV purchase requirements on private fleets if it is deemed necessary in order to attain these goals. The deadline for this rulemaking is the end of 1996 and purchase requirements, if invoked, would go into effect beginning in 1999.

Over twenty states have followed suit with their own rules and regulations that encourage fleets --especially state-owned fleets -- to purchase AFVs. Several cities and counties, not satisfied with the rate of implementation specified in federal and state laws, have also formulated policies to expedite the penetration of AFVs in the fleet market. Denver and Sacramento are two examples of metropolitan areas that have instigated their own AFV fleet implementation strategies.

## 1.2 Statement of Problem

As purchase deadlines draw near, it remains unclear how effective AFV fleet mandates will be in terms of mitigating air pollution, reducing petroleum needs, or even jump starting the AFV market. Fleet rules proposed to date are easy to circumvent, difficult to enforce, and confusing to fleet operators. Moreover, it is questionable whether government fiats are an effective, or even plausible, means of introducing AFVs into the automobile fleet market. Any attempt to "regulate" the fleet industry is inherently difficult because the only commonalty amongst those being regulated is the fact that they operate vehicles. They do not make the same product, provide the same service, or even operate their vehicles in the same manner.

Further complicating matters is the fact that vehicle fleets are as varied and diverse as organizational structures themselves. In fact, there is no widely recognized definition of a "vehicle fleet" or an accurate accounting of the number of vehicles residing in fleets. A fleet may consist of two vehicles or 2 million vehicles; it can include anything from forklifts to semi-trucks; and it can serve a multitude of purposes from transporting employees to delivering heavy equipment. There are no strong correlations between an organization's size, the number of vehicles it has, or the function of its fleet.

The role and position of a vehicle fleet within an organization also varies considerably. The fleet may be a minor part of an organization's business or essentially the whole business (e.g., taxi services). Fleet management responsibilities are delegated to a number of seemingly unrelated departments including travel, administration, finance, sales, operations, and purchasing. Although any of these can be a successful arrangement, each department has different goals and objectives which influence fleet decisions. Moreover, some organizations dedicate a full-time position to fleet management while others assign the duty to an employee who already has several other job responsibilities.

The diversity in function, structure, and composition of organizational fleets makes it difficult to formulate fair and effective policies regarding the implementation of AFVs. The dynamic nature of fleets adds to this difficulty. Historically, organizations have altered their fleet programs in order to stay in step with changes in the economy and tax law reforms (Chaudier 1989; Runzheimer 1993). This is accomplished by changing the number and type of vehicles, as well as the ratio of owned vehicles to leased or employee-provided vehicles. Organizations also divide or consolidate fleet sites when there is an economic reason to do so. The versatility demonstrated by fleets in the past suggests a strong potential for circumventing future AFV purchase mandates.

Because AFV purchase mandates are applied uniformly to vehicle fleets, they must be implemented in a way that does not invoke undue hardship on a particular type of business. Consequently, AFV fleet mandates typically contain several exemptions. For example, the CAAA excludes fleets with less than ten vehicles; these smaller fleets constitute a large portion of the entire fleet vehicle population. Approximately 30% of all fleet vehicles reside in fleets that have only 4 - 9 units (there is no record of the number of fleets with less than 4 vehicles) and this segment of the fleet population is the growing the fastest with a 32% increase in 1994 alone (Bobit annual). Currently, there is no strategy for developing this potentially large AFV market segment.

Another shortcoming with purchase mandates is the fact that they do not promote forward-looking long-term AFV investments. Most regulations give equal credit to all AFV types despite vast differences in their emission-reducing potential. In order to comply with regulations, fleet operators will tend to purchase the least expensive AFV that fulfills their regulatory obligation. Not surprisingly, the least expensive AFVs offer the fewest emission benefits. An immediate transition to marginally cleaner fuels -- the path of least resistance -- could come at the expensive of forestalling alternatives that offer superior long-term benefits. Moreover, there is no guarantee that once purchased, AFVs will be used to the greatest extent possible. Several fleet managers in this study stated that they would use AFVs primarily for low-mileage tasks.

### 1.3 Research Objectives

Government initiatives to introduce alternative fuels in the fleet market create the need to understand the organizational and decision-making characteristics of fleets. More sophisticated analysis is needed that goes beyond grouping fleets by physical attributes. After all, the AFV decision is tied to many factors which affect several parts, if not the entire, organization. Important considerations such as compliance with emission rules and mandatory trip reduction plans, infrastructure installation, travel needs, and corporate image will undoubtedly involve several individuals of various positions throughout the organization. Therefore, AFVs present the first real need to look at fleets in-depth, not as separate entities, but as an integral part of the organizational decision-making structure.

The primary objectives of this research are to 1) provide a means for classifying fleets in a manner conducive to developing effective AFV policy and implementation strategies and 2) develop an methodological framework for systematically assessing AFV fleet purchase behavior under different implementation scenarios. More specifically I am interested in the following issues:

- Who are the key fleet decisionmakers and what role will they play in the AFV decision ?
- What decision process will they adopt when making this decision? How will that process be influenced by fleet type? By external forces?
- What AFV marketing strategies will be most effective amongst different fleet types?
- What factors will have the greatest impact on market penetration? What are the real barriers to market entry?

The first research objective is concerned with identifying fundamental differences in the way organizations handle important fleet decisions. These differences include the number and organizational positions of the decisionmakers, the degree to which formal rules and guidelines dictate the decision process, the extent to which analytical techniques influence decision outcomes, and the overall autonomy of the fleet division. Collectively, these various decision factors comprise a fleet's decision-making structure. Accordingly, I will arrange the various decision-making structures into a fleet typology. A classification model will then be developed for categorizing new fleets into the typology using readily available information.

The second objective of this study deals with predicting how organizations will react to various AFV policies and implementation strategies. Critical decision paths are projected using a model adapted from the literature of decision-making theory. The model is used to predict how AFV problems are recognized and diagnosed, where information is sought, what type of analytical assessment is used, how choice sets are formed, who participates in the decision, and how much authorization is necessary. It is also useful for showing how AFV acquisitions will deviate from a routine vehicle purchase, who will participate in the decision at various points in the process, what stimuli are needed before action is taken, and what external factors will influence the decision process.

## 1.4 Contribution to Current Knowledge

This research, spurred by the fragmentary knowledge of fleet behavior and recent efforts to legislate alternative fuel vehicles into fleet applications, represents the first comprehensive assessment of the fleet decision process within an organizational context. It is fundamentally different from previous fleet studies concerned with the marketability of alternative fuel vehicles. Previous studies have focused on mapping AFV attributes to fleet travel demand in effort to estimate potential market size (Berg 1985; EPA 1991; ETFUCTI 1990; Mader et al. 1988; SCGC 1990; UIG 1985; Wagner 1979; Wagner 1980). This study examines the prospects for AFVs in a broader sense by analyzing the AFV purchase decision itself. This broader approach enables a better understanding of the type of organizations most likely to purchase a specific AFV under a given set of circumstances. It classifies fleets in a manner that is meaningful and useful for developing effective AFV implementation strategies. While studies of AFV fleet market potential are necessary and useful, knowledge of factors affecting market penetration -- the degree to which market potential is realized -- is imperative to formulating sound AFV policy.

This study also represents a departure from prior studies with regard to the chosen unit of analysis. Most studies and marketing efforts are premised on the assumption that the AFV issue is a fleet-level decision presumably made by the fleet manager or person responsible for day-to-day fleet activities (AGA/NGVC 1991; LADWP/SCE 1989; NAFA annual; Runzheimer 1993; Runzheimer 1995; SCGC 1990; SDG&E 1992). While focusing on the fleet manager, these studies overlook others within the organization who play a critical role in the AFV purchase decision. Many of the best selling attributes of AFVs, such as their ability to reduce vehicle emissions and enhance a company's "environmental image", mean nothing to the fleet manager whose primary responsibility is to keep the vehicles running at a minimum cost. Furthermore, most fleets operate on short-term budgets relative to the organization. Whereas an AFV investment with a four-year payback period may be unthinkable for a fleet manager, it may be viewed as a prudent public relations move by the company's vice-president. Fleet manager opinions are important but not necessarily indicative of an organization's intent to use AFVs.

This study also departs from conventional thinking with regards to how the AFV decision is perceived. Previous studies frame the acquisition of an AFV in terms of a routine vehicle purchase. However, the purchase of an AFV will not be made in a routine manner because of the importance of the decision in terms of 'actions taken, resources committed and precedents set' (Mintzberg et al. 1976). Businesses will face a situation not before encountered for which no pre-established guidelines exist. Because of their unique attributes and potential organizational implications, alternative fuel vehicles will take fleets into the realm of strategic decision-making. Consequently, the AFV purchase decision must be analyzed from a broader perspective that takes into consideration the needs of the entire organization. This organizational approach is the premise for my typology.

## 1.5 Study Overview

The layout of this dissertation is as follows. In chapter 2, I review the literature relevant to this research which includes several surveys and studies of AFV sales potential in the fleet sector. Many of these studies were conducted by utility companies and are not publicly available. In chapter 3, I provide a detailed description of the methodology used in this research with emphasis on data collection and analytical procedures. Chapter 4 is dedicated to explaining the data analysis which includes cluster procedures and the estimation of classification models. Results of these analytical processes are also presented in this chapter.

Chapter 5 is the first of several chapters dedicated to interpreting these results. Implications of the results are discussed in terms of the decision process. A model is adapted from the field of organizational decision theory and used to analyze the AFV purchase decision. In chapters 6 through 9 I evaluate my findings within the fleet typology framework. Each chapter profiles one of the four fleet types with regard to its decision-making structure and associated decision process. Finally, in chapter 10, I summarize the significance of my findings and state my conclusions.

# Theoretical Constructs and Previous Empirical Studies

## 2.1 Background

Much has been written about alternative fuel vehicles in general but very few studies deal specifically with the implementation of AFVs in the fleet sector. Most of the existing work on this subject, which has been conducted primarily by utility companies and government agencies, deals with assessing the marketability of AFVs which have attributes significantly different from conventional vehicles. None of these studies address the question of whether organizations would actually be willing to purchase AFVs or who will make that decision.

A second body of literature pertinent to this study deals with organization structure and decision-making processes -- the fundamentals of organizational theory. The alternative fuel vehicle decision will be an organizational decision due to its technical complexity, resource demands, and internal consequences. Explanatory models of decision-making behavior adopted from organizational theory are directly applicable to the fleet AFV purchase decision. Many of these models were instrumental in developing the fleet typology (Mintzberg 1979; Pfeffer 1981; Shrivastava and Grant 1985).

Although this chapter focuses primarily on studies of AFVs and organizational decision processes, information from other areas of research proved to be very valuable. The field of political science provided histories of policy implementation (Brigham and Brown 1980; Mazmanian and Sabatier 1983; Pfeffer and Salancik 1978). Inferences were drawn from these studies regarding the type of organizations likely to be first to comply with AFV mandates, those that would take a "wait and see" approach, and those most inclined to resist or circumvent AFV rules and regulations. Studies of fleet management practices (Botzow 1968; Chaudier 1989; Cooke and Woodard 1986; Dolce 1984) provide insights into the criteria for new-vehicle selections and those vehicle attributes most valued by fleet operators.

## 2.2 Overview of Fleet Surveys and Relevant Studies

In recent years several utility companies have conducted informal surveys, one-on-one interviews, and focus group sessions with fleet operators in an effort to assess the potential fleet market for natural gas and electric vehicles within their service areas. Usually the primary purpose of these exploratory studies is to generate an inventory of vehicle fleets that could potentially be replaced by natural gas or electric vehicles. In addition, several government agencies have also conducted studies regarding the prospects for AFVs in fleet applications. Because much of this work is recent and sponsored by utility companies attempting to assess latent natural gas and electricity markets, the results of these studies have not been widely distributed. Collectively these surveys and studies reveal important trends in the fleet industry, provide valuable insights regarding fleet behavior and management practices, and present an overall picture of the AFV attributes most desired by fleet operators as well as those considered most problematic.

The surveys summarized in this section are not a complete accounting of AFV fleet studies but rather those which proved useful to this research. The studies, which vary in scope, methodology, and purpose, provided information and inspiration to formulate hypotheses regarding AFV fleet prospects. These hypotheses were then tested using focus groups, interviews, and a statewide fleet survey. Below I highlight some of the salient findings from the most important surveys and studies.

Electric Vehicle Los Angeles Area Market Analysis. LADWP/SCE (1989).

The Los Angeles Department of Water and Power (LADWP) and Southern California Edison (SCE) contracted J.D. Power and Associates to conduct an investigation of potential light-duty vehicle fleet applications for electric vehicles in the Los Angeles air basin. This study included a literature review, an examination of R.L. Polk's data on light duty fleet vehicle registrations, and interviews with fleet vehicle dealers and managers of motor vehicle fleets. The study design attempted to ground the interviewee's responses by providing illustrations and fact sheets on six specific electric vehicles. (Some of these vehicles were hypothetical, some were G-vans and T-vans.) A total of 34 one-on-one interviews were conducted and included both dealers who sold vehicles to fleets and fleet operators. The results may be considered exploratory. A range of attitudes, motivations and information are revealed.

The most important conclusions from the fleet operator interviews include:

- Key vehicle purchase criteria include vehicle usefulness, reliability, and price;
- Initial cost (purchase price) is more important than operation and maintenance savings because fleets often operate on fixed budgets, vehicle purchase decisions are based in large part on cash flow, and life-cycle costs are considered too uncertain;
- However, operation and maintenance costs, as well as prior experience, define which vehicles are in the vehicle purchase choice set;
- Fleet size is a potential indicator of EV applications since larger fleets often own a larger variety of vehicles which perform a larger variety of tasks;

Those willing to test EVs were interested in the lower operating costs and longer vehicle life of EVs. Those who had no further interest cited recharging time, limited driving range, low performance and high battery cost as reasons not to try EVs.

The large fleets in the LADWP/SCE study cited "helping the environment" as the most important incentive for buying EVs followed by public recognition, utility discounts and tax credits. Small businesses in the LADWP/SCE study were more interested in financial incentives -- specifically, tax credits and special financing, but also rated the environment as an important incentive. The large/small fleet distinction distinguishes between fleets which perceive help with up-front costs (small fleets) as more important than operating costs (large fleets) as well as the diversity needed to incorporate an EV into the fleet.

The interviews showed that, as a group, fleet managers are very conservative in their decision-making. By and large, fleet managers are very skeptical of the claims for EVs. Lower operating costs, longer vehicle life, and lower repair incidence will have to be proven. These attitudes reflect a pattern of response which may be summarized as "we want what we already have".

The LAWDP/SCE study concluded that large fleets would be the best market to concentrate on initially because of the greater flexibility of large fleets, the greater potential to purchase large numbers of EVs if early trials prove satisfactory, and the potential for smaller fleets to accept EVs based on the experiences of larger fleets.

Natural Gas Vehicle Fleet Market Study, AGA/NGVC (1991).

The American Gas Association (AGA) and the Natural Gas Vehicle Coalition (NGVC) conducted a study in 1991 of North American fleet markets, with the primary focus on U. S. fleets. The study included secondary research, consultant field research, and a telephone survey of fleet administrators. The consultant field research covered major fleet leasing companies representing over 600,000 vehicles and large national fleets representing over 60,000 vehicles. The telephone survey covered 500 fleets accounting for 34,000 vehicles. This study is one of very few that looks specifically at fleet vehicle acquisition decisions and the implications for AFVs (specifically natural gas vehicles).

The main objectives of the study are to determine key fleet market characteristics, necessary conditions for NGV success, and appropriate gas industry market development strategies. Secondary objectives included identifying market drivers and decision processes, developing a market segmentation framework, and determining market perceptions and threats from competitive fuels.

Fuel cost was among the top "crucial cost" concerns expressed by study participants. Fleet managers were concerned about fluctuating prices. Many of the respondents recalled how projected savings disappeared soon after they purchased diesel vehicles in the late seventies (diesel fuel prices increased shortly thereafter). This underscores the importance of past experiences when selecting new vehicles. Maintenance was another important cost concern. Indirect maintenance costs such as down-time, mechanic training, and maintenance facility upgrading were as important as direct maintenance cost.

Operational factors were also addressed in the AGA/NGV survey. Range concerns were complex, leading this researcher to believe that some of the range concerns were real and some psychological. Even if the range was adequate for a majority of the vehicles in the fleet, it was still viewed as a problem. However, refueling requirements were less questionable. Even fleets that refueled centrally expressed the need to be able to refuel off-site at least occasionally.

Among the "vehicle specific" concerns expressed by survey respondents were refueling time, fuel tank weight and size, and resale value. Resale value is inextricably related to fuel availability, length of replacement cycle, and leasing arrangements. Therefore, it varies in importance depending on the fleet and the vehicle type. Resale value is not a vehicle purchase criterion for many fleets because vehicles remain in service until they are scrapped.

The study suggests that fleet operators are looking for an AFV partnership -- someone to share the risk who could assure them that problems would be taken care of quickly and easily. Along the same line, fleet operators wanted AFVs with good warranties. In general, it was noted that better information dissemination is necessary based on the number of fleet operators who have no knowledge of NGVs. The study points out that NGV acquisition is an executive level decision where corporate environmental policies will play an important role. Several high-ranking executives were interested in AFV emission credits that could be used to offset stationary source emissions.

Electric Vehicles in Commercial Sector Applications: A Study of Market Potential and Vehicle Requirements, EPRI (1984) (Berg 1984).

A carefully constructed sample of commercial businesses with at least one vehicle and the use of computer assisted telephone interviewing (CATI) separates this study from most other studies of potential AFV fleet applications. A total of 583 telephone interviews were conducted in a study by the Electric Power Research Institute (EPRI). The sampling scheme allows for population inferences with known error bounds. Some limits on differences between the intended (all commercial enterprises owning at least one vehicle) and realized populations (a sub-sample of Dunn and Bradstreet's commercial enterprise listing) are noted and evaluated. In general, any differences are likely to make the market potential estimates conservative.

The study concludes that light-duty trucks and vans tend to have usage patterns which are more amenable to limited range EVs than cars. Overall, vans and trucks represent about 50% of all fleet vehicles and approximately 80% percent of all commercial vehicles with high potential for EV substitution. However, approximately two-thirds of these EV-potential vehicles reside in fleets with less than 7 vehicles and thus would be exempt from any existing AFV purchase mandates.

In addition to vehicle performance, fleet operating factors were analyzed for their impact on market potential. Approximately half of all commercial fleets appear able to carry out "routine" EV maintenance, and most of these can do so at their own facilities. The study concludes that with little effort 80 percent of all commercial fleet vehicles could be assigned to specific drivers which is the "optimal operating environment for EVs". Payload capacity was found to be only a minor constraint to EV usage. Respondents rated initial capital investment, total life-cycle cost, and maintenance considerations as the three most important new vehicle purchase criteria.

Finally, the study looked at the "willingness" of fleets to use and purchase an EV. Forty-three percent of fleet managers indicated a willingness to use electric vehicles. These respondents indicated that, on average, they could use just under two vehicles per fleet. Willingness was positively correlated with fleet size and the number of vehicles traveling less than 60 miles per day. There was a strong negative correlation between willingness and vehicle purchase cost.

Assessment of Potential U. S. Market for Electric Vans: North American Van Market Survey, EVDC (1988) (Mader et al. 1988).

Another large survey aimed at defining the initial commercial fleet market for electric vehicles according to vehicle use characteristics was conducted in 1987 by the Electric Vehicle Development Corporation (EVDC). This survey focused on vans used in commercial fleets. Over 3,500 telephone interviews were completed with fleet administrators from the 30 largest metropolitan areas in the U. S., representing about 50%

of the light-duty fleet market. A stratified random sampling was used to ensure accurate representation of fleets.

Results were similar to the above EPRI study. The survey concluded that 80% of the sampled vehicles (365,000 vans) could be replaced by an electric vehicle with a 90-mile range. Other salient findings include the fact that 42% of the vans in the sample operated within 15 miles of the business on a daily basis, and one third of the vans operated along fixed routes. Over 60% of the vans represented in the survey resided in fleets of 11 or more vehicles; yet these fleets represented only 3% of all the surveyed fleets. This implies that a large portion of all vans operating in fleets would not be covered by any existing or proposed fleet regulation. However, the vans which are covered are highly-concentrated in relatively few fleets which is conducive to regulatory control. This is one of the primary reasons why fleet vehicles are targeted by AFV regulations. A considerably large number of vehicles and relatively few owners is conducive to regulatory control. It also allows manufacturers to focus on relatively few vehicles and customers.

In addition to determining the number of fleet vans with travel patterns amenable to EV use, the survey also solicited fleet manager attitudes about electric vans. Results show that concerns dealt with economic considerations such as longer life, fewer repairs, full warranties, and independence from gasoline price fluctuations. Respondents were impressed with the non-polluting attribute of the van with the highest praise coming from the cities with the worst air quality. The only "significant" negative feature was the limited mileage (60 miles per charge).

Fleet Vehicles in the United States: Composition, Operating Characteristics, and Fueling Practices. ORNL (1992) (Miau et al. 1992).

This report updates *Characteristics of Automotive Fleets in the United States 1966-1977* (Shonka 1978). The purpose of this study was to collect and summarize data from current sources pertaining to fleet vehicles in attempt to determine how fleet vehicles are operated, where they are located, and their usual fueling practices. Information is collected in part to "determine the feasibility and practicality of introducing AFVs into the fleet market, analyze potential penetration rates of AFVs in fleet markets, and establish infrastructure requirements for successful operation of AFVs by fleets". Conclusions are based on data from several studies including the Oak Ridge National Laboratory's (ORNL) own phone and mail survey administered to 33 fleet operators with 10 or more vehicles in their fleet.

The study provides statistics such as average replacement cycles for fleet and vehicle types, and general fleet compositions. In addition, it reveals that vehicle fleet programs are not immutable but rather fleet decision-makers are willing to make changes -- sometimes risky changes -- for uncertain gains. This finding is inferred from trends within the fleet sector over the last two decades. During this time fleets have shifted between small vehicles and large vehicles; changed from ownership, to leasing and employee reimbursement programs; switched resale methods, and changed mandatory vehicle replacement times. Results of my focus groups and interviews support this finding as many participants indicated a willingness to make changes to keep in step with economic fluctuations.

The study points out another fleet sector trend with important implications for AFV sales. Fleet sales, which account for 23.7% of all new car sales in the U.S., have been growing at a rate of 6.6% over the last 10 years. The large vehicle market can be attributed to a relatively high vehicle turnover rate (3.3 years compared to 7.8 years for a typical private passenger car). These trends are paramount to the argument that an expanding fleet market and high vehicle turnover rates provide the fastest means for introducing new vehicle technologies.

The ORNL study summarizes the reasons why fleets are considered a more attractive market for new vehicle technologies than the household market. These reasons are the motivation behind current AFV fleet policies. The reasons cited include:

1) Organizational resources permit fleet operators to accept some of the risk associated with the testing of new technologies.

2) Bulk buying practices enable automobile manufacturer to focus on a limited number of products and a small number of customers.

3) Fleets are more capable of assigning AFVs with limited performance characteristics to less-demanding tasks.

4) Fleet managers practice more conscientious maintenance and record-keeping practices.

5) High mileage accumulation provides manufacturers and fleet operators quick feedback via large amounts of operating data.

In addition, the earlier study (Shonka 1978) lays out some of the other common arguments for actively promoting new energy related technologies through fleet vehicles. Among these are: 1) the presumption that fleet vehicles are bought by "a well-informed fleet administrator who is more likely to consider life-cycle costs than a private individual", 2) fleets are often housed at one location overnight and 3) operating demands of the vehicles (maximum daily range and load carrying capacity) are clearly defined.

<u>National Association of Fleet Administrators (NAFA) Annual Surveys. NAFA (annual).</u>

Every year the National Association of Fleet Administrators (NAFA) administers several surveys to its members. These surveys deal with fleet policies and practices regarding: the purchase of new vehicles (*New Vehicle Acquisition Survey*), policies regarding the use of fleet vehicles (*Vehicle Use Polices and Procedures Survey*), the disposal/resale of used vehicles (*Used Vehicle Marketing Survey*), and a variety of other subjects (e.g., *Membership Attitude Survey*). Because the surveys are issued only to NAFA members in the U.S. and Canada, the sample is not representative of the entire fleet population (NAFA membership is composed primarily of large fleets -- over 25 vehicles -- and excludes taxis, rental fleets, and federal government fleets).

Nonetheless, these surveys are useful for identifying trends and changes in fleet practices. They are useful for formulating hypotheses regarding fleet management reactions to various AFV types. I will not detail the results of these surveys since they are similar to findings from other surveys reported here. However, there is one NAFA survey which deserves mention because it offers greater insight into fleet attitudes about certain AFVs.

In 1992 NAFA administered a survey to members who operate methanol flexible-fuel vehicles (FFVs) in order to solicit their opinions and attitudes about the vehicles and AFVs in general (NAFA 1993). Seventy nine fleet managers responsible for 1702 FFVs responded to the survey. The results show that. "despite reports of substantial problems with methanol fuel and FFVs, many fleets plan to acquire more flexible-fueled methanol vehicles". Overall these early adopters of AFVs seemed to expect some difficulties with the new technology and therefore were not too discouraged when problems do occur.

Two motivations were commonly cited for purchasing FFVs. Seventy eight percent of the respondents were motivated by an obligation to "help improve air quality" and 78% valued the "public relations benefits" of committing to clean fuels. Other motivating factors included a desire to gain expertise to deal with future fuel use (38%), the opportunity for financial subsidies being offered (23%), and credit towards mandatory trip reduction programs (19%). In an open-ended question asking which factors would encourage them to purchase more AFVs improving air quality again headed the list. Employee trip reduction credits was a distant second followed by public relations benefits.

The reasons listed for purchasing an FFV were echoed in this study. However, these reasons generally do not interest fleet managers as much as upper level executives. Many of the reasons are tied to larger organizational goals and objectives which may require input from departments with little knowledge of fleet operations. The willingness of these fleets to accept the potential drawbacks and inconveniences of FFVs in the absence of regulatory requirements or significant monetary gains bodes well for AFV fleet marketers. However, marketing strategies must target those within the organization who benefit most from using AFVs.

G-Van Demonstration Project Surveys, SCE, SMUD, DE (1988-1992)

In February of 1990 Southern California Edison (SCE) utility company initiated its electric G-van loan program. SCE loaned passenger and cargo vans to various public and private fleets in southern California. Participants were requested to fill out a questionnaire regarding their satisfaction with the vehicle. A review of the completed surveys revealed several trends. Generally, positive responses focused on the lack of tailpipe emissions, expected low maintenance, and the use of an abundantly available non-petroleum fuel. However, other characteristics of the electric G-van -- range, noise level, acceleration, cargo capacity, driveability, and recharge time -- were largely unsatisfactory. The expected purchase price of $35,000 was considered prohibitive.

The Sacramento Metropolitan Utility District (SMUD) conducted a similar loan program with G-vans for periods of one day to one week. They also administered a survey to participants. Responses reflected the above findings (based on a review of the completed surveys).

A third demonstration program using G-vans was conducted in the Detroit metropolitan area. Detroit Edison (DE) provided two G-Vans to seven public fleets for four weeks each. Those that used the vans completed a survey which was intended to provide information of vehicle requirements necessary for fleet use. Areas cited for need of improvement were range, acceleration, and ride/ handling. In addition, the absence of several "creature comforts" such as air conditioning and power steering were cited as significant shortcomings. Malfunctions were also common. Over half the respondents rated the G-van as "fair to poor". Detailed results of the Detroit demonstration survey have been published (ETFUCTI 1990).

The results of these three demonstration projects support my focus group and interview findings regarding the G-van. Participants who tried the vehicle where generally not satisfied with vehicle performance and many had experienced mechanical problems. The G-vans, which were plagued with several mechanical problems, are a poor example of the technology. Negative impressions of G-vans based on personal experiences and those of fellow fleet operators have been very damaging to the EV reputation. Negative memories of the G-vans linger. Several fleet operators participating in this study mistakenly perceive the obsolete G-Van to be representative of modern-day EV technology.

An Analysis of the NAFA Fleet Data Base: Passenger Cars Only, BNL (1979) (Shonka 1980).

In March of 1979 NAFA mailed questionnaires to all of its 1500 members from which they received 139 usable responses. The purpose of the survey was to inventory fleets and to "determine the physical demands and economic constraints for ten options selected as those most likely to affect the acceptance of a new transportation technology -- i.e., electric vehicles.

The results showed that some operating demands and desired options -- number of seats, trunk capacity, range and reliability -- varied by fleet type while others, such as recharge time, did not. Survey results focused on how much extra fleet operators would pay for vehicle characteristics and amenities. The study concluded that no one factor significantly affects the EV penetration rate in fleets but rather fleet administrators consider options, performance and price, simultaneously. Decreasing recharge time from 8 to 0 hours or increasing the maximum range from 100 to 300 miles had very little effect on the market penetration rate for EVs priced at $6000 (1979$). The study was one of the first to employ a model developed by BNL to estimate market penetration rates of EVs in the fleet market.

Vehicle Attributes Constraining Present Electric Car Applicability in the Fleet Market. BNL (1977) (Wagner 1979).

In Augnst 1977 a questionnaire was sent by the Bobit Publishing Company to subscribers of Automotive Fleet (a fleet trade magazine published by Bobit). A total of 1267 responses were returned from 12774 mailings. Again, the general intent was to estimate upper bounds on the fleet market penetration of electric vehicles with certain physical attributes.

The Bobit survey results identified the greatest constraints on fleet applicability of EVs to be range limitations (for a 44-mile range EV) and lack of power amenities. The least constraining attributes were recharging time (8 hours) and the inability to use interstate highways. The survey also found many similarities in fleet vehicle needs between government agencies and utility companies.

Natural Gas Vehicle Fleet Operator Survey and Focus Groups. SDG&E (1992)

In 1992 The San Diego Gas and Electric Company (SDG&E) sent a short questionnaire to fleet vehicle operators in their service area. Of the 769 surveys sent out, 226 were returned. The overwhelming conclusion of the survey was that fleet operators are not informed about NGVs or aware of programs and incentives currently in place to facilitate NGV development. However, once informed, over half of the respondents indicated an interest in SDG&E's NGV test drive program and 'NGV Conversion Incentive' program.

A more insightful study of fleet attitudes was conducted by SDG&E in the same year. This study consisted of a series of focus group sessions with fleet operators. SDG&E recruited thirty-eight employees from various organizations who were "involved with the management and operation of their company's fleet, and were either a key decisionmaker or a prime decision influencer". These 38 individuals, representing a cross-section of organizations with various fleet types and fleet sizes, were divided into four focus groups (one group comprised current AFV owners, and the remaining groups were determined by fleet size). Participants were randomly chosen from a listing of 2,680 fleet operators representing over 130 standard industry code (SIC) categories. The primary purpose of the study was to "examine fleet operators' opinions, perceptions, knowledge, and willingness to convert vehicles to natural gas" and to assess the experiences and satisfaction levels of those fleets already operating NGVs. SDG&E's overall goal was to develop effective pro-active NGV marketing strategies.

SDG&E drew the following conclusions from the focus group sessions:

- Public sector and large private fleets (20 or more units), which represent a third of all light and medium duty fleet vehicles in the SDG&E service area, are the best candidates for initial NGV purchases.

- The size of the potential market is limited by the fact that NGVs do not represent a solution to any current pressing fleet problems. Fleets are not actively seeking lower fuel costs (gasoline costs are lower than any time in the last two decades in constant dollars) nor is there a perceived threat of a petroleum shortage.

- Fleet operators showed concern regarding shorter ranges, longer refueling times, fuel availability problems, and other drawbacks associated with new technologies.

- Fleet operators are reluctant to switch to natural gas because of a lack of commitment from utility companies, OEMs, and the government. All three are perceived by fleet operators to be "detached and indifferent about the issue".

In addition to the above salient findings, I was able to discern several other important details from viewing video tapes of the focus groups:

- Fleet operators still perceive AFVs as experimental technology. They are skeptical about the future of AFVs and the rapidly changing technology. They are hesitant to commit to a specific vehicle type because they do not want to become "technology orphans" if the AFV they select is rendered obsolete.

- The cost concerns most frequently stated had to do with resale value, downtime, refueling costs (in terms of employee wages), and vehicle reliability. Long-term cost savings were discounted heavily compared to up-front subsidies. A three year payback period on an AFV investment was considered unreasonably long.

- Experiences or stories about AFVs, positive or negative, conveyed by other fleet operators strongly influence those who have not yet formed an opinion. Most fleet operators who dismissed AFVs did so based on hearsay that was often misleading or false.

- Safety concerns are of major importance amongst those with little or no AFV knowledge. However, it is a moot point amongst those who have even the slightest knowledge about AFVs.

- The AFV purchase is a multi-department decision involving upper management. However, managers will depend heavily on information provided by fleet personnel when forming their opinions. Fleets matters are generally low priority for managers who have little time to devote to such issues.

- Fleet operators will look to other fleets as a first source of AFV information. There is a very deep rooted network system amongst fleets. Trade journals and other fleet oriented publications are also important but promotions by AFV manufacturers and utility companies are considered with "cautious skepticism".

- Fleet managers are interested in vehicle specifications (horsepower, cargo capacity, engine type, maintenance needs) and actual in-use histories (maintenance needs, breakdowns).

Local Government Fleet Survey, CEC (1992)

The California Energy Commission (CEC) administered a mail survey to city and county government fleets in California. The purpose of the survey was to record current fleet management and maintenance practices. The CEC received replies from 168 fleets in 161 cities and 56 fleets in 45 counties (for an overall response rate of 39%).

The study found that most local government fleet operators get information about new laws and requirements concerning environmental issues from publications, regulatory agencies, and professional fleet management associations. The most frequently expressed concerns about AFVs were the high purchase and maintenance costs, fuel costs, fuel availability, and reliability. Fleets said they would purchase an AFV to satisfy regulations, improve air quality, and to reduce petroleum consumption. One in three fleets expects to buy an AFV in the next 2-3 years. This is consistent with other studies which show that government agencies will continue to lead the AFV fleet market (CEC 1992; Davis 1995; DOE 1993; Hu and Wang 1996; Hu et al. 1996; NAFA annual; Runzheimer 1995; Vyas and Wang 1996).

Survey and Analysis of Business Car Policies and Costs. Runzheimer International (biennial). Business Fleet Refueling Assessment, Runzheimer International (1994) (Chaudier 1993).

The biennial Runzheimer survey of fleets in the U.S. and Canada provided important fleet data. It is the most comprehensive survey of its type conducted on regular basis. In 1991 Runzheimer sent out 28,219 questionnaires to fleet operators in business, government, and utility organizations. A total of 1087 responses were returned. The questionnaire contained nearly 250 questions about fleet composition, management and administrative practices, desired vehicle characteristics, and AFV purchase intentions (in 1993 the number of questions and survey size was significantly reduced). The results provide data and information on policies, costs, and trends within the fleet sector. Trends are easy to identify because the past three surveys (six years) are listed for comparison along side current responses .

The survey covered a wide range of fleet topics including major problems facing fleets, how companies dispose of their vehicles, fleet changes adopted to control fleet costs, maintenance practices, legislative requirements, who drives company vehicles, driving demands for different types of businesses, written fleet policies, and operating procedures. Runzheimer divides fleets into business, government, and utilities which allows for convenient comparisons. They further distinguish business fleets by those that purchase vehicles, those that lease, and those that use employee-provided vehicles. Vans and trucks are also broken out. This data helped identify trends in fleet practices, vehicle selection criteria, cost concerns, and purchase patterns.

The survey also contains a series of questions specifically about alternative fuel vehicles. The first part of the AFV section is an accounting of AFVs and alternative fuel use in public and private fleets. The second part is a comparison of performance, operating costs, and maintenance needs between AFVs and conventional vehicles (for fleets that use

AFVs). Generally, fleets with first-generation AFVs find performance "somewhat inferior", operating costs "somewhat higher" and maintenance needs "somewhat greater". The final part of the AFV section deals with purchase intentions. Despite reportedly higher cost and poor performance, about 25% of government and utility fleet respondents using AFVs plan to buy or increase the number of AFVs in their fleet, compared to 3% for business fleet respondents. Higher planned government purchases of AFVs likely reflects the combined effect of better information, stronger commitments, and regulatory requirements.

In 1992 Runzheimer augmented their biennial survey with a survey designed to quantify potential use of CNGVs in fleet applications (the survey was funded by the Gas Research Institute). The objective of the survey was to develop profiles of light-duty business fleets. The survey also measured the effect of the 1990 Clean Air Act provision which exempts vehicles that are not "centrally refueled or capable of being centrally refueled". (Similarly, a provision in the Energy Policy Act of 1992 excludes commercial fleet vehicles that are "garaged at personal residences overnight".) The survey consisted of a questionnaire mailed to approximately 8000 fleet managers in 22 non-attainment areas plus Pittsburgh and Salt Lake City. The 368 respondents were then re-contacted for a follow-up phone interview.

Results show that only 25% of the respondents refuel at the business location and only 56% of the vehicles represented by these respondents were parked at a central business location at night. The survey also highlights the fact that business fleets are non-homogenous in terms of the type of vehicles used, where vehicles are refueled, and where they are stored at night. Very few fleets consisted solely of one type of vehicle (e.g., vans, pickups, automobiles) or one type of vehicle policy (e.g., leased, owned, employee-provided). Furthermore, few fleets kept all their vehicles at one location overnight or refueled them at the same location. This diversity amongst fleets suggests an ability to implement vehicles with different attributes and operating restrictions.

AFV Strategist Survey, Runzheimer International (1994).

In 1994 Runzheimer conducted a survey (updated every 6 months) which deals specifically with the implementation of AFVs in fleet applications . The survey was mailed to approximately 10,000 subscribers of Automotive Fleet Magazine. The survey profiles the attitudes, knowledge, and experiences of 1,435 fleet managers (representing 1.1 million vehicles) with regards to alternative fuel vehicles.

Foremost amongst the reasons for not purchasing an AFV are the lack of refueling facilities and limited driving range. Other reasons frequently cited are high purchase prices, few repair facilities, unavailable from OEMs, unacceptable performance, high life-cycle costs, uncertain air quality benefits, concerns about vehicle safety, and the fact that they are not required by law. The survey also shows that respondents have little or no interest in purchasing an AFV that costs $2000 more than a comparable gasoline vehicle. In fact, serious purchase considerations do not occur until the cost is within $1000 of a similar conventional vehicle (in most cases, far less than $1000). However, this survey, like most fleet surveys, does not provide information regarding other life-cycle costs. It is, therefore, impossible for fleet vehicle purchasers to make well-informed decisions about AFVs. How costs are presented will largely determine the rate at which AFVs enter the fleet market.

The survey confirms a strong information network amongst fleet operators. In fact, one-third of the respondents know another fleet operator who has experience with AFVs. Other reported sources for information on alternative fuels were: fleet industry publications, manufacturer information sources, fellow fleet operators, conferences, conventions, seminars and automobile shows, fleet organizations, leasing companies, and government studies.

A significant number of respondents (26.4%) "have or are developing a plan to convert a portion of their fleet to AFVs". Most of these fleets are government agencies and utility/fuel providers. Others have not decided what to do about AFVs and are "waiting until the last minute" to make sure current AFV regulations don't change.

A final segment of the survey deals with attitudinal indicators concerning environmental, social, and political topics germane to the AFV issue. This section is designed to create a profile of potential AFV fleet purchasers. Survey participants "agreed" or "disagreed" (using a Likert scale of 1-10) with 25 given statements. Respondents agreed strongly with statements like "I am concerned about the quality of air in my community"; "I would be willing to pay more for a vehicle that was better for the environment"; "reducing our use of imported oil should be a high priority"; and "I like to experiment with new ideas and technologies".

However, they agreed equally strongly with statements like "no one has the right to tell me what type of vehicle I can drive" and "there is too much government regulation in our lives today". These positions are not contradictory but reflect the resentment of fleet operators who feel they are already over-regulated (a common theme in my focus group sessions). It also suggests that fleet operators generally agree with the need for AFVs, although not strongly enough to purchase one.

<u>Vehicle Fleet Managers Survey: Characteristics of Vehicle Fleets and Alternative Fuel Usage and Preferences, SCGC (1989)</u>

In November of 1989 the Southern California Gas Company (SCGC) conducted 20 exploratory telephone interviews, four focus groups, and a mail survey of 289 professional vehicle fleet managers. The purpose was to collect information which would aid in the development of NGV marketing strategies. In addition to obtaining data on fleet characteristics (number and types of vehicles, refueling practice, etc.) to use for estimating the potential market in SCGC's service area, the survey data was also used to gauge AFV awareness and identify AFV decision-making criteria. The study focused on natural gas but also included methanol and propane vehicles.

Responses indicate that fleet managers questioned SCGC's long term commitment to NGV technology. Respondents wanted to know long-term projections for fuel availability, what kind of service support can be expected, and what assurances there were that the price of natural gas would not rise after they invested in NGVs.

Overall the respondents were generally uninformed about natural gas vehicles and relevant fleet rules and regulations. However, they were very interested in learning about AFVs in general. Test drive demonstrations, trade journal articles, and colleague testimonials were cited as the most trusted sources of information. Fleet managers also stated a preference for "turn-key" AFV solutions. Strong technical support and good warranties were considered imperative.

<u>EPACT Fact Finding Fleet Surveys: Alanta, EIA (ongoing)</u>

Section 407 of the 1992 Energy Policy Act (EPACT) directs the Energy Information Administration (EIA) to generate information that will facilitate the sale of AFVs and help potential purchasers and users of such vehicles. In 1995 the EIA began to fulfill this directive by conducting a fleet survey in the Atlanta area (an air quality non-attainment area).

Data were collected on a sample of private fleets with six or more vehicles. Preliminary findings reveal that of the estimated 24,000 fleets in the Atlanta area, 24% were aware of legislation that requires fleets to use clean fuels in the future. Two percent already have AFVs in their fleet and 3% are planning on purchasing AFVs within the year. Also of interest is the fact that approximately 25% of the light-duty vehicles operating in private fleets belong to fleets with less than 20 vehicles and therefore would be exempt from EPACT AFV purchase requirements. The EIA is currently conducting similar surveys in several other cities participating in the Department of Energy's 'Clean City Program'.

Estimated Number of Fleet Vehicles Affected by the Clean Fuel Fleet Program. EPA (1991)

This report details the calculations and assumptions used to estimate the number of fleet vehicles which are affected by the Clean Fuel Fleet Program in the 1990 Clean Air Act Amendments. The figures represent the Environmental Protection Agency's (EPA) "understanding of current fleet policies and practices as portrayed through a number of surveys, reports, and fleet publications." EPA concludes that for the 21 affected urban areas combined, approximately 110,000 clean-fuel vehicles (CFVs) will be sold in 1998. In the year 2000, 236,000 CFVs will be sold and a total of 517,000 will already be in motor vehicle fleets.

One major problem noted in the study is the language of the law which targets fleets that have 10 or more vehicles that are "centrally refueled" or "capable of being centrally refueled". The number of vehicles affected could differ significantly depending on whether this stipulation is interpreted broadly or narrowly. Many fleets could circumvent the fleet program requirements of the federal Clean Air Act Amendments (CAAA) simply by changing refueling procedures. In reference to the possibility of circumventing CAAA requirements, several interviewees in this study and the AGA study hinted that their companies would "probably eliminate them (centrally refueled vehicles) and go to another system such as paying employees' expenses for the use of their private vehicles".

Table 2.1 lists the AFV fleet surveys described above. It is not a complete list but rather a review of the primary AFV studies which serve to anchor this research.

## Table 2.1: AFV-Related Fleet Surveys

| Survey, Organization & Year of Survey | Target Population & Response Rate | Objective/Information |
|---|---|---|
| EV Fleet Market Analysis for the L.A. Area LAWDP/SCE 1989 | Light-Duty Vehicles (LDVs) Business: Utility: Gov't (B:U:G) 34 interviews w/ fleet mgrs. & vehicle dealers. | Estimates EV fleet potential in L.A. area. Understand perceptions of EV performance, cost, & image. Gain insights for marketing strategies. |
| NGV Fleet Mkt Study AGA/NGVC 1991 | LDVs. B:U:G. National 500 phone interviews w/fleet operators. | Formulates market development strategy. Identify key market drivers, fleet management practices, and prevailing perceptions of NGVs. |
| EVs in Commercial Sector Applications: A Study of Mkt. Potential & Vehicle Requirem'ts EPRI 1984 | Business LDVs. National 583 phone interviews with fleet managers. | Assesses potential EV fleet market in terms of fleet vehicle characteristics & operating needs. |
| North America Van Mkt. Survey EVDC 1987 | Business LDVs. 30 largest U.S. metropolitan areas. 3500 phone interviews w/ fleet managers. | Assesses potential EV van fleet market in terms of fleet vehicle characteristics & operating needs. |
| Fleet Vehicles in the U.S.: Composition, Operating Characteristics and Fueling Practices ORNL 1992 | LDVs. B:U:G. National 33 phone & mail surveys to fleet managers. | In addition to their own survey, ORNL summarizes other fleet studies. Covers vehicle needs and operating practices. AFV implications are noted. Updates 1978 ORNL study. |
| NAFA Membership Surveys NAFA annual | LDVs. B:U:G. National Mail survey to NAFA members. Response ~ 20% | Surveys deal with vehicle acquisition and resale practices, fleet policies, and member attitudes regarding contemporary issues including AFVs. |
| G-Van Demonstration Surveys: SCE, SMUD, DE 1988-92 | Private & public fleets participating in demonstration. About 40 questionnaire surveys. | After using G-Van for periods of 1 day to several weeks, fleets evaluated performance and satisfaction level. |
| Analysis of NAFA Fleet Database: Passenger Cars Only. BNL 1979 | LDVs. Mail survey to NAFA members. Response 139/1500 | Determines physical demands & economic constraints likely to affect acceptance of EVs. |
| Vehicle Attributes Constraining EV Applicability in Fleets BNL 1977 | LDVs. Mail survey to Automotive Fleet Magazine subscribers. Response 1267/12774 | Estimates upper bounds of EV fleet market given specific vehicle attributes. |

## Table 2.1: AFV-Related Fleet Surveys (continued)

| Survey, Organization & Year of Survey | Target Population & Response Rate | Objective/Information |
|---|---|---|
| NGV Fleet Operator Survey and Focus Group Sessions<br>SDG&E 1992 | LDVs. Mail survey to fleet mgrs. in SDG&E service area Response (226/769). Also, four focus groups w/ fleet decisionmakers. | Determines NGV awareness & bring incentive programs to attention of fleets. Assess satisfaction level of NGV users. Examine opinions, perceptions, & willingness to use NGVs. |
| Local Government Fleet Survey<br>CEC 1992 | LDVs & HDVs. Mail survey to all city & county fleets in CA. Response ~39% | Analyzes current fleet management & maintenance practices. Summarize attitudes regarding AFVs and purchase intentions. |
| Survey and Analysis of Business Car Policies and Costs<br>Runzheimer biennial | LDVs. B:U:G. National U. S. and Canadian fleets.<br>Response 1087/ 28219 | Collects data on operational practices, vehicle attributes, vehicle needs, fleet composition & AFV use/purchase intentions. Special survey in 1992 on fleet applications for CNGVs. |
| AFV Strategists Survey.<br>Runzheimer 1994 | LDVs. Mail survey to <u>Automotive Fleet Magazine</u> subscribers.<br>Response 1435/10,000 | Profiles attitudes, knowledge, and experiences of fleet managers with regards to AFVs. |
| Vehicle Fleet Managers Survey: Characteristics of Vehicle Fleets and Alternative Fuel Usage and Preferences<br>SCGC 1989 | LDVs. B:U:G. 20 phone interviews, 4 focus groups, & a mail survey to fleet managers in SCGC service area. | Collects data to aid in development of NGV marketing strategies. Includes fleet composition and operating characteristics, AFV awareness, & attitudes. |
| EPACT Fact Finding Survey<br>EIA (ongoing) | LDVs. B:U:G Mail survey to Atlanta area fleets. Additional surveys planned for other non-attainment cities. | Assesses alternative fuel awareness. Used to assist Department of Energy in AFV rulemaking. |
| Estimated Number of Fleet Vehicles Affected by Clean Fuel Fleet Program<br>U.S. EPA 1991 | Fleets covered under the Clean Fuel Program stipulated in the 1990 Clean Air Act Amendments | Evaluates Clean Fuel Fleet Program and estimates the number of affected fleet vehicles. Assesses feasibility of program based on current fleet policies and practices. |

## 2.3 Studies of Organizational Structure and Decision-Making Theory

Organizational decision-making theory is a relatively new field of research. Prior to the 1950's studies of organizational decision-making were limited to the arena of behavioral science which focused on individual choices. This field of research, rooted in statistics and economics, focused largely on the theories of rational choice and expected utilities. It dealt with individuals within organizations and was concerned primarily with developing normative models to increase managerial effectiveness. However, these studies were conducted in settings far removed from the organizational environment and thus emphasis on the micro aspects of decision-making failed to account for the organizational influences that often dominate decision behavior.

The first studies to recognize differences between behavioral decision theory and organizational decision processes viewed the latter as a special case of rational individual decision-making (Cyert and March 1959; March and Simon 1958; Simon 1957). They describe organizational decision-making as a rational approach with limiting bounds. Much of this work was premised on the idea that "satisficing coalitions" compose the core of organizational decision-making (Cyert and March 1963). It is assumed that these coalitions, consisting of managers with common organizational goals, generally follow the rational decision making models of man but the extent of their rationality is severely "bounded" by the complexity of the organizational structure. As a result, organizations do not always act rationally in accordance with well-behaved utility functions.

Studies of behavioral decision theory contributed significantly to the understanding of goal setting in organizations, the politics of group decision-making, bargaining and negotiating processes, and decision compromises. However, efforts to adapt behavioral models to organizational decision making have been only marginally successful. Organizational behavior is systematically different from that anticipated in the standard theories of rational individual decision-making. Organizations gather information which they don't use then search for more; often do not recognize a problem until they have a solution; and routinely copy inappropriate solutions (March and Shapira 1992).

The inability to describe organizational decision processes through behavioral models necessitated a new field of organizational decision theory and the development of more appropriate models. Lindblom's classic article in 1959 on "the science of muddling through" was the first significant break from the principles of behavioral management science (Lindblom 1959). He asserted that formal analysis plays only an "incremental" role in the decision process and, therefore, organizational decision-making cannot be accurately depicted by rational analytical models

This idea was later refined in a subsequent article (Braybrooke and E. 1963) where the authors describe the process of "disjointed incrementalism". Disjointed incrementalism is a decision process by which organizations get "as far as they can, little by little". They simplify decisions by emphasizing marginal changes and limiting the solution set to only a few alternatives. Consequently, progress is gained through small disjointed steps, not necessarily in an orderly sequence. Problems are adjusted to the circumstances and information is used only as it becomes available or is needed. As a result, the final decision is usually deferred to the last possible moment.

Quinn (1980) argues that although it is disjointed, this incremental stepwise approach is not only "logical" but essential in complex organizational decisions. He analyzed decision issues as they evolved by interviewing several people at all levels within the organization. He concluded that successful executives set only the broadest goals that are open to different interpretations as events and opportunities emerge. In this manner executives can guide proposals without committing to a rigid solution that may be proven wrong by unpredictable events. This appears to be an emerging strategy amongst organizations considering alternative fuel vehicles.

This piecemeal iterative approach to organizational decision-making was the basis for several subsequent models of decision-making including one adapted for the purpose of this study originally proposed by Mintzberg, Raisinghai and Theoret (1976). The premise of the model is that there is no simple sequential relationship amongst the steps that constitute the decision process. The model provides a map of all possible decision routes upon which the decision process can be traced as it passes through different phases and levels within the organization.

One important variable in determining the decision route has to do with the type of decision and the context in which it is made. Hickson et al. (1986) explore this idea empirically with a study of 150 organizational decisions. The authors found that the decision process depends on the complexity and politicality of the decision issue. Fahey (1981) also recognizes the inextricable relationship between the type of decision and the process. He defines decision types in terms of urgency and complexity and notes a "high degree of variability" in decision processes across these different decision types.

Understanding the linkage between decision types, decision-making structure, and the decision process is paramount to this study. The AFV decision outcome will be a function of all three components. This study is concerned with understanding the role each will play in determining the outcome of the AFV decision. The resulting analytical framework provides an means for predicting the significance of each thus enabling the formation of effective AFV implementation strategies.

# Research Methodology

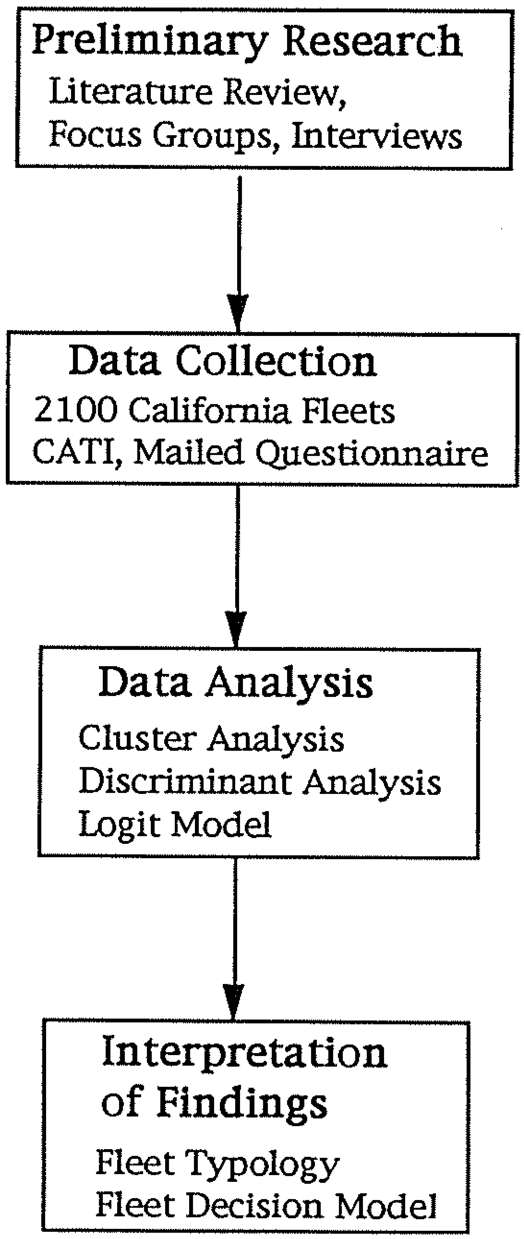
## 3.1 Introduction

This study comprises two main components -- a qualitative assessment of fleet decision-making and a quantitative analysis of fleet decision structures. Data were collected on organizations and their respective vehicle fleets throughout California using computer aided telephone interviews, mail questionnaires, focus group discussions, and one-on-one interviews. The research methodology consists of an iterative process that requires the constant exchange of information and model building. This grounded theory approach (Glaser and Strauss 1967) was chosen to integrate the complementary characteristics of the qualitative and quantitative components of the study.

Although the emphasis of this study is on fleets composed primarily of light and medium-duty vehicles, it addresses a diverse array of fleets varying in size, type, and function. Special measures were taken to include small fleets which have so far been underrepresented or excluded from AFV fleet studies. (Small fleets are less likely to belong to industry associations, whose mailing lists are typically used to construct survey sampling frames.) Although this study is not AFV-specific, special emphasis is placed on alternative fuel vehicles that show promising potential within the next 10 years and that have attributes significantly different from petroleum vehicles. Natural gas and electric vehicles are the two AFVs emphasized most in this study.

The research methodology consists of four stages: preliminary research, data collection, data analysis, and interpretation of the findings. The relationship between each of these stages is shown in Figure 3.1 and discussed in the following section.

# Figure 3.1: Research Methodology



### 3.2 Preliminary Research

The preliminary research consists of three parts; a literature review, a series of focus group sessions, and one-on-one interviews with fleet personnel. The literature review focused on studies and surveys pertaining to the use of AFVs in fleet applications. Most of these studies, inspired by recent legislation, have been sponsored by utility companies and government agencies (utility companies are interested in developing new markets for natural gas and electricity and government agencies are targeted by AFV fleet regulations). Empirical background information from these studies provided valuable insights into the expected behavior of fleet managers who are faced with the decision whether or not to invest in alternative fuel vehicles. These studies also provide a good measure of AFV awareness and provide a general indication of fleet manager attitudes towards alternative fuel vehicles.

The literature review served two important purposes. First, the information was used to determine the main issues surrounding the use of AFVs in fleet applications and how those issues could potentially influence the decision process. The second purpose of the literature review was to gather information for use in the next stage of the study. This information was used to formulate questions which were posed directly to individuals who were primarily responsible for deciding whether or not their organization would purchase alternative fuel vehicles. These questions were presented in focus group sessions and in one-on-one interviews with fleet managers, mechanics, business owners, vice-presidents and others identified as being influential in resolving important fleet decisions.

Fifty-nine individuals participated in seven focus group sessions and 35 others in one-on-one interviews. The focus group participants consisted of fleet operators from a diverse array of fleet types. Although the participants represented several different organizational positions, each was identified as the individual primarily responsible for new-vehicle purchase decisions. Organizations represented in these focus groups include state and local governments, public utility companies, small and large businesses, nonprofit organizations, automobile leasing enterprises, and trucking firms (a complete list of the organizations that participated in the focus group sessions and one-on-one interviews is provided in Appendix A). Special efforts were taken to include organizations with small vehicle fleets which are usually precluded from large surveys because of the difficulty of distinguishing them from private households. A combination of sources was used for the sampling frame including industry mailing lists, trade journal subscription lists, government databases, and local telephone directories.

Topics broached in the focus groups include decision-making procedures, fleet responsibilities, standard operating procedures and policies, fleet autonomy, AFV legislation, knowledge of AFV types, sources of information, primary concerns and considerations, strategies for implementing AFVs, purchase incentives, and likely reactions to various implementation scenarios. Background information was also collected on each organization and respective vehicle fleet. A subject outline was generally followed but participants were give considerable latitude as far as opening the discussion to different topics. When necessary, questions were modified, deleted, or added depending on what was discerned from previous sessions.

All focus group sessions and interviews were conducted in Sacramento and Los Angeles – the two cities in California leading efforts to incorporate AFVs into fleets. Los Angeles and Sacramento have both proposed rules intended to facilitate the implementation of AFVs in fleet applications. However, there are important differences between the two cities such as the level of AFV awareness, employee worktrip reduction requirements (which can be met through AFV purchases), and the level of air pollution in the two cities.

It is hypothesized that fleets operating in areas with serious pollution problems tend to be more aware and receptive to AFV purchase options.

Like the focus groups, one-on-one interviews were conducted with individuals of various ranks and duties who were determined to be influential in major fleet decisions. In many cases two or more individuals were interviewed from each organization. A toial of 35 individuals from 22 organizations were interviewed (the same sampling frame was used as the focus group sessions). Although all these individuals influenced strategic fleet decisions to various degrees, they represented several different organizational positions. Among the interviewees were business owners, fleet managers, purchasing department personnel, finance department personnel, environmental analysts and mechanics. Interviews were slightly less structured than the focus groups and lasted from one to two hours. One-on-one interviews provided an opportunity to delve deeper into the critical issues revealed in the focus group sessions.

Previous studies that interviewed fleet operators, either individually or in focus groups, did so on the premise that the fleet manager alone would make all decisions pertaining to AFV acquisitions. This is an unlikely scenario. By interviewing several employees from different departments within the organization, I was able to more accurately identify the real decisionmakers and evaluate the 'true' role each will play in the decision process. When interviewed, individnals sometimes overestimate or understate the impact of their opinion on important strategic fleet decisions. Only by interviewing others within the organization is their 'real' influence revealed. Furthermore, the AFV fleet decision may involve many issues which extend beyond the expertise of any one individual within an organization. By interviewing several individuals it was possible understand the dynamics and complex interactions likely to take place during the decision process.

Participants in my focus groups and interviews represented fleets with a wide range of experience with alternative fuels. Twenty percent of the focus group participants currently used AFVs. Most of these are public fleets and most of the vehicles are methanol flexible-fuel vehicles (FFVs), with the exception of a few utility companies which operate natural gas and electric vehicles. All of the Sacramento interviewees had investigated or driven a natural gas or electric vehicle (this was a selection criterion). Most participated in an electric vehicle (EV) loan program after being contacted by the local utility company (the interviewees were given an electric-powered van to use for periods ranging from one day to three weeks). One private fleet owned an natural gas vehicle (NGV). Eight of the thirteen Los Angeles area interviewees had at least one AFV in their fleet (including propane vehicles) and another had ordered several methanol FFVs.

Findings from the one-on-one interviews and focus group sessions helped lay the foundation for developing a typology of fleets based on their decision-making structure. This preliminary research revealed four distinct decision-making structures amongst vehicle fleets (see Table 3.1).These structures are distinguished by levels of formalization and centralization. Detailed descriptions of each decision-structure are given in subsequent chapters. Findings from this stage of the research were also used to help identify the critical phases of the potential AFV purchase decision.

## 3.3 Data Collection

The next research step involved the collection of data used to test the proposed typology. Data were collected using a multi-part statewide fleet survey conducted in 1994. The survey was administered to 2708 fleets operating in California. It was a collaborative effort between myself and researchers at the Institute of Transportation Studies at Irvine (ITS-Irvine) (Golob et al. 1995a; Golob et al. 1995b). Although the two studies had very different objectives, the cooperative arrangement was mutually beneficial.

**Table 3.1: Initial Typology of Fleet Decision-Making Structure**

| | High Formalization | Low Formalization |
|---|---|---|
| **High Centralization** | Hierarchic Decision-making Fleets | Autocratic Decision-making Fleets |
| **Low Centralization** | Bureaucratic Decision-making Fleets | Democratic Decision-making Fleets |

The survey sampling frame was taken from vehicle registrations procured from the California Department of Motor Vehicles (DMV). Registration records provided a good sampling frame. The sampling frame for previous fleet surveys typically consisted of rosters from industry associations, government agencies, and private research firms. Careful scrutiny of those rosters found them to be inaccurate, incomplete, and generally unacceptable.

DMV registrations were screened in order to identify records with multiple vehicles registered to one individual or location. Because initial screenings found several non-business households with multiple vehicles registered to one individual (many households had more than 5 vehicles registered to the same address), a ten vehicle minimum cutoff was invoked (by ITS-Irvine). Sites with less than ten vehicles were excluded from the survey in order to screen out multi-vehicle households. Program algorithms were used to identify and exclude those sites. The final survey was based on a proportionate sample of registration sites. However, the survey excludes fleets belonging to state and federal governments, rental and leasing fleets, emergency vehicles, and fleets composed entirely of large trucks (>14,000 lb. GVW).

Careful measures were taken to identify the primary fleet decisionmaker for the purpose of collecting information. Where more than one decisionmaker was identified, efforts were taken to include all those capable of influencing the decision outcome. This was accomplished through a screening protocol where organizations were contacted to collect background information and to identify the primary fleet decisionmaker(s). At this time a computer aided telephone interview (CATI) was conducted. The initial CATI resulted in 2711 completed interviews which equates to a 71% completion rate once an eligible fleet decisionmaker was identified.

The second part of the survey consisted of a seven page mail questionnaire which was administered to 2708 fleet sites that consented during the CATI interview (the CATI and mail questionnaire are provided in appendix B). Of the 2708 organizations that were sent a mail questionnaire, 2131 were returned for a 78% response rate. Of these, 2117 were deemed usable.

Historically, fleet surveys have suffered from extremely low response rates, often 10% or less (NAFA annual; Runzheimer 1991; Runzheimer 1993; Runzheimer 1995; Shonka 1980; UIG 1985; Wagner 1979). In light of this fact, a total response rate of 55% for both parts of the survey is noteworthy. The relatively high response rate was due in part to a survey awareness campaign. The survey was announced in several fleet newsletters and at conferences throughout the state in order to stress its importance to fleet operators who are constantly inundated with survey requests.

The mail questionnaire was used to collect data regarding vehicle acquisitions and operations, AFV attitudes and purchase intentions, and fleet decision-making behavior. Although design of the survey instrument was a collaborative effort, ITS-Irvine's stated preference task dictated – to a large degree – the size and make-up of the questionnaire. The key questions for this dissertation were inserted, by myself, into the questionnaire.

### 3.4 Data Analysis

The mail questionnaire survey included a series of seven questions regarding the key decisionmakers and the formality and centralization of the decision-making structure. The collective responses to these binary-formatted questions enabled each fleet to be classified into a single typology category. This was accomplished by writing a computer program that placed each fleet respondent into one of the typology categories if the response pattern of the seven questions matched one of the predetermined response patterns for that typology category. There are 128 possible response patterns of which 38 correspond to the four typology categories. Any respondent with one of those 38 patterns successfully "fit" into the typology. The typology was then evaluated based on the number of respondents that were successfully categorized.

This success rate was then compared to the results of a cluster analysis using the same questions. Several clustering methods were applied and the results used to validate the original typology. Verification and refinement of the typology through response pattern frequency evaluations and cluster analysis is further described in the following chapter.

Once the typology was finalized and each fleet respondent properly categorized, it was possible to develop a predictive model for future classifications. The model is designed to classify fleets by placing them in the typology category with the highest calculated probability using data that is readily available and publicly accessible. Instead of using detailed decision-making questions for classification, the model is based on variables concerning fleet attributes that can be easily measured and retrieved from public records. These attributes act as proxies for the prominent decision-making behavior. Relevant attributes include general physical characteristics (e.g., fleet size), types of vehicles used, purpose of the fleet, and organization type. Two models were estimated -- a multinomial logit model and a quadratic discriminant model. Details regarding model development are provided in the following chapter.

# Data Analysis: Typology and Model Results

## 4.1 Overview

Historically, researchers have categorized vehicle fleets using simple distinctions such as the purpose, composition, and size of the fleet or the service provided by the organization (Bobit annual; Miau et al. 1992; Runzheimer 1993; Shonka 1978). Typical fleet categories include: emergency fleets, government fleets; small and large fleets (the number of vehicles used to distinguish each varies); small, medium, and heavy-weight vehicle fleets, truck fleets, business fleets, and delivery fleets. One notable exception to the usual classification methods is the NGV/AGA fleet study which developed a typology based on fleet structure and management style (AGA/NGVC 1991).

My classification scheme takes this one step further by distinguishing fleets by their decision-making structures. Decision-making structure can be defined broadly as "the context within which decisions are made" (Bower 1970). It has to do with where decisions are made within the organization, who influences those decisions, and the degree to which systems and procedures facilitate decisionmaking (Fahey 1981).

Organizational decision-making behavior has long been described in terms of contextual dimensions. Two of these dimensions -- centralization and formalization --have been consistently used to define an organization's dominant decision-making structure (Fredrickson 1986; James and Jones 1976; Langley 1990; Mintzberg 1979; Pugh et al. 1968; Shrivastava and Grant 1985). These same dimensions have been found in this study to be good indicators of a fleet's decision-making behavior and thus form the basis of my typology.

For the purpose of this study, formalization is defined as the extent to which rules and procedures guide the fleet decision process. Fleets with formalized decision-making behavior usually express these rules and procedures as a written part of their official fleet policy. Generally, as the level of formalization increases the decision process is more likely to be initiated only in response to problems which disrupt standard operating procedures and solutions more likely to engender only incremental changes that address precise problems (Fredrickson 1986; Quinn 1980). Problem resolution follows formal guidelines and usually begins with an attempt to apply previous solutions which resulted in favorable outcomes (Cyert and March 1963). The process usually involves heavy analysis and several levels of authorization. In highly-formalized decision structures, the process is almost as important as the outcome (Fredrickson 1986).

Centralization has to do with the number of people involved in fleet decisions and their decision-making autonomy. A decision-making structure where decisions are made at a single point in the organization by one or two individuals without further authorization is considered highly centralized. Other indicators of centralized decisionmaking noted in the literature (Fredrickson 1986; Mintzberg 1979) are :

- Decisions processes are initiated by only a dominant few
- Decision action results from proactive opportunity-seeking behavior.
- Solutions emphasize "positive" goals (rather than immediate fixes)
- Solutions result in major departures from existing circumstances
- Decisions are highly integrated with the goals of the organization
- Cognitive limitations prevent optimal solutions

There are four possible configurations of centralization and formalization which can be used to define fleet decision-making structure. These four combinations form the basis of my fleet decision-making typology (see Figure 3.2). Two of the four fleet types identified in this study exhibit a relatively high level of centralization when deciding fleet issues. Only one or two individuals influence or participate in important fleet decisions. Organizations with the other two fleet types have a more diffused decision process involving several individuals and departments. Likewise, two of the fleet types have a formal decision process that follows preset rules and guidelines. The other two are guided more by intuition, personal judgment, and political bargaining.

This chapter describes the procedures used to develop the typology and classification models and provides the results of each. Two methods were used to validate the typology; identification of high frequency response patterns and a cluster analysis. In addition, several models were estimated for classifying fleets into the typology.

## 4.2 Response Pattern Frequencies

Seven questions included in the survey mail questionnaire were designed to distinguish fleet types based on where and how important fleet decisions are resolved. The questions provide a means of measuring the level of formalization and centralization of the fleet decision-making process. This information was then used to test the initial typology.

The seven survey questions reveal the importance of cost analysis in decision-making, whether a bidding process is used, the number of people who normally participate in strategic fleet decisions and their organizational positions, how much authorization is necessary, and the decision-making autonomy at each fleet site (the original survey questionnaire is listed in appendix B). When taken together, these survey questions provide a means for measuring the extent to which centralization and formalization govern a fleet's decision-making behavior.

Surveyees were asked to consider "important fleet decisions" that had "significant cost implications or resulted in substantial changes in fleet operations". The two examples given were installation of on-site refueling facilities and the decision to invest in alternative fuel vehicles. The seven survey questions were framed as requiring "yes" or "no" responses (a "not applicable" response was counted as a negative response for this part of the analysis). The binary responses to the seven questions render 128 possible response patterns ($2^7$) when examined together (e.g., seven "yes" responses equal one response pattern). The initial fleet typology was then assessed by looking at frequencies for the specific response patterns associated with each fleet type.

### 4.2.1 Results of Response Pattern Frequency Analysis

Each fleet decision making structure, described in chapter 4, is associated with specific response patterns. For instance, an autocratic fleet is defined as one which exhibits the following characteristics:

- Fleet decisions are made by only one or two individuals
- Fleet decisions are made at the upper management level
- Fleet decisions require little or no approval
- Fleet decisions are not guided by formal written rules or fleet policy

Since the autocratic decision-making fleet structure is the only one of the four typology fleet types that exhibits all of these characteristics, any fleet with this response pattern would be classified as an autocratic fleet. Response patterns which define each fleet type are listed in Table 4.1. Of the 128 possible response patterns, only 38 were determined useful in defining the four fleet categories.

Frequencies of all 128 response combinations were systematically determined using SAS programming software. The cumulative frequency for the 38 patterns representing the

## Table 4.1: Typology Category Response Patterns

| | Bureaucratic | Autocratic | Hierarchic | Democratic |
|---|---|---|---|---|
| 1) Formal written rules guide fleet decisions. | yes or no | no | yes* | no |
| 2) Detailed cost analyses are used. | yes | yes or no | yes or no (yes if #3 is no) | yes or no (yes if #3 is no) |
| 3) Final choices are made after soliciting bids. | yes | yes or no | yes or no (yes if #2 is no) | yes or no (yes if #2 is no) |
| 4) Decisions are made by only 1 or 2 individuals. | no | yes | yes | no |
| 5) Decisions are made at upper management levels. | yes or no | yes | yes | yes or no |
| 6) Little or no authorization/approval is necessary. | no | yes | no | no |
| 7) Decisions are made at headquarters but implemented at individual fleet sites. | yes or no | yes or no | yes or no | yes or no |
| **Frequencies** | **656** | **201** | **668** | **108** |

* May also be 'no' if both questions 2 and 3 are 'yes'.

typology categories was 1633 which represents 81% of the total cases (101 cases were not used because of missing or incomplete data). In other words, 81% of the sample survey was successfully categorized into the original typology. Of these respondents, 1385 (85%) required only 21 of the 38 associated response patterns. This indicates significantly large subsets within the typology categories. Frequencies of the other 17 response patterns associated with the typology categories are relatively low comprising only 12% of the total sample. Overall, results of the response pattern frequency analysis show that the fleet decision-making typology performed exceptionally well.

The results reveal a large subset of fleets in both the bureaucratic and hierarchic decision-making categories. The bureaucratic fleet subgroup is distinguished by the use of formal written rules to formulate solutions at central headquarters which are then implemented uniformly at several individual fleet sites. In addition to these characteristics, the hierarchic subgroup is distinguished by its emphasis on detailed cost analyses and use of solicited bids to facilitate decision-making. Table 4.2 shows the two subgroups responses combinations. Both of these subgroups tend to be composed primarily of large organizations with many fleet sites.

In addition to the above response pattern frequency analysis, a cluster analysis was conducted using the same questions. The cluster analysis was used to search for apparent groupings of response patterns. Bartels et. al. (1970) first proposed using cluster analysis as a means for determining the homogeneity of a particular data set and to identify "natural classes". If the clusters are strongly differentiated the data set is assumed to comprise significant groupings which can be used for classifying new observations (Anderberg 1973).

Table 4.2: Bureaucratic and Hierarchic Subgroups

| | Bureaucratic Subgroup | Hierarchic Subgroup |
|---|---|---|
| 1) Formal written rules guide fleet decisions. | yes | yes |
| 2) Detailed cost analyses are used. | yes | yes |
| 3) Final choices are made after soliciting bids | yes | yes |
| 4) Decisions are made by only 1 or 2 individuals. | no | yes |
| 5) Decisions are made at upper management levels. | yes or no | yes |
| 6) Little or no authorization/approval is necessary. | no | no |
| 7) Decisions are made at headquarters but implemented at individual fleet sites | yes | yes |
| Frequencies | 247 | 124 |

## 4.3 Cluster Analysis

Three different clustering procedures were used in this analysis. Two procedures were based on the agglomerative hierarchical clustering method where each observation begins in a cluster by itself. The two closest clusters are then merged to form a single new cluster. This process is repeated until only one cluster is left. The third cluster procedure is based on the divisive hierarchical clustering method which reduces one large cluster containing all the cases into a pre-specified number of clusters.

### 4.3.1 SAS Clustering Procedure

The first cluster procedure utilizes the SAS cluster program which has the capacity to perform a clustering analysis on non-Euclidean distances. In order to perform a cluster analysis on non-Euclidean distances the SAS program first computes a distance matrix using a similarity measure. Once the distance matrix is computed the similarity measures are converted into distance measures.

The Jaccard formula was used to compute similarity coefficients between each pair of observations. A similarity coefficient ($p$) measures the relationship between two observations given the values of variates common to both (Everitt 1980). The variates generally take values in the range of 0 to 1 and can be arranged in a two-way association table as depicted in Table 4.3.

The Jaccard coefficient is defined as the number of variables coded "1" for both observations divided by the number of variables coded "1" for either or both observations. The mathematical representation is $p = a/(a+b+c)$.

## Table 4.3: Two-Way Association Table of Variates

| | | Observation i | | |
|---|---|---|---|---|
| | | 1 | 0 | |
| Observation j | 1 | $a$ | $b$ | $a+b$ |
| | 0 | $c$ | $d$ | $c+d$ |
| | | $a+c$ | $b+d$ | $p$ |

As an example, assume two observations within the fleet data set gave the following binary responses to the seven typology questions:

| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Observation i | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| Observation j | 0 | 1 | 0 | 0 | 1 | 1 | 0 |

The resulting Jaccard coefficient is:

$p = 2/(2+1+2) = 0.4$

The Jaccard coefficients are converted to a distance measure by subtracting them from 1. Each case is then assigned to the cluster whose center is closest to that particular observation. The distance is computed using the centroid method where the distance between two clusters is defined as the squared distance between their centroids or means. The centroid method was used because it is generally more robust towards outliers compared to other hierarchical methods (Sokal and Michener 1958).

The centroid method is calculated as:

$$D_{kl} = ||\overline{X}_k - \overline{X}_l||^2$$

Where:

$D_{kl}$ = the dissimilarity measure between clusters $C_k$ and $C_l$

$\overline{X}_k$ = mean vector for cluster $C_k$

$\overline{X}_l$ = mean vector for cluster $C_l$

Resulting clusters are regrouped through several iterations until the specified number of clusters is reached. The SAS output lists the response patterns of each observation and its corresponding cluster. Results of the SAS cluster analysis revealed groupings of response patterns similar those in Table 4.1. However, program limits restricted the number of allowable groupings so cluster sizes were significantly different than the response pattern results.

### 4.3.2 BMDP 2M Clustering Procedure

The second cluster procedure utilizes program 2M in the BMDP statistical software package. This particular program also computes distances between cluster centroids using the Jaccard coefficient distance measure. A primary difference between the SAS analysis and the BMDP analysis is the format of the output.

The SAS output listed the response combination for each observation and the cluster to which it belongs. This enables a visual inspection of the cluster composition and allows a direct comparison with the results of the response pattern frequency analysis. Output for the 2M cluster analysis shows a dendrogram or cluster tree formed by a leaf-to-stem algorithm. The cluster tree represents the amalgamation of cases at each step in the analysis. Since the tree begins with each case in a separate cluster and combines two clusters in each step, the result is a tree of N by N-1 dimension where N is the number of cases. Visual examination of the cluster tree revealed four distinct main clusters. Two of the four contained significant sub-clusters. The resulting characteristics of the cluster structure (number of clusters, sub-cluster divisions, and cluster sizes) is very similar to the results of the pattern response frequency analysis.

### 4.3.3 BMDP KM Clustering Procedure

A final method of cluster analysis was performed using BMDP program KM, which uses the k-means clustering methodology. This method is practical for large data sets because it begins with all the data in one cluster and repeatedly splits a cluster into two until the requested number of clusters is reached. Cases are iteratively reallocated into the cluster whose center is closest in Euclidean distance to that observation. After the initial run was completed, the procedure was repeated on the resultant clusters in order to distinguish sub-groupings. The output from this analysis includes a scatter plot and a table showing cluster size and means (see Appendix C).

The first KM cluster procedure resulted in four main groupings with the following frequencies (104 cases were excluded due to missing data):

| Cluster | Frequency |
|---|---|
| H (Hierarchic) | 634 |
| B (Bureaucratic) | 862 |
| A (Autocratic) | 198 |
| D (Democratic) | 319 |
| Total | 2013 |

Clusters B and D are slightly larger than expected from the frequency analysis due to the fact that the BMDP KM program assigns each case to a cluster rather than rejecting those that exceed a given acceptance limit. These two clusters received most of the outliers that did not fit into one of the typology categories in the response pattern analysis.

The scatter plot for this cluster analysis indicates the existence of four very distinct groups. A subsequent run of the BMDP KM program revealed sub-clusters in groups H and B. Cluster H was divided into two groups: H1 with 296 cases and H2 with 338 cases. Similarly, a second run subdivided group B into: B1 consisting of 435 cases and B2 with 427 . The scatter plot from this run indicates a significant distance between the two sub-clusters. The final cluster groupings from this procedure are:

| Cluster | Frequency | |
|---|---|---|
| | | 296 |
| H | 634 < | |
| | | 338 |
| | | 427 |
| B | 862 < | |
| | | 435 |
| A | 198 | |
| D | 319 | |
| Total | 2013 | |

Results of the pattern identification analysis and all three cluster procedures strongly support the original typology. However, in addition to the four main categories, subgroups are distinguishable within the bureaucratic and hierarchic decision-making fleet types. In both cases the subgroup consists of fairly large organizations with many vehicles at multiple fleet sites. Fleet control stems from a central headquarters where decisions are acted upon and carried out at the individual fleet sites. These large fleets are slightly more formal and rely on more sophisticated means of evaluating alternatives. The final fleet typology which includes these subgroups is depicted in Figure 4.1. These categories are used in the next stage of the analysis to develop a classification model.

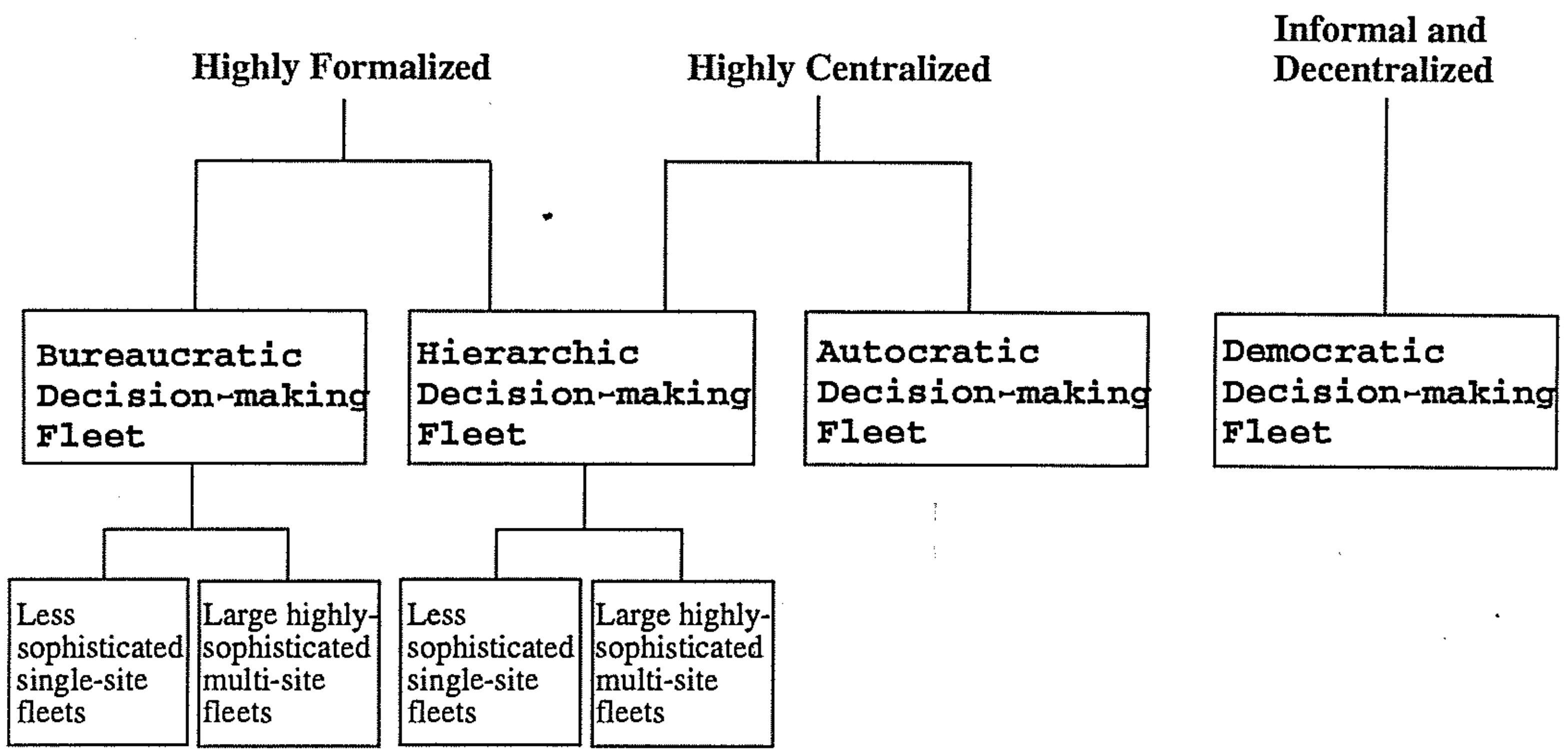
## 4.4 Estimation of Fleet Classification Models

### 4.4.1 Logit Models

The objective of this analysis is to use qualitative response models to classify fleets into the typology. It is impractical to classify fleets using detailed information regarding their decision behavior. Therefore, it is necessary to use proxies for determining their decision-making structure. Proxy variables used for modeling purposes come from readily available descriptive data pertaining to both the organization and the fleet. Such explanatory variables include fleet size, vehicle types used, organization size, business type (e.g., manufacturing, construction, retail), and whether the fleet belongs to a private organization or a government agency.

Qualitative response models are typically used as discrete choice models in the context of utility maximization. However, the logit model can be used as an explanatory model of categorical phenomena (Cramer 1991). When two or more alternatives are given and a single observation is available for each set of explanatory variables, a probabilistic alternatives model can be formulated based on random utility theory. This formulation leads to the classical utility maximization form of the "logit" or "multinomial logit" model (MNL) where disturbances are assumed to be independent and identically distributed random variables with Weibull distributions. When an observation contains categorical data, as is the case in this analysis, the logit model structure can be obtained by making the following assumptions:

# Figure 4.1: Typology of Fleet Decision-Making Structure with Subgroups



Let

$$P_i(j) = f(x), \tag{1}$$

where $P_i(j)$ is the probability that observation i is in category j for $i = 1$ to N and $j = 1$ to M, where N is the number of observations and M is the number of categories and f(x) is a function of the explanatory variables. It is assumed that these probabilities follow an exponential distribution given by:

$$P_i(j) = f(x) = \exp[x'_{ij}\beta] \,/\, \Sigma_j \exp[x'_{ij}\beta] \ , \tag{2}$$

where ß is an unknown parameter vector and $x_{ij}$ is a vector of observations on variables that are functions of the attributes of the alternatives. This is the conditional multinomial logit model which can be estimated by the maximum likelihood method. The likelihood ratio (LR) test can be used to test the null hypothesis that the model coefficients are not significantly different from zero. The LR test is given by LR = -2[£(0) - £(ß)], where £(0) is the log likelihood value with all model coefficients constrained to zero and £(ß) is the log likelihood value at convergence for the unrestricted model. The LR test statistic is a chi-square distribution with the degrees of freedom being equal to the number of restricted coefficients. A measure of overall model fit is given by the likelihood ratio index $\rho^2$, which is the likelihood of a correct prediction attributed to the model parameters. The $\rho^2$ value is calculated as:

$$\rho^2 = 1 - [£(\beta)/£(0)] \tag{3}$$

This measure is similar to the regression $R^2$ value in that it is bounded between zero and one. A likelihood ratio index value of one would indicate a perfect model fit whereas a value of zero indicates the model has no explanatory power.

In addition to the likelihood ratio, the statistical software package also computes a second goodness of fit measure labeled "percent correctly predicted" (PCP). This statistic is expressed as:

$$(100/N) \sum_n \hat{y}_n \quad (4)$$

where $\hat{y}_n = 1$ if the highest predicted probability agrees with the chosen alternative, otherwise $\hat{y}_n = 0$.

The PCP statistic is used in this study as relative indicator of model performance but little weight is given to its overall ability as a goodness of fit measure. Ben-Akiva and Lerman (1991) note that the PCP statistic cannot be used with a high level of confidence as a goodness of fit measure because of its potential to overestimate model performance. Tardiff (1976) concurs but suggests that it (along with other predicted percentage statistics) may provide an "intuitive feel" for how well a model performs. Because the PCP statistic is automatically computed for both the logit model and the discriminant analysis, it is left in the results for comparative reasons.

An inherent property of the logit model is independence of irrelevant alternatives (IIA) (McFadden et al. 1977). This property implies that the relative probabilities of one alternative to another is independent of the presence or absence of any other alternatives. If some interdependence exists between alternatives, then this formulation of the multinomial logit model cannot account for the interdependency. In this case the nested logit model can be used since it is not constrained by the IIA assumption.

In the nested model structure the probability that an observation is in one of the main categories (or branches) follows the same form as in equation (2). For each branch which contains a nested structure beneath it, the log sum exponential utility of the nest enters as an explanatory variable of the branch. The coefficient on the log sum terms can then be used to test for dependence of the nested alternatives. The coefficient on the log sum term ($\theta$) must be between 0 and 1. If $\theta$ does not satisfy the constraint $0 < \theta \leq 1$, the tested structure is rejected; if $\theta = 1$, then the model is equivalent to the MNL model and the alternatives are assumed to be independent (Sobel 1980).

### 4.4.2 Logit Model Results

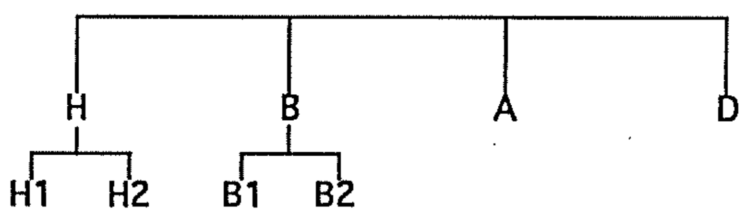
Based on the results of the response frequencies and cluster analyses, the typology in Figure 4.1 was adopted for classifying new observations. Several models were estimated including two logit models which use fleet category as the dependent variable and survey data to form independent variables. The first logit model was estimated with a nested structure using the subgroups within the hierarchic and bureaucratic categories. This structure is represented as Structure 1 in Figure 4.2. The second model is estimated using a simple multinomial structure (Structure 2 in Figure 4.2). Finally, a model is estimated for a simplified structure consisting of only three typology categories (Structure 3 in Figure 4.2). All logit models are estimated using the SST v2.0 statistical software package (Dubin and Rivers 1988).

The first model, the nested structure, is estimated in stages. First a logit model is estimated for each nest which yields Pr(H1 | H1,H2), Pr(H2 | H1,H2), Pr(B1 | B1,B2) and Pr(B2 | B1,B2). An MNL model is then estimated for the overall structure H/B/A/D. The

# Figure 4.2: Typology Structure of Estimated Models

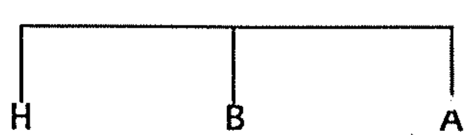
**Legend**
H = Hierarchic
B = Bureaucratic
A = Autocratic
D = Democratic

**Structure 1 (nested model)**




**Structure 2**


**Structure 3**



MNL model yields Pr(H) = Pr(H1,H2), Pr(B) = Pr(B1,B2), Pr(A) and Pr(D). The final subgroup probabilities are calculated as:

Pr(H1) = Pr(H1 | H1,H2)*Pr(H1,H2)

Pr(H2) = Pr(H2 | H1,H2)*Pr(H1,H2)

Pr(B1) = Pr(B1 | B1,B2)*Pr(B1,B2)

Pr(B2) = Pr(B2 | B1,B2)*Pr(B1,B2)

Pr(A) and Pr(D) from the MNL estimation.

In the MNL estimation of the upper level model, equation (2) has the form:

$$P_i(j) = f(X) = \exp[x'_{ij}\beta + \theta \ln \Sigma_l \exp(z'_{ij}\gamma)] \,/\, \Sigma_j \exp[x'_{ij}\beta + \theta \ln \Sigma_l \exp(z'_{ij}\gamma)] \quad (5)$$

where $l$ is the number of alternatives used at the nested level, x is the set of explanatory variables entering the upper level alternatives, and z is the set of explanatory variables entering the nested level.

The nested model was estimated using 1924 observations. Due to missing data in the explanatory variables, 193 observations were excluded from the analysis. The observed classifications based on the dependent variables are:

| Independent Variable | | Frequency | Sample Percentage |
|---|---|---|---|
| Nest | H (Hierarchic) | | |
| | H1 (multi-site) | 231 | 30.76% |
| | H2 | 520 | 69.24% |
| Nest | B (Bureaucratic) | | |
| | B1 (multi-site) | 232 | 34.52% |
| | B2 | 440 | 65.48% |

Main Model

| | | |
|---|---|---|
| H (Hierarchic) | 710 | 36.90% |
| B (Bureaucratic) | 637 | 33.11% |
| A (Autocratic) | 265 | 13.77% |
| D (Democratic) | 312 | 16.22% |

Tables 4.4 through 4.6 show the estimated coefficients and statistics for the main model and the nested model structure. The overall model has a likelihood ratio index ($\rho^2$) value of 0.146. The coefficient on the nest H log sum is 0.1427 with a t-statistic value of 0.63 whereas the coefficient on the nest B log sum is -0.5331 with a t-value of -2.62. The coefficient on the H nest log sum is not significantly different from zero, but it is significantly different than one, indicating dependency of the two H categories. However, because the coefficient on the B nest log sum violates the constraint $0 < \theta \leq 1$, this model structure is rejected.

The second model estimated was an MNL model of six alternatives represented by Structure 2 in Figure 4.2. This model ignores the possible dependencies of the alternatives. The MNL model is estimated based on 2018 observations. This model has a $\rho^2$ value of 0.101 and an assigned distribution of H1 (11.45%), H2 (25.72%) B1 (11.50%), B2 (21.80%), A (13.78%) and D (15.75%). Complete results are presented in Table 4.7.

The lack of explanatory power in the independent variables in both models is due to the fact that the survey was not specifically designed with this modeling effort in mind. The survey was primarily designed as a stated preference survey for the purpose of measuring fleet operator preferences toward purchasing alternative fuel vehicles (ITS-Irvine's research objective). Organization and fleet background information, which is critical to this modeling effort, was of secondary importance. As a result, the descriptive variables lack the detail and specificity necessary for a formulating a better fitting logit model.

Based on the above modeling results, a third structure (Structure 3 in Figure 4.2) was estimated. It was formed by collapsing the nested alternatives into one alternative each (H and B), and dropping group D which is the least cohesive category . This model estimates a less refined typology structure. The results for structure 3 are presented in Table 4.8. This model is estimated on 1700 observations. The resulting distribution is H = 750 (44.12%), B= 672 (39.53%), and A= 278 (16.35%). This less refined model structure performs significantly better than the two previous structures with a likelihood ratio index value of 0.182.

**Table 4.4: Logit Model of Branch H in Structure 1**

| Independent Variables | Coefficients (t-stat) |
|---|---|
| Group H1 constant | -0.3072 (-0.75) |
| For-profit dummy | -0.4956 (-2.25) |
| Number of full-time employees | 0.0711 (0.74) |
| Largest holding is minivan dummy | 0.6823 (1.59) |
| Largest holding is shuttle bus dummy | 1.2080 (1.84) |
| Number of veh. @ other sites | 0.1256 (3.24) |
| Financial institution dummy | 1.8987 (1.63) |
| Retail trade/ dealer dummy | 0.5783 (1.82) |
| % of new vehicles purchased | -0.0057 (-2.15) |
| % of new vehicles lease-purchased | -0.0065 (-1.81) |
| $L(0) = -520.55$<br>$L(\beta) = -444.36$<br>LR test = 152.4 with 9 d.f.<br>N = 751<br>% Correctly predicted = 69.374<br>$\rho^2 = 0.146$ | |

**Table 4.5: Logit Model of Branch B in Structure 1**

| Independent Variables | Coefficients (t-stat) |
|---|---|
| Group B1 constant | -0.3405 (-0.92) |
| Organization Headquarters dummy | -0.4817 (-2.19) |
| Number of full-time employees | 0.1914 (2.23) |
| Number of veh. @ other sites | 0.1207 (3.59) |
| Manufacturing dummy | -1.1292 (-3.20) |
| Construction/mining dummy | -0.9930 (-1.92) |
| Educational institution dummy | -1.3336 (-2.09) |
| Contractor/consultant dummy | -0.7330 (-2.12) |
| % of new vehicles purchased | -0.0064 (-3.06) |

L(0) = -465.79
L(β) = -393.14
LR test = 145.3 with 8 d.f.
N = 672
% Correctly predicted = 69.94
$\rho^2$= 0.160

Table 4.6: Multinomial Logit Model of Upper Level in Structure 1

| Independent Variables | Coefficients (t-stat) |
|---|---|
| Group H constant | 1.4764 (2.07) |
| Group B constant | 1.4529 (6.71) |
| Group A constant | -0.2255 (-0.49) |
| Group H log-sum | 0.1427 (0.63) |
| Group B log-sum | -0.5331 (-2.62) |
| For-profit dummy (B) | -1.2954 (-10.91) |
| Local government dummy (A) | -1.2882 (-3.60) |
| Number of full-time employees (B) | 0.1903 (3.52) |
| Number of full-time employees (A) | -0.4191 (-4.27) |
| Number of veh. @ other sites (A) | -0.1066 (-2.33) |
| Fleet operates locally dummy (H) | -1.1271 (-1.68) |
| Fleet operates state-wide dummy (H) | -1.1669 (-1.69) |
| Fleet operates Regionally dummy (H) | -1.7246 (-2.43) |
| Total vehicles operated at site (A) | -0.0022 (-1.66) |
| Log total vehicles operated at site (H) | -0.2023 (-4.57) |
| Organization Headquarters dummy (H) | 0.7941 (4.54) |
| Organization Headquarters dummy (A) | 0.7426 (2.31) |
| Largest holding is cars and wagons dummy (H) | -0.2778 (-1.89) |
| Largest holding is cars and wagons dummy (B) | -0.2255 (-1.39) |
| Largest holding is compact pickup (B) | -0.2802 (-1.53) |
| Largest holding is compact pickup (A) | -0.4421 (-1.96) |
| Largest holding is full-size pickup (B) | -0.3355 (-2.41) |
| Largest holding is full-size pickup (A) | -0.3622 (-2.23) |
| % of new vehicles purchased (H) | 0.0052 (3.10) |
| % of new vehicles purchased (A) | 0.0087 (3.29) |
| % of new vehicles lease-purchased (H) | 0.0053 (2.27) |
| % of new vehicles lease-purchased (A) | 0.0062 (1.70) |
| Construction/mining dummy (H) | 0.9776 (2.66) |
| Construction/mining dummy (B) | 1.0444 (2.67) |
| Construction/mining dummy (A) | 1.0739 (2.68) |
| Utility dummy (B) | 0.9466 (2.84) |
| Financial institution dummy (H) | 1.6744 (1.92) |
| Financial institution dummy (A) | 2.2124 (2.10) |

L(0) = -2667.2
L( ) = -2283.6
LR test = 767.2 with 32 d.f.
N = 1924
% Correctly predicted = 48.96
$\rho^2 = 0.144$

**Overall Nested Model Structure 1**

L(0) = -3653.54
$L(\beta) = -3121.1$
LR test = 1064.9 with 49 d.f.
N = 1924
% Correctly predicted = 11.4
$\rho^2 = 0.146$

**Table 4.7: Multinomial Logit Model for Structure 2**

| Independent Variables | Coefficients (t-stat) |
|---|---|
| Group H1 constant | -0.5935 (-2.90) |
| Group H2 constant | -0.3067 (-0.96) |
| Group B1 constant | -0.0831 (-0.28) |
| Group B2 constant | 1.2344 (11.23) |
| Group A constant | 0.1661 (0.41) |
| For-profit dummy (B1) | -1.1057 (-6.19) |
| For-profit dummy (B2) | -1.5120 (-11.21) |
| Local government dummy (A) | -1.3414 (-3.79) |
| Number of full-time employees (B1) | 0.2834 (4.05) |
| Number of full-time employees (A) | -0.4527 (-4.99) |
| Number of veh. @ other sites (B1) | 0.1181 (4.20) |
| Number of veh. @ other sites (A) | -0.1156 (-2.65) |
| Log total veh. operated at site (H2) | -0.2059 (-4.39) |
| Organization Headquarters dummy (H1) | 0.3220 (1.50) |
| Organization Headquarters dummy (H2) | 1.1183 (5.08) |
| Organization Headquarters dummy (A) | 0.6949 (2.27) |
| Largest holding is cars and wagons dummy (H2) | -0.2503 (-1.78) |
| Largest holding is cars and wagons dummy (B1) | -0.1755 (-0.97) |
| Largest holding is compact pickup (A) | -0.4573 (-2.11) |
| Largest holding is full-size pickup (B1) | -0.1837 (-1.01) |
| Largest holding is full-size pickup (A) | -0.3476 (-2.29) |
| % of new vehicles purchased (H2) | 0.0055 (2.90) |
| % of new vehicles purchased (B1) | -0.0041(-2.31) |
| % of new vehicles purchased (A) | 0.0049 (2.52) |
| % of new vehicles lease-purchased (H2) | 0.0058 (2.37) |
| Manufacturing dummy (B2) | 0.7023 (3.50) |
| Construction/mining dummy (H2) | 0.8175 (3.26) |
| Construction/mining dummy (B2) | 0.9738 (3.30) |
| Construction/mining dummy (A) | 0.7978 (2.77) |
| Utility dummy (B2) | 0.9689 (2.96) |
| Business services dummy (B2) | -0.3158 (-1.45) |
| Contractor/consultant dummy (B1) | -0.6701 (-2.16) |

$L(0) = -3615.8$

$L(\beta) = -3251.3$

LR test = 729 with 31 d.f.

N = 2018

% Correctly predicted = 35.83

$\rho^2 = 0.101$

Table 4.8: Multinomial Logit Model for Structure 3

| Independent Variables | Coefficients (t-stat) |
|---|---|
| Group H constant | 1.0167 (1.84) |
| Group B constant | 1.4552 (2.59) |
| For-profit dummy (B) | -1.3402 (-6.84) |
| For-profit dummy (A) | 0.8578 (3.43) |
| Local government dummy (B) | 0.1187 (0.55) |
| Number of full-time employees (B) | 0.2155 (3.13) |
| Number of full-time employees (A) | -0.4093 (-3.99) |
| Number of veh. @ other sites (B) | 0.04976 (1.76) |
| Number of veh. @ other sites (A) | -0.1070 (-2.26) |
| Log total veh. operated at site (H) | -0.0870 (-1.12) |
| Log total veh. operated at site (B) | 0.1141 (1.39) |
| Organization Headquarters dummy (B) | -0.5563 (-2.89) |
| Organization Headquarters dummy (A) | -0.1020 (-0.31) |
| Largest holding is cars and wagons dummy (H) | -0.3457 (-1.68) |
| Largest holding is cars and wagons dummy (B) | -0.2622 (-1.21) |
| Largest holding is compact pickup (A) | -0.3357 (-1.43) |
| Largest holding is full-size pickup (B) | -0.1597 (-1.16) |
| Largest holding is full-size pickup (A) | -0.3284 (-1.87) |
| % of new vehicles purchased (B) | -0.0051 (-2.84) |
| % of new vehicles purchased (A) | 0.00174 (0.77) |
| % of new vehicles lease-purchased (H) | 0.00349 (1.50) |
| Manufacturing dummy (B) | 0.1889 (0.90) |
| Construction/mining dummy (B) | 0.05466 (0.21) |
| Construction/mining dummy (A) | 0.09049 (0.37) |
| Utility dummy (B) | 0.9963 (2.69) |
| Business services dummy (B) | -0.1334 (-0.69) |
| Contractor/consultant dummy (B) | -0.1701 (-0.90) |

$L(0) = -1867.6$
$L(\beta) = -1527.8$
LR test = 679.6 with 26 d.f.
N = 1700
% Correctly predicted = 57.59
$\rho^2 = 0.182$

The variables which contribute most to classifying observations in all three models are profit status, relative size (based on number of employees and the number of vehicles at various sites), vehicle operating jurisdiction (locally, regionally, or statewide), site status (organizational headquarters or branch office), number of new vehicles purchased or leased each year (in terms of total fleet percentage), general composition of fleet (number of pickups versus cars), number of vehicles at other sites, and the general business of the organization (e.g., financial or construction).

Results indicate that category A members (autocratic) are most likely to be private businesses with one small fleet and category B members (bureaucratic) are more likely to be a local government agency or non-profit organization (especially a utility company). Organizations with fleets in category A are also much smaller than organizations with fleets in category B. Generally, fleets in category B are slightly larger than those in category H (hierarchic) but both are significantly larger than those in category A. These results are consistent with the original typology category descriptions.

### 4.4.3 Quadratic Discriminant Model

Another method for analyzing discrete or categorical data is discriminant analysis. Discriminant analysis is used for distinguishing observed categories and for classifying new observations drawn from the same population. Whereas cluster analysis may be used for producing classifications from initially unclassified data, discriminant analysis is concerned with the distinct but related problem of assigning individuals to previously established classes (Everitt 1980).

Discriminant analysis methods rely on the nature of the within group covariance structure. Linear discriminant analysis assumes that the within group covariance matrices are all equal and that the within group data distributions are multivariate normal. The quadratic discriminant analysis used in this study relaxes the constraint that the categories have a common covariance structure but retains the assumption of multivariate normality. In quadratic discriminant analysis a classification function is estimated for each category. The classification functions are functions of the linear and quadratic (sum of squares and cross-products) terms of the explanatory variables. The quadratic classification function for classifying observation i into group j has the form:

$$f_{ij}(X_i) = \alpha_j + X_i\beta_j - X_i\theta_jX_i' \tag{6}$$

Where i = 1 to N; j = 1 to J; $f_{ij}(X_i)$ is the classification score; $X_i$ is a 1 x k vector of explanatory variables for observation i; $\alpha_j$ is a group j specific constant term; $\beta_j$ is a k x 1 vector of linear coefficients for group j; and $\theta_j$ is a k x k matrix of quadratic coefficients for group j.

The constant terms in the classification model are functions of the within group covariances. The k x k within group covariance matrix ($\Omega_j$) is calculated for each group as the sum of squares and cross-product matrix divided by the group degrees of freedom, $n_j$-1, where $n_j$ is the number of observations in group j. The coefficient terms are given by:

$$\theta_j = \frac{1}{2}\Omega_j^{-1} \tag{7}$$

$$\beta_j = \Omega_j^{-1}\bar{X}_j \tag{8}$$

$$\alpha_j = \ln P_j - X_j'(\frac{1}{2}\Omega_j^{-1})X_j - \frac{1}{2}\ln(\det(\Omega_j)) \tag{9}$$

where $\bar{X}_j$ is a k x 1 vector of variable means for group j. $P_j$ is the prior probability for each group and is represented as:

$$P_j = n_j/N \tag{10}$$

The probability that observation i belongs to group j is calculated by:

$$P_{ij} = \frac{e^{f_{ij}(x_i)}}{\sum_{1}^{n_l} e^{f_{ij}(x_i)}} \tag{11}$$

Cases are then classified according to the 'maximum probability rule' (as was done in the logit analysis).

As an example, suppose there are N binary categorical observations, with $n_1$ observations in group one and $n_2$ observations in group two, which are described as a function of three explanatory variables, $X = [X_1\ X_2\ \ X_3]$. The within group covariance matrices would have the form:

$$\Omega_j = 1/(n_j-1)\ X'X = 1/(n_j-1) \begin{vmatrix} \sum_1^{n_j} X_{1i}^2 & \sum_1^{n_j} X_{2i}X_{1i} & \sum_1^{n_j} X_{3i}X_{1i} \\ \sum_1^{n_j} X_{1i}X_{2i} & \sum_1^{n_j} X_{2i}^2 & \sum_1^{n_j} X_{3i}X_{2i} \\ \sum_1^{n_j} X_{1i}X_{3i} & \sum_1^{n_j} X_{2i}X_{3i} & \sum_1^{n_j} X_{3i}^2 \end{vmatrix}$$

and the coefficients are:

$$\theta_j = \frac{1}{2}\Omega_j^{-1} = \frac{1}{2}(n_j-1)(X'X)^{-1} \tag{12}$$

$$\beta_j = \Omega_j^{-1}\overline{X}_j = (n_j-1)(X'X)^{-1}\overline{X}_j \tag{13}$$

$$\alpha_j = \ln P_j - \overline{X}_j'(\frac{1}{2}(n_j-1)(X'X)^{-1})\overline{X}_j - \frac{1}{2}\ln(\det(1/(n_j-1)\ X'X)) \qquad (14)$$

The BMDP software program 5M was used to perform a quadratic discriminant analysis of model structures two and three. The following explanatory variables were used in the analysis:

| | |
|---|---|
| PROFIT: | For-profit dummy |
| NONPROF: | Non-profit dummy |
| LOCGOV: | Local government dummy |
| NUMEMP: | Number of full-time employees |
| VEHOTHER: | Number of vehicles at other sites |
| TOTVEH: | Total number of vehicles operated at site |
| LNTOT: | Log of total vehicles operated at site |
| V12: | Organization headquarters dummy |
| CARWAG: | Largest holding is cars and wagons dummy |
| MINIVAN: | Largest holding is minivan |
| FULLVAN: | Largest holding is full size van |
| CPICK: | Largest holding is compact pickup |
| FSPICK: | Largest holding is full-size pickup |
| BUY: | % of new vehicles purchased |
| L_BUY | % of new vehicles lease-purchased |
| TYPE2: | Manufacturing dummy |
| TYPE3: | Construction/mining dummy |
| TYPE4: | Utility dummy |
| TYPE5: | Business services dummy |
| LOCAL: | Fleet operates locally dummy |

### 4.4.4 Discriminant Analysis Results

Detailed output for the discriminant model is provided in Appendix D. The output gives the mean vectors of explanatory variables for each group, the quadratic coefficients matrix for each group, the linear coefficient vector for each group, the group specific constants, and a classification matrix comparing observed and predicted results. The Wilks test for the equality of group means and pairwise tests of group means are also provided. Table 4.9 summarizes the results of the discriminant analysis for model structure 2. The discriminant analysis correctly classified 27.1% of the observations. As previously explained, the data set does not contain enough explanatory power to differentiate between the more refined typology categories in this model structure.

The model does perform well in predicting cases which belong in category A (autocratic fleets) with 81% of the 279 cases correctly predicted. However, the results indicate that the model has difficulty distinguishing between category A and the other categories, as category A is significantly over predicted. The p-values for the test for equality of group means and the homogeneity of the covariance matrices indicate that both the group means and the covariance matrices are significantly different.

Table 4.10 presents the results of the discriminant analysis for the less refined typology of model structure 3. This model correctly classifies 40.8% of the cases and again accurately predicts category A with 85% of the 279 cases correctly classified. This model also has difficulty distinguishing between categories H (hierarchic) and A (autocratic) with category H cases misclassified into category A . Classification of category B (bureaucratic) cases are better than category H but still a large number are misclassified into category A. The model overpredicts the number of autocratic fleets while underpredicting hierarchic and bureaucratic fleets.

Based on the results of the two modeling approaches, it appears that the MNL model performs better in terms of predicting or classifying cases into typology categories. The MNL model correctly predicted 58 percent of the cases for model structure 3, whereas the discriminant analysis predicted 40.8 percent. However, the 'percent correctly predicted' statistic for MNL models cannot be interpreted as an absolute measure of model performance for reasons previously stated. Evaluation of the model coefficients in the MNL model is generally much simpler than in the discriminant analysis. Because all explanatory variables enter the discriminant analysis as well as all the interactions of the variables, it is

Table 4.9 Quadratic Discriminant Analysis for Model Structure 2

| Group | Percent Correct | Freq. | Number of cases classified into each category | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | H1 | H2 | B1 | B2 | A | D |
| H1 | 27.3 | 231 | 63 | 12 | 9 | 9 | 115 | 23 |
| H2 | 9.4 | 520 | 47 | 49 | 12 | 18 | 350 | 44 |
| B1 | 22.0 | 232 | 52 | 7 | 51 | 19 | 49 | 54 |
| B2 | 16.8 | 441 | 96 | 17 | 28 | 74 | 147 | 79 |
| A | 81.0 | 279 | 17 | 8 | 2 | 7 | 226 | 19 |
| D | 26.6 | 319 | 45 | 19 | 21 | 15 | 134 | 85 |
| Total | 27.1 | 2022 | 320 | 112 | 123 | 142 | 1021 | 304 |
| Test for equality of group means | | | | | F-stat = 6.405, p = 0.0000 | | | |
| Test for Homogeneity of covariance Matrices | | | | | p = 0.0000 | | | |

Table 4.10 Quadratic Discriminant Analysis for Model Structure 3

| Group | Percent Correct | Freq. | Number of cases classified into each category | | |
|---|---|---|---|---|---|
| | | | H | B | A |
| H | 20.9 | 751 | 157 | 108 | 486 |
| B | 44.7 | 673 | 166 | 301 | 206 |
| A | 84.9 | 279 | 22 | 20 | 237 |
| Total | 40.8 | 1703 | 345 | 429 | 929 |
| Test for equality of group means | | | | F-stat = 12.143, p = 0.0000 | |
| Test for Homogeneity of covariance Matrices | | | | p = 0.0000 | |

difficult to determine the effect of any one variable. It is equally difficult to determine interactive effects.

The discriminant analysis does not provide any statistical measure for the significance of the model parameters. Unlike logit models, the discriminant analysis provides no general statistical test to determine the significance of a particular coefficient in a given discriminant function. The discriminant function is the result of a weighting procedure of within group covariances and a set of explanatory variables. It is not the result of an optimizing estimation such as maximizing the log likelihood or minimizing the ordinary least squares.

The goal of the discriminant analysis is to assign observations to the categories to which they have the greatest resemblance while, at the same time, minimizing the effects of misclassification. The primary measure of the performance of the discriminant analysis is its predictive power or ability to properly classify observations into appropriate categories. By comparison, qualitative response models such as the logit models can be evaluated on both their predictive power as well as by statistical tests of model parameters.

In summary, there is empirical evidence which suggests that two of the typology fleet categories can be subdivided. The resulting sub-categories differ primarily in the number of sites and how decisions are implemented. Classification of fleets into the typology was accomplished using two different types of models. The logit model performed slightly better than the discriminant model, however, both could be greatly improved by using more specific data. Performance losses stem primarily from a lack of independent variables which adequately account for the more subtle differences amongst fleet types. Results of the classification models suggest that, given carefully selected independent variables, both the logit and discriminant models may be effective analytical tools for distinguishing amongst fleet types.

# Alternative Fuel Vehicles and the Organizational Decision-Making Process

## 5.1 Organizational Decisionmaking

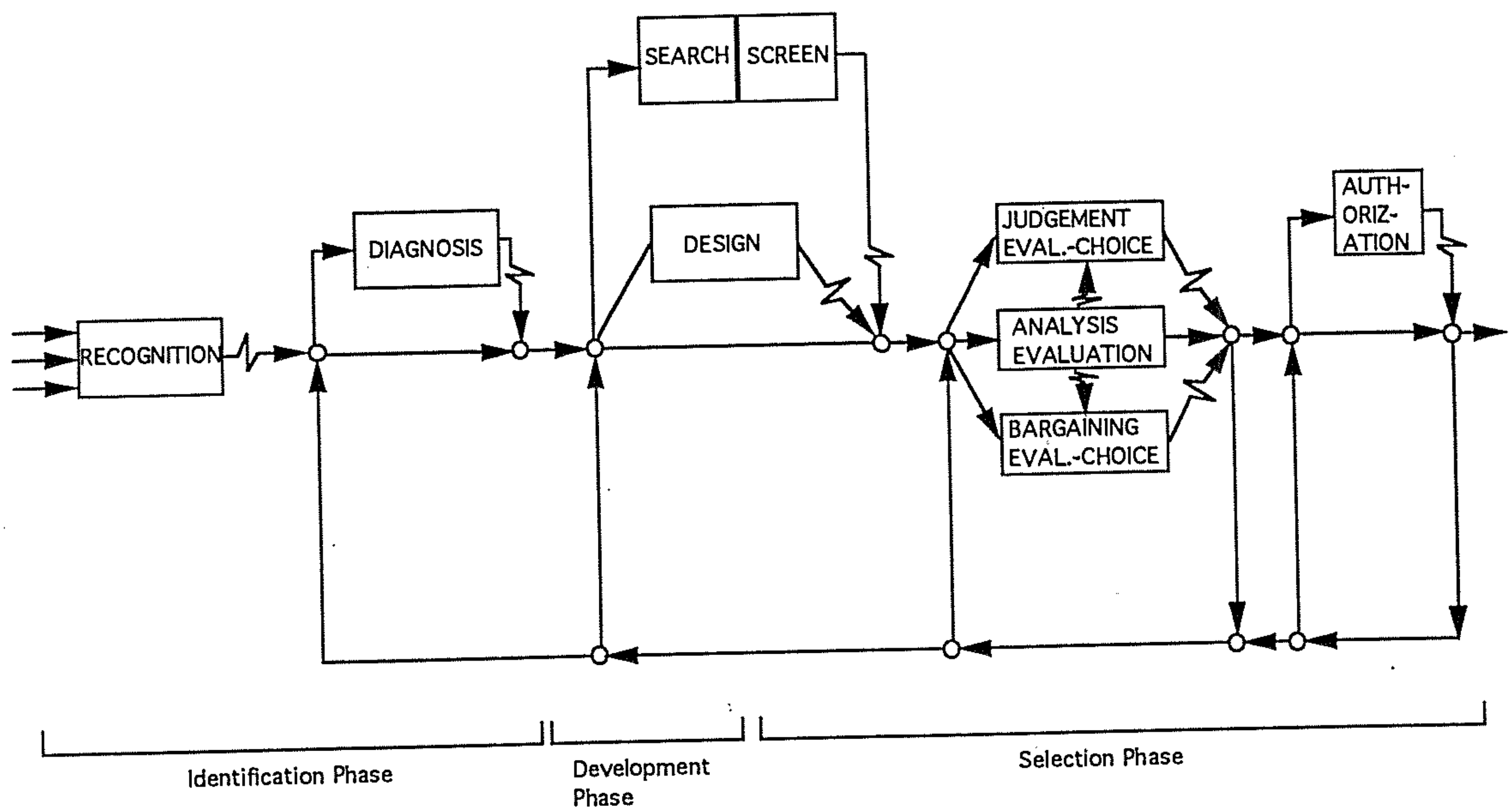
Several normative and descriptive models of decision making have been developed which depict the decision process as a series of steps and phases. These models typically consist of three to nine sequential phases through which the decision process progresses (e.g., Patterson 1969). Nearly all of the models include a *recognition phase* where the decision topic is first recognized, a *developmental phase* where relevant information is sought and alternatives developed, and a *selection phase* where the choice is made.

However, identifying phases does not lead to an adequate description of how decisions are actually made in organizations. There is no simple relationship amongst the phases and no clearly defined order of progression. The process as a whole does not advance in an orderly laid out fashion but in a slow iterative often circuitous fashion where phases, and steps within the phases, are taken out of order and repeated over and over (Hickson et al. 1986; Mintzberg et al. 1976). During the course of a decision, updated information generates new alternatives; unforeseen circumstances open up new courses of action; personal preferences override obvious choices; and internal power struggles govern the entire process. At times the process itself seems meaningless as information is gathered but not used; more information is sought and ignored; and choices are made before data are presented (March and Shapira 1992). The process is always undergoing re-evaluations, reappraisals, and reassessments. At the extreme there is little evidence of any methodological process as solutions can come before problems, in a veritable "garbage can" of decision-making (Cohen 1972).

Mintzberg, Raisinghani and Theoret (1976) made a significant contribution to organizational decision theory through their study of multiple decision situations. They followed twenty-five organizational decisions, tracing them from beginning to end. They concluded that important organizational action is usually reached through a series of small choices combined to produce a major decision. As organizations move through several decision points they encounter barriers, or "decision interrupts", along the way. An interrupt may result in cycling back through a previous decision in a learning process to find out what will work. The chosen solution is often very different from what was initially anticipated and the whole process can take several months or years depending on the scope and importance of the decision.

Mintzberg et al. (1976) developed a model that identifies the discrete phases of organizational decision-making but, unlike normative models which postulate a simple sequential relationship between them, proposes a disruptive iterative path from problem recognition to final solution. The phases and routines of the Mintzberg model are illustrated in Figure 5.1. The lower part of the chart shows lines running back toward the beginning of the decision process. These lines represent loops or cycles that take place in the normal course of the decision process or as a result of decision interrupts. Overall, the Mintzberg model resembles a map which depicts the possible paths and detours that can be taken en route to problem resolution.

## Figure 5.1: Organizational Decision-Making Model




Source: From "The Structure of 'Unstructured' Decision Processes" by Henry Mintzberg, Duru Raisinghani, and Andre Theoret, published in Administrative Science Quarterly 21, no. 2 (1976), P. 266.

## 5.2 Description of the Mintzberg Model

### 5.2.1 Decision Urgency

Mintzberg distinguishes decisions by urgency and the stimuli that evoke them. He notes that these stimuli are best represented by a continuum. At one extreme are *opportunity* decisions, those undertaken on a purely voluntary basis to improve a situation that is already satisfactory. At the other extreme are *crisis* decisions which are associated with high pressure situations and demand an immediate response. *Problem* decisions are defined as those that fall in between the extremes and are subject to less pressures than crisis decisions.

So far almost all interest in AFVs is the result of opportunities. Organizations view AFVs as a way of improving corporate image; a means for complying with regulations such as worktrip reduction ordinances; a means of being exempted from traffic control measures; and as a shrewd investment in bankable emission credits. Many fleets that have purchased methanol vehicles simply decided to take advantage of temporary subsidies and tax breaks offered by local or state governments. Utility companies with large fleets of electric and natural gas vehicles, are capitalizing on an opportunity to capture a larger share of the energy market.

However, the motives for exploring AFV options may soon change as opportunities turn to problems and, perhaps, even crises. It is reasonable to postulate that approaching AFV purchase requirements will increase the urgency of the AFV issue. Opportunities will be transformed to problems as the need to meet AFV quotas propels the AFV issue to the top of the organization. These problems could eventually erupt into crises as effective dates for mandatory AFV purchases draw even closer.

As the AFV decision takes on a greater urgency or becomes a "crisis" situation, the decision process decreases in time. Most of this reduction will likely be realized at the front end of the decision process during the recoguition and the development phases, although all phases will likely be curtailed. Crisis situations generally require less stimuli to provoke the decision process and generally do not require as much diagnosis. Also, less effort will be devoted to searching for the optimal solution because pressures will motivate the organization to settle for the first satisfactory solution. More emphasis will be placed on solutions that have been implemented successfully in other fleets. Turn-key solutions will be heavily favored over those requiring even minor changes in fleet operations.

In an expedited decision process, the focus will be on only a few alternatives reducing the need for extensive quantitative analysis. Judgment decisions will likely meet less resistance and be rushed through the authorization process. Levels of authorization may be waved. In short, as urgency increases the decision process becomes more streamlined.

Hickson et. al. (1985) describe another scenario under which the AFV issue may be "whipped through to a decision exceptionally quick". They posit that extremely rare unprecedented cases which fall outside usual parameters and are not subject to normal procedures are sometimes rushed to the top simply because there is nowhere else for the decision to go. In this case the decision process is highly centralized while usual formalities are foregone. The authors suggest that these are not necessarily the most serious decisions but the "oddballs" that do not fit the preserves of the established system. Some fleet managers in this study indicated that, due to the novelty and complexity of the AFV decision, the issue would leap frog to the top of the organization.

### 5.2.2 Identification Phase

The Mintzberg model proposes three general phases similar to most decision-making models -- identification, development, and selection. The identification phase comprises two elements. The first of these is what Mintzberg calls the decision recognition routine. It is this stage where opportunities, problems and crises are recognized and evoke action. An opportunity decision regarding the purchase of an AFV will likely remain dormant until an appropriate time to act on it which may come only after possible solutions have been identified and favorable circumstances present themselves. Crisis decisions, on the other hand, are usually incited by a single outside stimulus and usually involve a short identification phase that results in immediate action.

An important consideration in the recognition routine is determining the conditions required to turn ideas into action. Solutions will be acted upon only after a problem has been recognized and receives attention from key people in the organization (Cyert and March 1963). Recognition of a potential solution is often the catalyst that brings the problem to the attention of the key players (Cohen 1972). Because AFVs generally do not pose a solution to any current pressing fleet problems, the stimuli that evoke action will likely come from outside fleet operations (e.g., the need to comply with worktrip reduction requirements).

The second element of the identification phase is the diagnosis routine which involves "tapping existing information channels and opening new ones to clarify and define the issues" (Mintzberg et al. 1976). Diagnosis can be a formal explicit routine such as the formation of a special committee, task force, or the hiring of consultants. This type of diagnosis will likely be more prevalent in situations where AFVs are pursued as a long-term solution to non-fleet problems (e.g., as a means of meeting new-source emission offset requirements). However, diagnosis of the AFV purchase decision may also be an implicit part of the decision process.

### 5.2.3 Development Phase

The next phase of the decision-making process is the development phase which is described in terms of two basic routines, search and design. A search routine is initiated to find ready-made solutions. If none are found, a design routine is initiated to develop custom-made solutions or to modify ready-made ones. The four types of search behaviors described by Mintzberg are memory search, passive search, trap search, and active search. A memory search is the recollection of similar organizational experiences, passive search is simply remaining alert for unsolicited alternatives, trap search involves letting people know an alternative is being sought, and active search is directly seeking solutions or alternatives. It is common for the search routine to progress in this order.

Most fleet managers I spoke to were in the passive stage of the search routine. Generally, information acquired through a passive search is less specific than that acquired in an active search mode (Connolly 1977). Memory searches were difficult to distinguish as many are simply individual recollections of the organization's past experiences with diesel, propane or alternative fuel vehicles. Typically organizations with knowledge about AFVs were initially contacted by a government agency or utility company. As the AFV decision increases in urgency, organizations will begin actively searching for AFV information. Most fleets covered under AFV mandates still have not decided how to deal with AFVs. Many are waiting until the last minute to make sure current AFV regulations do not change. The search for AFV information will likely intensify considerably as the 1998 CAAA deadline approaches.

Another routine in the development phase is 'design' where custom-made solutions are generated or ready-made solutions are modified for special applications. A practical definition for the purpose of this study is any change necessary in current operations or infrastructure to accommodate an AFV. For instance, an organization which installs EV recharging facilities or alters route assignments to accommodate shorter-range vehicles has more or less "designed" a solution. An AFV which can simply be "plugged into a fleet" with little or not adjustment in vehicle use or infrastructure is considered a ready-made solution .

### 5.2.4 Selection Phase

The final phase in the model is the selection phase which consists of the screening routine, selection routine and authorization. The screening routine is first used to reduce the number of alternatives to a manageable number that can be handled by the decisionmaker. Screening is often an implicit part of the search; as alternatives appear they are immediately screened for appropriateness and then either included in the choice set or rejected outright.

Findings from this study indicate that the screening procedure in the AFV purchase decision will likely be a two-tiered process. The first level of screening compares the different types of AFVs and dismisses those choices which are not suitable because of operational barriers (e.g., an AFV that does not have the required range). Once the decisionmakers narrow the choice set to possible AFV types, they will further screen the remaining choices using cost factors. The primary cost factor used with conventional vehicles is purchase cost. However, this may simply be a consequence of the fact that there is relatively little difference between other cost components amongst conventional vehicles. It is hypothesized that, because many AFVs have a greater purchase price differential, other cost factors such as service warranties, fuel costs, and maintenance costs will be weighted more heavily in the selection phase.

The second routine in the selection phase is *evaluation choice* which comprises three modes: judgment, bargaining and analysis. Most of the literature dealing with organizational decision-making deals with these three aspects. *Judgment* decisions are made by one individual or a dominant few. The decision does not rely on in-depth analysis but rather on the perceptions and convictions of the decisionmaker. Cognitive limitations prevent this individual from always behaving as a purely "rational" decisionmaker with well-defined objective functions.

In *bargaining*, the selection is made by a group of decisionmakers, often with conflicting goal systems. Politics and consensus building play an important role. *Analysis* consists of a factual evaluation usually carried out by technocrats and followed by managerial selection. Formal analysis is typically used for objective input into decisions. However, it is sometimes conducted for symbolic reasons, for a posteriori justification of decision choices, or merely to give the impression of action (Langley 1990).

The final routine of the selection stage is authorization. Choices must be authorized when the decisionmaker lacks the jurisdiction needed to implement the decision. Usually the decision follows a hierarchical route of approval up the organizational chart, however, individuals may also seek authorization to proceed with an AFV decision either at the outset or during development (Mintzberg et al. 1976).

The phases and routines described above highlight the crucial steps that constitute the decision process. The fleet typology enables one to predict how organizations will react to these stages during the AFV decision process. The final component of my fleet decision-making framework pertains to the *type* of decision under consideration.

## 5.3 Types of Fleet Decisions

It has been shown that the type of decision under consideration directly affects the decision process in terms of how long the process takes, how repetitive it is, and the number of interruptions and delays (Hickson et al. 1986; Mintzberg et al. 1976). Generally, decisions can be classified as one of three types depending on their complexity, novelty, scope, political ramifications, resource commitments, and organizational consequences. Although different nomenclature is used for these three decision types (Hickson et al. 1986; Mintzberg 1979), I will use the designations of Kleindorfer et al. (1994) who refer to them as *strategic*, *tactical*, and *routine* decisions.

Strategic decisions are generally novel, complex, substantial, and unprecedented. They determine future courses of action, occupy the thinking of upper management, involve significant resource commitments, and impact a relatively large portion of the organization. Tactical decisions have less of an impact on operations and are less severe in their consequences. They include pricing decisions, marketing strategies, and inventory management. Routine decisions are repetitive in nature, local in scope, have relatively minor consequences, and are usually dealt with at the lower levels of the organization. An example of a routine decision is scheduled equipment replacement.

A fundamental premise of this study is that the AFV fleet issue will be a *strategic* decision. However, this is not to say that a much different type of AFV decision could transpire. For instance, the "AFV decision" may simply be whether or not to purchase a single flexible-fuel (methanol) vehicle (FFV) with no intention of additional purchases. In this case the purchase of a single FFV, which costs about the same as a petroleum vehicle and is nearly indistinguishable from an operating standpoint, would likely not be a strategic decision requiring involvement beyond the fleet level. The FFV purchase would proceed in the same manner as a routine vehicle purchase. This study is concerned more with decisions resulting in a commitment towards more advanced alternative fuel technologies.

Thus far I have discussed three important factors which will determine the decision path taken by organizations considering alternative fuel vehicles. The fleet decision structure (fleet typology), the urgency surrounding the decision (opportunity, problem, crisis), and the nature of the decision (strategic, tactical, routine) are all inextricably related and determinant of the decision process. In the following section I elaborate on how each might affect the AFV purchase decision.

## 5.4 The Alternative Fuel Vehicle Purchase Decision

### 5.4.1 Recognition of the AFV Issue

The vehicle fleet, when running properly, is often almost an invisible part of the organization from the decisionmaker's perspective. Therefore, the first step in the decision process is recognizing AFVs as a viable alternative to petroleum-fueled vehicles. They could provide a solution to a specific problem or merely represent an opportunity for improving existing conditions. Fleets in this study reported two primary reasons why they began investigating AFVs. They either became interested after learning of pending AFV purchase requirements or after becoming aware of the potential public image benefits of AFVs.

The first inroads into the AFV fleet market are being made by government agencies and large high-profile organizations with notable reputations. My findings indicate that these organizations are the most receptive to AFVs and will likely continue to be the first to comply with AFV mandates. In a study of regulatory conformity, Pfeffer and Salancik (1978) found that government agencies and "highly visible" organizations are the first to comply with regulatory controls. There is empirical evidence that these types of organizations, especially state and federal agencies, will continue to be pioneers in AFV fleet market development (CEC 1992; NAFA 1991; Runzheimer 1993; Runzheimer 1995).

Besides legislative mandates, the potential for improving public relations is the motivation most often cited by interview and focus group participants for investigating AFVs. In addition, 71% of our mail survey respondents stated that the clean fuel vehicle image being associated with their organization was an important consideration. Compared to conventional vehicles, the potential corporate image benefit of AFVs is relatively large. Promotion of this AFV attribute could go a long way towards expediting the infiltration of AFVs into the fleet vehicle market.

Regardless of how or why AFVs are brought to the attention of organizations, the recognition stage is a critical step in the decision process. It is a time of high political activity when individuals decide where they stand on an issue. A forceful AFV advocate at this stage will greatly increase the chances of the issue reaching a level of action (Fahey 1981; Howell and Higgins 1990).

This is borne out by organizations in this study which have successfully implemented AFV programs. In each instance, there was a serious commitment from the very top of the organization. Employees from all levels of the organization agreed that this support from upper management was critical. They noted how the enthusiasm of upper level executives permeated the entire organization . This organization-wide support was perceived by study participants to be one of the most important elements of a successful AFV fleet program.

A slightly different perspective of this unified commitment to the AFV program was offered by an interviewed fleet operator who stated that "without everybody's support (for the AFV program), things will never work right". He pointed out that using AFVs requires the cooperation of several individuals. For example, the driver who fails to recharge an EV for the next user, fails to adhere to recommended maintenance schedules, or ignores small mechanical problems until they become too large, can single-handedly cause a company's AFV program to fail.

### 5.4.2 Searching for the "Right" Alternative Fuel Vehicle

The search for a practical AFV solution will likely begin with the simplest and least expensive alternatives. Typically searches start in the "neighborhood" of existing solutions and focus on the most convenient choices (Cyert and March 1963). The first source of information will likely be the experiences of other fleets. Participants in this study relied on an extensive fleet network for information regarding new technologies and operating techniques. This was demonstrated during our focus groups where most of the participants seized the opportunity to make new contacts and get first hand information regarding a wide range of subjects. Nearly every focus group participant mentioned the importance of their fleet network as an information source.

Recent survey results from Runzheimer (1994) also reveal the importance of fleet networks. One-third of the 1435 respondents surveyed was already aware of at least one fleet that operated alternative fuel vehicles, most of which conveyed positive experiences. The experiences of a relatively few fleets could have far-reaching consequences. Fleet operators in this study revealed that the most valued sources of information are individuals with first-hand experience with AFVs. Aguilar (1967), in his study of information sources, found that amongst managers personal sources exceed impersonal sources in perceived importance -- 71% to 29%.

In addition to peers, there are several other places where prospective AFV purchasers will search for AFV information. A recent survey of large fleets (Runzheimer, 1994) lists the most common sources of vehicle information. Topping the list is fleet industry publications (used by 90.4% of the respondents), manufacturer information (78.7%), fellow fleet executives (43%), conferences, conventions, seminars and automobile shows (42.1%), NAFA (34.5%), leasing companies (27.9%), government studies (27.9%) and car magazines (27.4%).

Although leasing companies were listed as a common source of information for only 27.9% of those surveyed, my interviews and focus group sessions revealed that they are a valued source of information for fleets that lease vehicles. Fleets which lease vehicles often rely heavily on the advice and information provided by their leasing company. The leasing companies which participated in this study see their role as an information provider. With respect to AFVs, their stated position is to simply convey what they know to the fleet operator as objectively as possible.

### 5.4.3 Screening AFV Options

It is hypothesized that the screening of AFV alternatives will proceed as a "progressive elimination" based on discrete criteria (Tversky 1972). Furthermore, the order in which the criteria are applied will not be arbitrary but will begin with "critical thresholds" (Recker and Golob 1979) which specify some minimum level of acceptability. These critical thresholds will pertain to job suitability and cost factors -- the two most important criteria for fleet vehicle selection (AGA/NGVC 1991; LADWP/SCE 1989; Runzheimer 1993; Runzheimer 1995; SCGC 1990; SDG&E 1992; NAFA annual-a; UIG 1985).

In terms of suitability, many fleet operators will look for a vehicle that has the same attributes as the vehicle it is replacing, regardless of whether or not those attributes are actually needed. Participants in this study showed that they are not accustomed to thinking in terms of which vehicle attributes are essential to their travel needs. When asked whether or not they could use an electric vehicle with a 80-mile range and 6 hour recharge period, nearly all the participants questioned responded negatively. However, after more thoughtful consideration nearly every respondent reversed their opinion and came up with an application for one or more such vehicles (in most instances several applications were eventually realized). Such reactions lead this researcher to hypothesize that the distinction between real and perceived operational barriers is often blurred. Initial reactions to AFVs do not always accurately reflect a fleet's capacity to use such vehicles.

The second screening criterion has to do with cost factors. A critical concern revealed in this study has to do with costs associated with vehicle malfunctions. Losses associated with vehicle breakdowns not only include repair costs but also business losses (driver salaries, delivery delays, canceled appointments, etc.). This is why many fleet operators have strong opinions regarding the merit of particular automobile makes and models. The LADWP/SCE study summarizes the importance of past experiences this way:

> "In most cases, maintenance and life cycle costs are not quantified or arrived at scientifically. Businesses rack up experience with vehicle makes and models. They remember the bad transmissions, carburetors, power trains, engine blocks, electrical systems, steering boxes and flimsy bodies. They won't buy Dodges; they only buy Dodges; they're going to Ford; they left Ford..." (p 31).

Such brand loyalty will likely influence the screening process towards the major automobile manufacturers. Also, AFVs that resemble familiar models (e.g., an EV that uses an existing automobile body type) will likely be favored over AFVs that are much different looking than automobiles currently on the market.

### 5.4.4 Factors Influencing the Final Selection

Choice routine is the stage in the decision process where selections are made through analytical assessments, judgment evaluations, and bargaining tactics. During the course of this research four hypotheses were tested regarding factors which could influence the final selection. The first two hypotheses deal with considerations thought to be significant primarily in judgment choices while the remaining two pertain more to analytical selections.

*Hypothesis 1: Fleets will not purchase foreign-made alternative fuel vehicles.*

There is some indication of a strong commitment amongst fleet operators to purchase American-made vehicles. In a survey of U.S. fleet operators conducted by NAFA, 89% of the respondents stated that they do not buy vehicles with traditionally "foreign" nameplates; 87% cited a "perceived or written 'buy American' company policy" as the reason why (NAFA 1991). When asked in the same survey about their vehicle purchase intentions, less than 3% of the respondents planned to purchase any foreign vehicles in the coming year (this percentage dropped even lower in subsequent surveys (NAFA annual-a)). This American automobile preference (or buy American sentiment) was also evident in this study. State survey results reveal 82% of the respondents feel it is important that the AFV they purchase is made by a domestic manufacturer (approximately 15% of all light-duty fleet vehicles operating in the U.S. are imports (Bobit annual)).

However, from discussions with fleet operators who subscribe to buy American policies, I have found that in most cases these practices and attitudes are not immutable. Most of the fleet managers with such policies felt that clean-burning AFVs would be a justifiable exception. Clean air and energy diversity are apparently perceived as patriotic causes which would justify the purchase of foreign-made AFVs. Moreover, fleet operators in this study suggested that the meaning of "American-made" has lost significance. They give examples of vehicles that are "American" simply because 51% of the parts are made in the U.S. Often these vehicles are not even assembled in the U.S. In any case, most of the participants with "buy American policies" indicated that they would waive such a policy if AFV fleet mandates were imposed or if American automobile manufacturers did not offer competitively priced AFVs.

*Hypothesis 2: AFV purchase decisions will be influenced by fleet mechanics.*
*Corollary: Mechanics will generally discourage the use of high-tech AFVs.*

It was originally hypothesized that in-house mechanics would be very influential in AFV issues and that they would adamantly resist the purchase of such vehicles, especially EVs and other high-tech options. It was reasoned that these new vehicle types would be troublesome for mechanics and would require additional training. In addition, it was hypothesized that a disgruntled mechanic could single-handedly jeopardize future investments in AFVs through improper vehicle maintenance and repair.

However, this does not seem to be the case for two reasons. First, interview and focus group findings suggest that opinions of mechanics will not weigh too heavily in the AFV purchase decision. Second, interviews with mechanics revealed an unanticipated positive attitude towards technological advances in their field. The mechanics interviewed seemed to welcome technological advances and viewed them as a way to get ahead in their field. Fleet mechanics are unlikely to actively oppose AFV purchases and, at any rate, will not likely be influential enough to derail AFV purchase plans.

*Hypothesis 3: Fleet operators are highly cognizant of full life-cycle vehicle costs.*

It is generally maintained that fleet operators are more cognizant than private vehicle owners of the costs associated with owning and operating an automobile. A fleet manager's primary objective is to minimize costs and his/her performance is evaluated accordingly. Therefore, it is rational to assume that fleet operators would be more inclined to employ sophisticated detailed cost analyses when comparing vehicles for purchase or lease. Full cost comparisons would be beneficial for many types of AFVs which, due to their higher purchase costs, can only compete economically on a total life-cycle cost basis.

However, empirical evidence indicates that the majority of fleet operators do not perform detailed cost analyses when considering which vehicles to purchase. In a recent survey only 24% of the fleet operators said they consider full life-cycle costs when selecting a vehicle (Runzheimer 1993). In two other separate surveys, overall operating cost was regarded as an important AFV consideration by less than 25% of the respondents (Runzheimer 1995; SCGC 1990) Results from my focus group sessions and interviews with fleet operators support these findings. Very few of the participants said they considered life-cycle costs when comparing vehicles for purchase. Only the largest and most sophisticated fleets had accounting systems capable of disaggregating the total cost of owning and operating a vehicle. In fact, only about one-quarter of all large business fleets even use computers to monitor automobile expenses (Runzheimer 1993). My findings indicate that, when selecting a new vehicle, most fleets simply compare purchase prices while giving implicit consideration to resale value.

Participants in this study indicated that experience with similar vehicle makes and models is also weighed much more heavily than operating costs when selecting a new vehicle. The final choice is often more judgmental than analytical with fleet operators being more brand-loyal than cost-conscious. This puts many AFVs at a disadvantage because they generally have higher purchase prices, lower resale values, and no performance history. Even an AFV that offers a significant life-cycle cost savings is likely to be precluded from the final choice set if the savings are obscured behind a high sticker price.

Fleet market penetration of AFVs will depend largely the extent to which fleets look beyond the vehicle purchase price to the total life-cycle cost. The purchase price provides a reasonable criterion for selecting amongst vehicles which are relatively similar in other cost considerations. However, it is inappropriate for comparing most types of AFVs to conventional vehicles. Fleets in this study indicated a willingness to compare other vehicle cost factors (besides purchase price) once they became aware of the need to do so. However, many were unsure how to interpret the cost differences. This highlights the need to educate fleet operators about the significance of operating costs and the importance of making those costs an explicit AFV attribute.

*Hypothesis 4: Expectations of low resale value will discourage fleets from purchasing AFVs.*

A key assumptions of most past studies regarding AFV market potential is that fleets will be 'rational' in their decision making. This assumption gives rise to the initial hypothesis that, since resale value is the largest single unknown vehicle life-cycle cost component, fleet operators would be reluctant to buy AFVs. (AFVs will likely have low resale potential until a used alternative fuel vehicle market is established). This hypothesis is far from being entirely true.

Resale value is consistently ranked low amongst new vehicle purchase criteria in fleet surveys (AGA/NGVC 1991; LADWP/SCE 1989; Runzheimer 1993; SCGC 1990; SDG&E 1992). Our mail survey revealed 56% of the respondents considered AFV resale value, at most, only "somewhat important". Focus groups and interview findings reveal that resale value is a very complex issue. Some firms do keep detailed accounts which allow life-cycle cost comparisons, but for the most part they are not carefully derived. Many fleets do not understand the concept of full life-cycle cost analysis, do not believe it applies to them ("we do not keep vehicles long enough"), or do not think that it is important.

Consideration of resale value varies with fleet type and vehicle usage. Generally, fleet vehicles with short replacement cycles (i.e., high-mileage vehicles) are most likely to be selected with resale in mind. Large private fleets which dispose of several vehicles each year are the most likely to recognize a vehicle's resale potential at the time of purchase. Amongst these fleets there seems to be a certain amount of pride with obtaining high resale values for used vehicles. In fact, many consider themselves "manufacturers of used cars" and are willing to utilize various disposal methods in order to get the highest price for their used vehicles (Runzheimer 1991).

Many fleets in this study, especially small fleets, "run their vehicles into the ground" and then scrap them or "cannibalize" them for spare parts. This is also standard practice for specialty vehicles and medium to heavy-duty vehicles. These type of vehicles are generally much more expensive, have longer life expectancies, and are difficult to resell because of a limited resale market. Several interview and focus group participants suggested that AFVs would be treated as specialty vehicles with regard to resale -- i.e., the AFV will be kept for the duration of its functional life.

An important resale concern raised in the focus group sessions had to do with liability issues. Participants expressed concern about possible litigations resulting from selling someone a "bad" AFV. One individual shared a story of how he went to great lengths to fix up a natural gas vehicle before selling it. He did not recoup the investment upon resale. Perhaps more importantly, fleets are concerned about damaging their reputation for offering quality used cars at reasonable prices. Many fleets have a loyal following within the used car market. If their reputation is jeopardized, sales may decrease, prices may have to be lowered, and advertising costs will likely rise. Potential reputation damage and increased liability are very real concerns amongst fleet operators. In fact, most focus group members indicated that they would re-convert an AFV conversion back to a petroleum vehicle before selling it.

### 5.5 Additional AFV Purchases

The AFV decision will be a dynamic process that may be decided quickly or it may take place only after several feedback cycles over an extended period of time. Internal and external influences could delay or streamline the decision process. Examples of likely AFV decision processes for each fleet type are given in the following chapters. Each assumes that the decision process is undertaken as a result of an 'opportunity' to purchase alternative fuel vehicles.

It is important to note that each successive AFV purchase made by an organization may follow a different decision path. Once a particular AFV is successfully incorporated into the fleet, the next AFV purchase will likely become more streamlined. Eventually, the AFV purchase may become a routine procedure much like the purchase of a conventional vehicle. The first AFV that works satisfactorily, be it an EV, CNG or methanol vehicle, may become, by default, the preferred AFV for future purchases. Fleet operators, like most individuals, stick with solutions that are successful. This is especially true if the organization is heavily invested in a particular AFV type (e.g., has installed refueling facilities).

Some organizations may initially experiment with different types of AFVs. This was the case for a few of the larger organizations in this study. These organizations were collecting their own first-hand data on different AFVs through direct usage. Although it would be possible to incorporate different types of AFVs into one fleet, there was no intention to do so. Rather, these organizations where planning to eventually commit to one particular AFV type. There are several trade-offs to diversifying the fleet with several AFV types. For instance, the use of different AFV types holds greater potential for replacing a large number of conventional vehicles, however, such a scenario will likely also require greater infrastructure investments.

# The Autocratic Decision-Making Structure

## 6.1 Characteristics of the Autocratic Decision-Making Structure

Autocratic decision-making fleets comprise 10% of my survey sample, however, it is likely that they were undersampled due to the fact that small fleets (less than ten vehicles) were not included in the sampling frame. Fleets with an autocratic decision-making structure exhibit very informal, highly-centralized decision behavior. Decisions are typically made by one individual (e.g., the business owner) who is very familiar with and fully responsible for day-to-day fleet operations. Solution choice sets are shaped around this individuals perceptions and interests. The decisionmaker usually has several important non-fleet-related responsibilities and, therefore, does not have a substantial amount of time to devote to fleet issues. The vehicle fleet is often considered a low priority that demands attention only when something goes wrong.

Because the decisionmaker is usually an owner, manager, or executive officer, he/she is in an ideal position to interpret how the decision in question will affect the rest of the organization. This is important because the AFV purchase decision may be motivated for reasons that go beyond the scope of fleet operations. Bankable emission credits, corporate tax breaks, and compliance with mandatory employee trip reduction programs are just a few of the incentives that mean little to a fleet manager (the person who oversees daily operations) but could appeal to a business owner or executive officer.

The autocratic fleet decisionmaker is usually influenced more by past experiences and the recommendations of colleagues than by the systematic comparison of viable options. Intuition and personal judgment replace rigid analysis for evaluating alternatives. Outcomes are often a reflection of the decisionmaker's likes and dislikes and, more often than not, a direct extrapolation of his/her personal opinion. In this regard, vehicle purchases closely resemble that of a private household where brand loyalty, vehicle reputation, and personal tastes are often every bit as important as economic factors.

Because the autocratic decision process involves only one or two individuals, decision times can be much shorter. The decision environment is non-political and the final selection requires little if any approval. The autocratic decisionmaker is uniquely qualified to make choices which maximize the organization's objectives because he/she usually has an excellent understanding of those objectives. Therefore, decisions are consistent and integrated with company goals. Furthermore, there is little resistance from other employees during the decision process or implementation.

Because the decision is not "bogged down" by formalized procedures or by the convictions of other interested parties, it is more likely to be motivated by proactive opportunity-seeking behavior. This leads to greater potential for major changes opposed to incremental departures from existing circumstances. The streamline centralized decision process also enables organizations to move quickly when faced with a rapidly changing environment. Large changes can be made quickly in the mind of one individual. Although this enables quick implementation of new technologies, it can also lead to "last minute" decisions.

Autocratic decision-making behavior is prevalent in small owner-managed private businesses with functionally simple organizational structures and few levels of management. These organizations tend to be "high in centralization and low in both formalization and complexity" (Mintzberg, 1979). The operating environment of these types of organizations is best summarized by Pugh (1969) who noted that they are guided "not by explicit regulation but by implicitly transmitted customs ... typical in organizations of small or medium size where ownership and management still overlap". Good examples of organizations with an autocratic fleet decision structure are independent local businesses which offer services such as landscaping, plumbing, and appliance repairs. These organizations usually have one small vehicle fleet and travel needs that seldom extend beyond the local vicinity. Vehicles are often taken home at night by the employees.

The main advantages of an autocratic structure is that decisions can be implemented quickly since the process does not involve lots of individuals, departments, formalities, or sophisticated evaluative techniques. Also, solutions are generally well-integrated with company goals. The main disadvantage is the fact that solution development is limited by the cognitive abilities of only one or two decisionmakers.

### 6.2 Implications for the AFV Purchase Decision

Although there is no one-to-one linkage between fleet type and decision process, it is possible to predict how different fleet types will likely react at each decision stage for a given set of circumstances. To accomplish this, it is necessary to understand the fundamental behavioral characteristics that will influence the decision process. The following section highlights some of the important behavioral characteristics of autocratic fleets that will likely influence the AFV purchase decision.

Autocratic fleet decisionmakers do not rely on support from staff, advisory committees, or field experts to identify problems and search for solutions. They belong to fewer fleet associations and subscribe to fewer industry publications than other fleet types. Moreover, there are relatively few employees to act as the company's "eyes and ears" ready to pick up outside information. Consequently, knowledge of AFVs will come from familiar places, primarily through well-established networks within their business communities. However, these information contacts will likely be fellow business owners rather than full-time fleet managers who are more aware of fleet industry news. As a result, the information the decisionmaker receives may be outdated, incomplete, or even inaccurate. A special effort should be made to get AFV information to those businesses that fall outside the main fleet network.

Autocratic fleet decision-makers purchase vehicles much like the private consumer and are, therefore, predisposed to the same purchase habits. Due to time and resource constraints, the autocratic fleet decisionmaker will likely consider only one or two specific AFVs. These will most likely be AFVs that have successfully been used in other fleets familiar to the decisionmaker. Autocratic fleets will copy AFV solutions implemented elsewhere. Very few management systems will be used to evaluate AFV options and participation by others will be limited to a few individuals who may offer technical or financial information. Vehicle attributes and costs will be traded-off in the decisionmaker's head.

Although autocratic fleet decisionmakers were the most vocal about AFV cost concerns, they are perhaps least aware of the magnitude of those costs. This is evident by their fleet management practices. Autocratic fleets are least likely to conduct any type of analytical cost assessment when making purchase choices. In fact, very few even monitor vehicle costs or use any type of computational analysis for tracking expenses. The only record of vehicle costs is often a mental record of negative incidents such as a drastic breakdown or a high repair bill. These memories are used to preclude certain vehicle makes or models from the next purchase choice set.

Therefore, it is hypothesized that the final vehicle selection will be based largely on a comparison of purchase prices. This puts higher-priced AFVs, such as EVs and CNGVs, at a distinct disadvantage as candidates for use in this type of fleet, even though the higher purchase price may be offset by lower operating and maintenance costs. Even autocratic fleet vehicle purchasers that do consider operating expenses are unlikely to realize the full potential cost advantage of an AFV that offers fuel cost savings (Greene 1983). Small businesses typically operate on short-term budgets which favor immediate gains over long term benefits. When asked specifically to trade-off upfront costs and long term savings, autocratic fleets in this study overwhelmingly favored AFV purchase discounts over economic incentives with longer payback periods. This confirms previous findings that even a 2-year AFV payback period (the time required to recoup higher purchase costs through lower operating costs) is generally unacceptable (SDG&E 1992). These findings underscore the importance of providing autocratic fleets with financial incentives that help defray upfront costs.

Autocratic fleets also placed the least value on corporate image enhancement as motivation for purchasing AFVs. Although their expressed concerns for cleaner air were as strong as other fleet operators participating in this study, they were least inclined to purchase an AFV for public relations benefits. On the other hand, hearsay and rumors could play an important role. Throughout the interviews and focus groups, several autocratic fleet decisionmakers dismissed certain AFV options because of negative stories (some true, some false, but most exaggerated). Small autocratic fleets tend to be influenced most by rumors because they do not have as much access to reliable AFV sources as other fleet types (e.g., AFV campaigns have not targeted smaller fleets).

The possible impact of misinformation on the autocratic fleet decision process is best illustrated with the following example. Many of the autocratic fleet participants in this study had serious reservations about the safety and integrity of the fuel tanks on compressed natural gas vehicles (CNGVs). Participants from other fleet types, who were generally more aware and educated about CNGVs, did not share this concern. Most of these other fleet operators had seen a promotional video which showed several tests being performed on the tanks such as dropping them from high altitudes and shooting them with high-powered rifles. This single video had a tremendous impact on the acceptance of compressed natural gas vehicles. Although tank safety was no longer an issue for those who viewed the video, it was a common reason amongst autocratic fleets for dismissing CNGVs as a viable option.

Of all those who participated in my focus groups and interviews, the autocratic fleet operators were the most likely to hold off on any AFV decision until they absolutely had to address the issue or until the potential benefits of AFVs were proven to them. They felt that the "big guys" [large fleets] were better equipped to deal with the uncertainties of nascent AFV technologies and, therefore, should be the "guinea pigs". The overall attitude of the autocratic decision-making fleets is best summarized as "wait and see" skepticism.

However, small fleets with autocratic decision-making structures should not ignored as potential candidates for AFV purchase. They represent a significant portion of all fleet vehicles and are a tantalizing prospect for AFV sales. They will not likely.be the first to adopt AFVs but may be quick to follow the lead of others. Small entrepreneurial-type businesses often engage in risky propositions; in fact, their very existence is usually due to an inherently risky venture (Mintzberg 1979). These types of organizations operate in dynamic enviroument where change and adaptation are often necessary to survive in very competitive markets. This environment is ideal for innovative change. However, autocratic fleets are currently the least informed about AFVs. Because they are generally small in size, autocratic fleets are not targeted by regulatory controls or AFV information campaigns. Greater efforts should be made to bring autocratic fleets up to date on the status of AFV technology and purchase incentives.

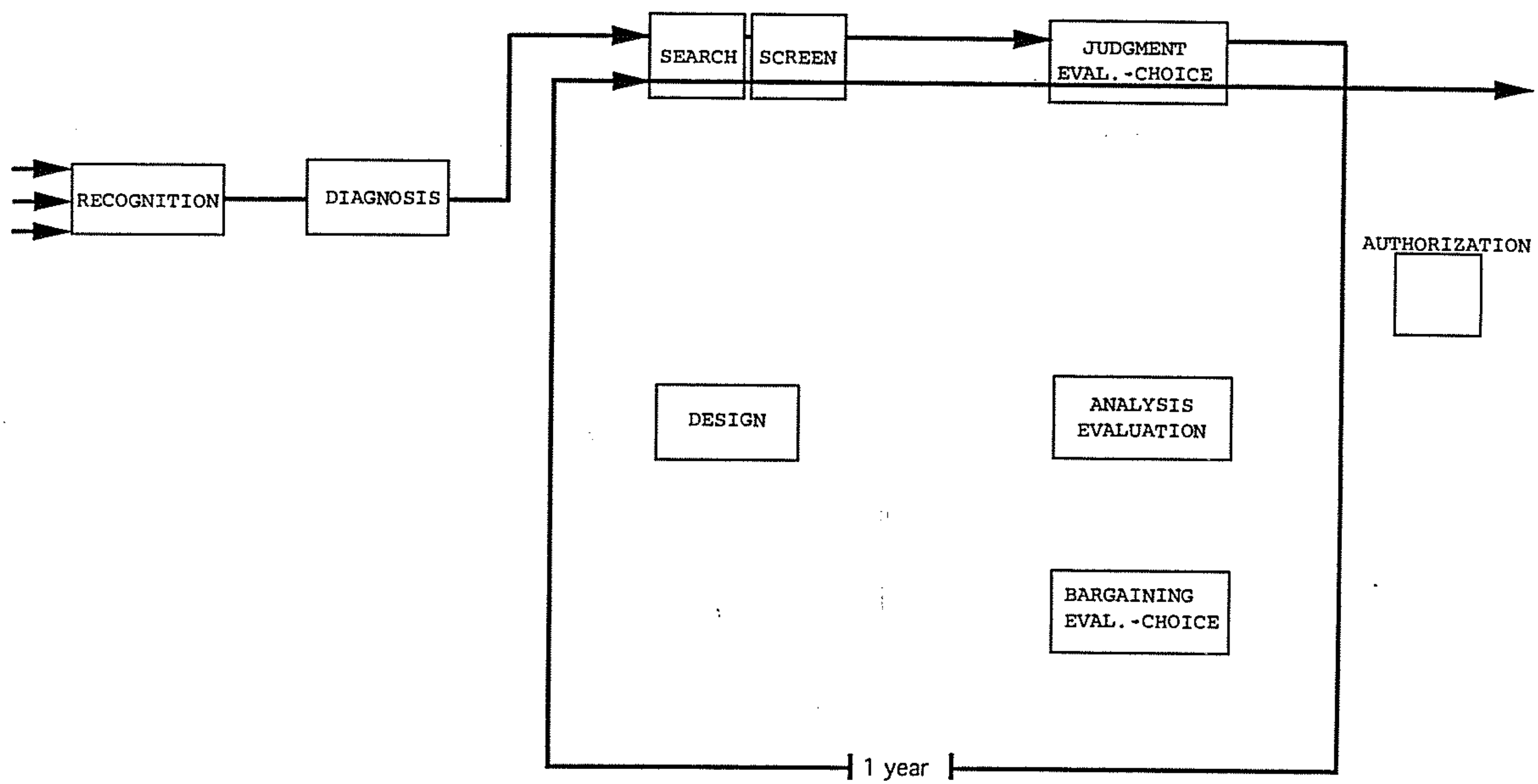
## 6.3 Example of an AFV Purchase within the Autocratic Decision-Making Structure

The following hypothetical example, illustrated in Figure 6.1, represents one of several possible decision paths which could be taken by an autocratic fleet in deciding to purchase an alternative fuel vehicle. Although the decision path is one of many, it is very plausible given the current conditions. The decision process emphasizes the circumstances under which most autocratic fleets will likely face the AFV issue.

In this example, a small business owner learns of compressed natural gas vehicles through an associate who operates one in his fleet (recognition routine). The business owner decides to investigate further after learning of a significant tax break for using such vehicles (diagnosis routine). He contacts his associate to get more information and lets his local automobile dealer know he is interested (search routine). However, after a couple of days of investigating, he decides to postpone purchasing an AFV because of rumors about pending changes in vehicle technology (he does not wish to be a "technology orphan") (judgment choice). After approximately one year he re-visits the issue after hearing of a special deal on CNGVs. Once again he looks for information on CNGVs but this time he is more encouraged because a CNGV is now available from a major automobile manufacturer whom he has dealt with in the past. Finally, he selects and purchases a single CNGV from the familiar manufacturer (judgment selection).

In this example, each stage of the decision-making process is carried out implicitly in the mind of the autocratic decisionmaker. The autocratic decisionmaker recognizes the opportunity, collects the necessary information, evaluates it himself, makes a judgment choice, seeks no authorization, and oversees its execution. He is not interested in developing a variety of options but rather focuses on one or two best alternatives. He collects just enough information to reject or accept the first reasonable alternative and little or no computational analysis is conducted.

Figure 6.1: An Example Autocratic Fleet Decision Process



# The Bureaucratic Decision-Making Structure

## 7.1 Characteristics of the Bureaucratic Decision-Making Structure

Of all the mail survey fleet respondents, 33% have bureaucratic decision-making structures. Bureaucratic fleets, generally the largest in the survey, are common amongst public and institutional organizations. In fact, 44% of all the bureaucratic-type fleets in the survey belonged to a local government agency (state and federal government agencies were no included in the survey) or non-profit organization. Representative fleets include universities, utility companies, public transit authorities and non-profit organizations.

Unlike the autocratic decision structure, bureaucratic decision-making is highly formalized and decentralized. Whereas autocratic fleets rely on personal judgment to reach decisions, bureaucratic decision outcomes are the result of objective evaluations carried out systematically through pre-established routines. Company policies dictate the bureaucratic fleet decision process and centralization gives way to formal procedures. Official rules and standard operating procedures determine the activities, information flows, and interactions of the decision process. There is heavy reliance on precedent. Actions bureaucrat fleets take today are largely determined by a long history of activities and resultant outcomes reflected in the organization's official rules and guidelines (Allison 1971; March and Shapira 1992).

Like the autocratic fleet, the bureaucratic decision-making fleet operates in a "satisficing" mode rather than emphasizing goal optimization (March and Simon 1958). Information searches are usually confined to areas previously utilized and favor quick fixes or incremental changes over more forward-looking long-term solutions. Technical evaluations, financial assessments, and cost-benefit analyses are often a part of the operating procedure.

A practice common to all bureaucratic fleets is the solicitation of bids for major purchases. Bureaucratic-type fleets procure vehicles through a bidding process where specifications are drawn, a bid is let, and a contract is awarded to the lowest bidder capable of fulfilling the contract requirements. Usually a written or implicit company policy stipulates the solicitation of bids. However, the bidding process does not replace cost evaluations as most bureaucratic fleets also conduct a detailed cost comparison of the competing alternatives.

Bureaucratic decision-making is hierarchically dispersed involving several individuals from different organizational levels, departments, and/or geographic locations. There is no single 'decisionmaker' but rather several people who influence the decision outcome. Decisions usually flow from the top-down although the stimulus that triggers decision action can be occur at any level. Decisions must usually be approved by several departments (e.g., finance department) and final choices are subject to many levels of formal authorization. Final authorization is often a formal procedure carried out by individuals far removed from the issue. However, the final decision is not made by these individuals any more than the "choices of the individuals are made by the hands that sigu the papers" (March and Shapira 1992).

Because bureaucratic fleets tend to involve several people and departments, there are many places where a decision can be interrupted, delayed or terminated. The multiple levels of approval required present a barrier to innovative change. A chain of "yeses" is required to implement a new idea while only one "no" is needed to reject it. A number of different departments and managers could prolong an AFV purchase whether or not it directly affects them. The decision could be unintentionally stalled, such as when the necessary paperwork gets "buried" on a manager's desk, or it could be purposely undermined. One example of the latter revealed during the focus group sessions is for the vehicle purchaser to write bid specifications in such detail as to preclude all but one vehicle model.

The bureaucratic decision-making structure is common amongst government agencies and large highly functionalized, mechanistic-type organizations with several levels of specialization (Inkson et al. 1970; Mintzberg 1979; Pugh et al. 1969). It is also common amongst old large private sector firms in mature or regulated industries (Shrivastava and Grant 1985). A disproportionately large percentage (54%) of all government fleets surveyed in this study were found to operate under the bureaucratic decision-making structure. It is also prevalent amongst fleets of non-profit organizations. Many non-profit organizations (e.g., Red Cross) are closely tied to government agencies (many rely on government funding) and thus mimic the fleet management methods of those government agencies. In fact, most procure vehicles by "piggybacking" on government bids.

In situations where the organization has more than one fleet site, fleet policies are usually established centrally and administered locally. Of all the bureaucratic fleets in the survey sample, 76% had a central headquarters location. Of those, 67% indicated that strategic decisions are made at a central headquarters but implemented at individual fleet sites. Because decisions are instituted uniformly, each individual fleet site is a potential 'decision interrupt'. If just one or two fleet sites are unable to adapt to a particular outcome, the organization may have to reconsider the proposed solution. Because the needs of each fleet site must be met, decision outcomes are usually restricted to minor changes.

A positive aspect of bureaucratic decision-making is the fact that decision outcomes depend more on sophisticated formal analysis than the judgment of one individual. Formal analysis is used for "substantive input to decisions" and to ensure successful implementation (Allison 1971). This scientific approach reduces the incidence of individual bias influencing the final decision.

The main drawback of the bureaucratic decision-making structures is the fact that decision behavior is dictated by pre-established procedures. Conditions that set off the decision action are largely predetermined as are the possible responses. Programmed responses are activated only when critical variables get outside some specified range recognized by the system (Steinbruner 1974). Such a structure serves well for improving efficiency in performance-oriented organizations but is not conducive to invoking innovative changes such as the implementation of AFV technologies. An organization with "too good a memory" could limit its alternatives "to the extent as to stifle innovation" (Scott 1981). As a result, solution development is likely to be motivated by reactive behavior and focus on short-term immediate fixes.

## 7.2 Implications for the AFV Purchase Decision

Bureaucratic fleets do not recognize problems that are not monitored by the system and, therefore, will not likely be early adopters of AFV technologies. However, there are two important exceptions -- government agencies and public utilities. Bureaucratic decision-making fleets belonging to these two types of organizations (53% of all utilities fleets and 54% of all local government agencies in this study had bureaucratic decision-making fleets) have been and will likely continue to be the first purchasers of AFVs (CEC 1992; Davis 1995; DOE 1993; Hu and Wang 1996; Hu et al. 1996; NAFA annual-a; Runzheimer 1995; Vyas and Wang 1996). Our mail survey found that 36.4% of the responding local government fleets were "likely" to acquire an alternative fuel vehicle "within the next year or two" (28% already had at least one AFV) compared to 8.9% of the business fleets.

Government fleets will continue to purchase AFVs at an increasing rate because 1) many are specifically targeted by legislative directives that mandate them to use AFVs and 2) public fleets are subject to much public scrutiny. It is not clear which of these two reasons carries the most weight. Most government fleet operators cited both reasons for their interest in AFVs. At times government fleet operators in this study bemoaned the fact that they would have to lead the AFV market. Yet, at other times these same fleet operators seemed to willingly accept the role of AFV pioneer. They felt that their high profile status made it their responsibility to "set an example" in the fight against air pollution.

Despite being in the public eye, or perhaps because they *are* in the public eye, government fleet operators are least concerned about the short-term economic burden that may accompany a switch to AFVs. Although sensitive to saving taxpayers money, savings from shrewd fleet operations usnally get returned to a general fund. Fleet operators are aware that because of shrinking budgets, fleet appropriations may be smaller the following year if the current allocation is not completely exhausted. This budgetary arrangement coupled with AFV purchase mandates will help maintain the government's role as a leader in the AFV fleet market.

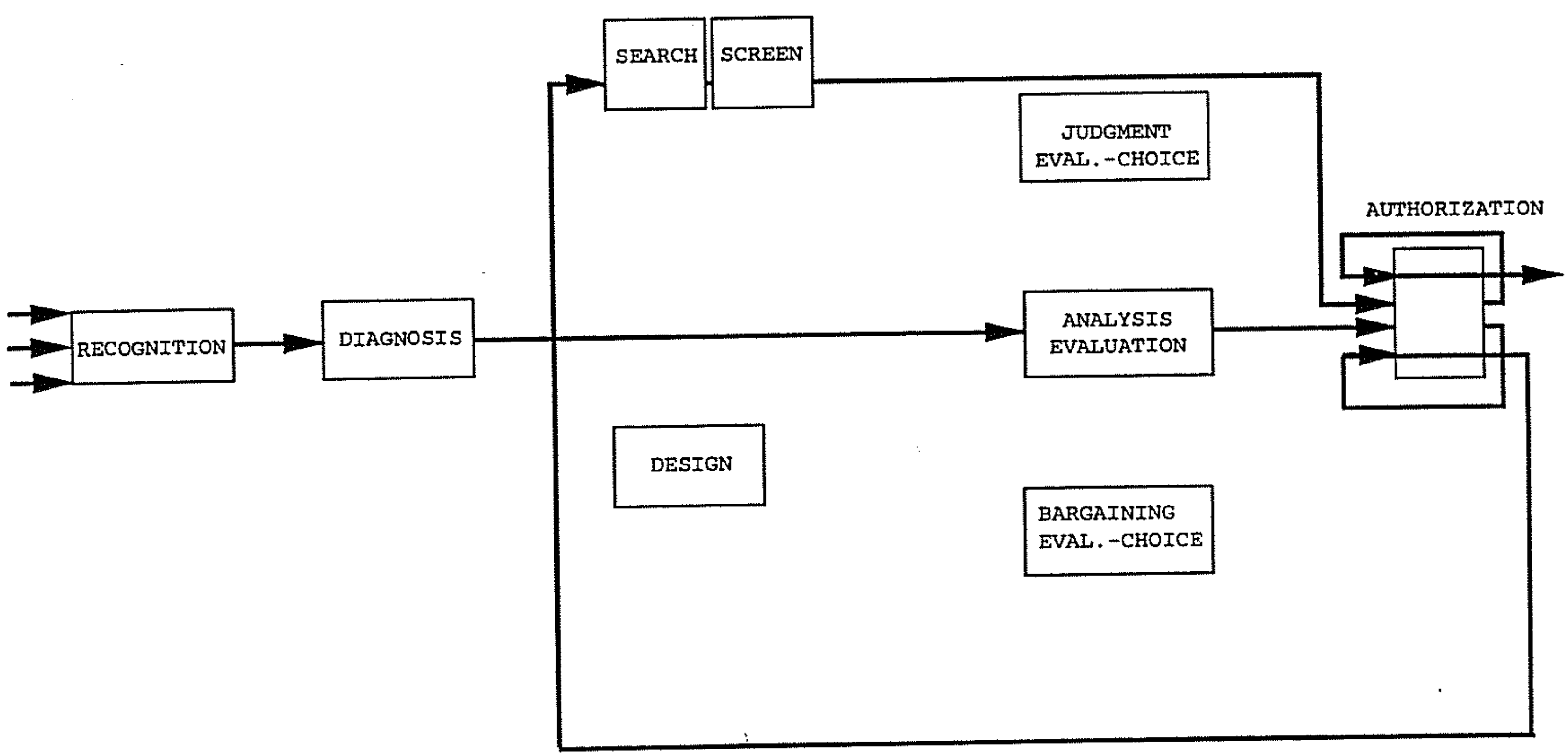
On the other hand, the decision by non-government fleets to investigate AFVs will likely be reactive and pursued only if it provides a solution to a problem or crises monitored by the system. Implementation of AFVs will likely be incremental and only to the extent that it eradicates the problem at hand, rather than a forward-looking proactive step towards a long-term commitment. Bureaucratic decision-making fleets will likely adopt the AFV solution that results in minimum departure from the existing state. Therefore, it is hypothesized that non-government fleets with bureaucratic decision structures will purchase only as many AFVs as required and will favor those vehicles which are most similar to conventional vehicles

## 7.3 Example of an AFV Purchase within the Bureaucratic Decision-Making Structure

The following example, depicted in Figure 7.1, describes how the AFV purchase decision might progress in a fleet with a bureaucratic decision-making structure. Alternative fuel vehicles become an issue only after direct notice of impending AFV purchase deadlines (recognition routine). An ad hoc committee is immediately set up to investigate the necessary requirements for compliance and the possible courses of action (diagnosis routine). Upon careful deliberation the committee recommends the purchase of either natural gas or methanol vehicles. Based on this recommendation, a detailed cost analysis is conducted on the two types of vehicles. The cost analysis reveals methanol vehicles to be the lowest-cost satisfactory alternative (analysis/evaluation choice).

Specifications are drawn up for the purchase of methanol vehicles. These specifications are subject to two levels of approval. The fleet manager and the finance department both approve the specifications (authorization) and so bids are solicited for a specified number of methanol vehicles (search routine). The lowest bid is reviewed and approved by the purchase department followed by a final approval from the administration department (authorization).

Figure 7.1: An Example Bureaucratic Fleet Decision Process



*Chapter 8*

# The Hierarchic Decision-Making Structure

## 8.1 Characteristics of the Hierarchic Decision-Making Structure

Hierarchic decision-making structures, found in 33% of all fleets surveyed in this study, are most common amongst highly-departmentalized organizations with medium to large fleets. Like bureaucratic fleets, a majority of hierarchic fleets are geographically dispersed; 67% of the hierarchic fleets sampled in our survey had a central headquarters. However, independent sites are slightly more autonomous. Approximately 45% are totally responsible for their own fleet decisions while the rest rely on directives from headquarters.

Hierarchic decision-making fleets share attributes with both autocratic and bureaucratic fleets. They are highly centralized and very formalized. Decisions are made by only one or two upper level managers but are guided by policies and standard procedures. The hierarchic fleet decision behavior is more sophisticated than autocratic fleets but less so than bureaucratic fleets. Detailed cost analysis is used in major fleet decisions; especially if the costs are substantial, a large number of vehicles are affected, or precedence is being set. Nearly all hierarchic fleets either conduct an in-depth analytical assessment of the alternatives or make selections through the solicitation of bids (most do both). In most cases authorization is required but, unlike the bureaucratic fleet process, the authorization is often a 'rubber stamp' formality.

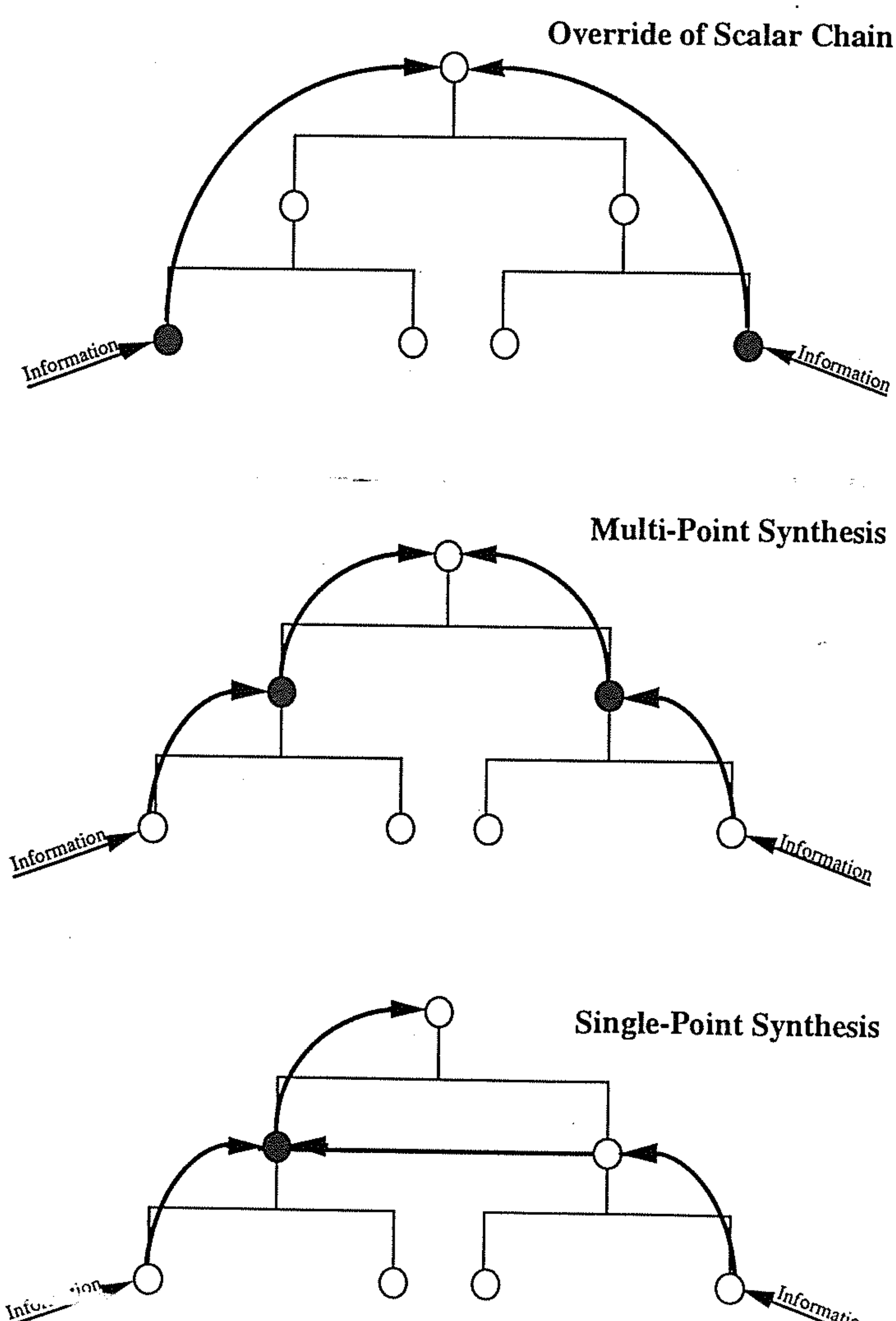
Major fleet decisions are made at the top of the organization although they may be initiated anywhere within the organizational hierarchy. Those who make fleet policy are not necessarily familiar with day-to-day fleet activities but rather rely on a large support system for information. Fleet managers are often an integral part of that support system. Several other departments may provide feedback or expertise on such issues as safety, training, public relations, and legal ramifications of the decision. Committees are often formed to investigate the need for action and recommend possible solutions.

In most cases relevant information is sent up the chain of command where it is acted upon and then sent down the line of authority for implementation. For instance, an organization's environmental division may realize a need to purchase AFVs in order to comply with a new fleet rule. This fact is eventually conveyed up to the vice-presidential level for action. The fleet decision made at the vice-presidential level may concern how much money should be allocated for procuring AFVs; at the management level, which AFVs to buy; and at the fleet level, how the AFVs are to be used.

Although fleet decisions are made by only one or two individuals near the top of the organization, advice and input from lower levels of the hierarchy can play an important role in the decision. Information may come from many different departments, individuals, and fleet sites. In this study it was found that, under normal circumstances, information within the hierarchic decision-making structure usually reaches the decisionmaker via one of three routes (Figure 8.1). It can be conveyed directly from the lower levels of the organization thus overriding the scalar chain of command (Mintzberg 1979); it can be consolidated and synthesized at several points within the organization then passed up to the decisionmaker; or it can be consolidated and synthesized at one point before being passed up to the decisionmaker.

The manner in which the decisionmaker receives information can significantly influence the AFV decision. Scalar override requires more time and information processing by the decisionmaker but since the information is not filtered by other managers, there is

# Figure 8.1: Information Routes within Organizations



less chance of biases creeping into the feedback loop. There is also less potential for politics and self-interests to corrupt the information before it reaches the decisionmaker.

Through scalar override the decisionmaker is able to directly solicit the opinions of individuals throughout the organization who will be affected by the decision. One-on-one communication gives the decisionmaker an opportunity to explain his/her position and gain a better understanding of the factors considered important by the individuals affected by the decision outcome. The decisionmaker can also find out directly the pros and cons of acquiring AFVs from different parts of the organization likely to be impacted by the decision. For instance, the decisionmaker may be informed of how AFVs can be used to meet mandatory trip reduction requirements from the transportation coordinator; this important information might be lost in less direct communications. The result is that the decisionmaker gets a better overall picture of how different alternatives fit the needs of the entire organization.

Single point synthesis, on the other hand, may simply reflect the needs or desires of the individual who must summarize information provided by others and then pass it on for decision action. This information, which is sometimes formalized in a written report, can be manipulated and controlled in order to shape the impressions of the decisionmaker. In this case, individual biases or even apathy can shape the AFV decision. Final recommendations may be based more on individual preference than an accurate accounting of the facts. The individual consolidating information could distort their advice in a manner that will benefit them personally (Cyert and March 1963; Pettigrew 1972). For example, a fleet manager who sees AFVs as merely an inconvenience could exaggerate their negative aspects while downplaying the benefits.

Problems arise when the those with the ability to decide and those with the right to decide are not the same. Recommendations from the individuals perceived to be most knowledgeable about a specific issue carry the most weight, however, the person perceived to be the most knowledgeable is often far from it (Tosi 1975). Expertise is often found at the lower levels of the organization but recognized at the top (Mechanic 1964). As information is conveyed up the hierarchy those in higher positions often misrepresent others' ideas as their own. They are then consulted as the "expert" on the situation which often leads to less than optimal outcomes.

The multi-point synthesis has components of both the scalar override and single-point synthesis. Relevant data is assembled at various points within the organization before being passed up the chain of command. However, information still reaches the decisioumaker from several points. This information route reduces both the potential for bias and the amount of information that must be processed by the decisionmaker, however, it eliminates neither. The hierarchic fleet decisionmakers in this study that had already purchased AFVs received much of their information directly from individuals throughout the organization (scalar override). However, these decisionmakers were highly-motivated to purchase AFVs and often took the initiative to seek out information and opinions from employees.

Like bureaucratic decision-making fleets, hierarchic fleets rely to a great extent on formal rules and procedures to guide the decision process. However, there is an important difference. Hierarchic fleets are more capable of recognizing problems that do not fit within the existing decision-making structure and are less inclined to try to force decision issues to conform to standard procedures. In fact, there is some evidence that decision cases which do not fit the preserves of existing procedures and for which there is no precedent can be quickly elevated to the top levels of management (Hickson et al. 1986). The complexity and novelty of the AFV decision could propel it to the top of the organization and thus streamline the decision process.

The hierarchic fleet decision-making structure was prevalent in organizations which have several semi-autonomous fleets affiliated with different departments. For example, the marketing department may operate a fleet of luxury cars for entertaining clients; the sales division a fleet of economy cars because of large travel demands; and the service department a fleet of vans for carrying equipment. Usually the vehicles in these sub-fleets are stored and maintained at the same location. While each department has control over their own vehicles, most critical decisions are made by one or two individuals who oversee the entire fleet operation. However, these decisions can be made on a department-to-department basis.

### 8.2 Implications for the AFV Purchase Decision

Hierarchic decision-making structures are not overly reliant on rules, regulations or computational analysis (like bureaucratic structures) nor over-dependent on the judgment of a single individual (like autocratic structures). The decision process encompasses both non-quantitative factors and analytical evaluation. This situation represents the best circumstances for adopting AFVs which have attributes that appeal to both the economic-minded businessman and the image-conscious corporate executive.

Hierarchic decision structures are also prominent in large fleets with diverse travel needs. Inherent to this type of fleet composition is the ability to substitute vehicles and re-arrange schedules in order to accommodate various AFV attributes and limitations. This versatility makes hierarchic fleets good candidates for AFVs with operating restrictions (e.g., limited ranges). Intra-fleet vehicle substitution can significantly increase the number of potential AFV purchases. One study found that by substituting vehicles the average van fleet could use 9% more EVs ( with a 60-mile range) than without substitution (Berg 1984).

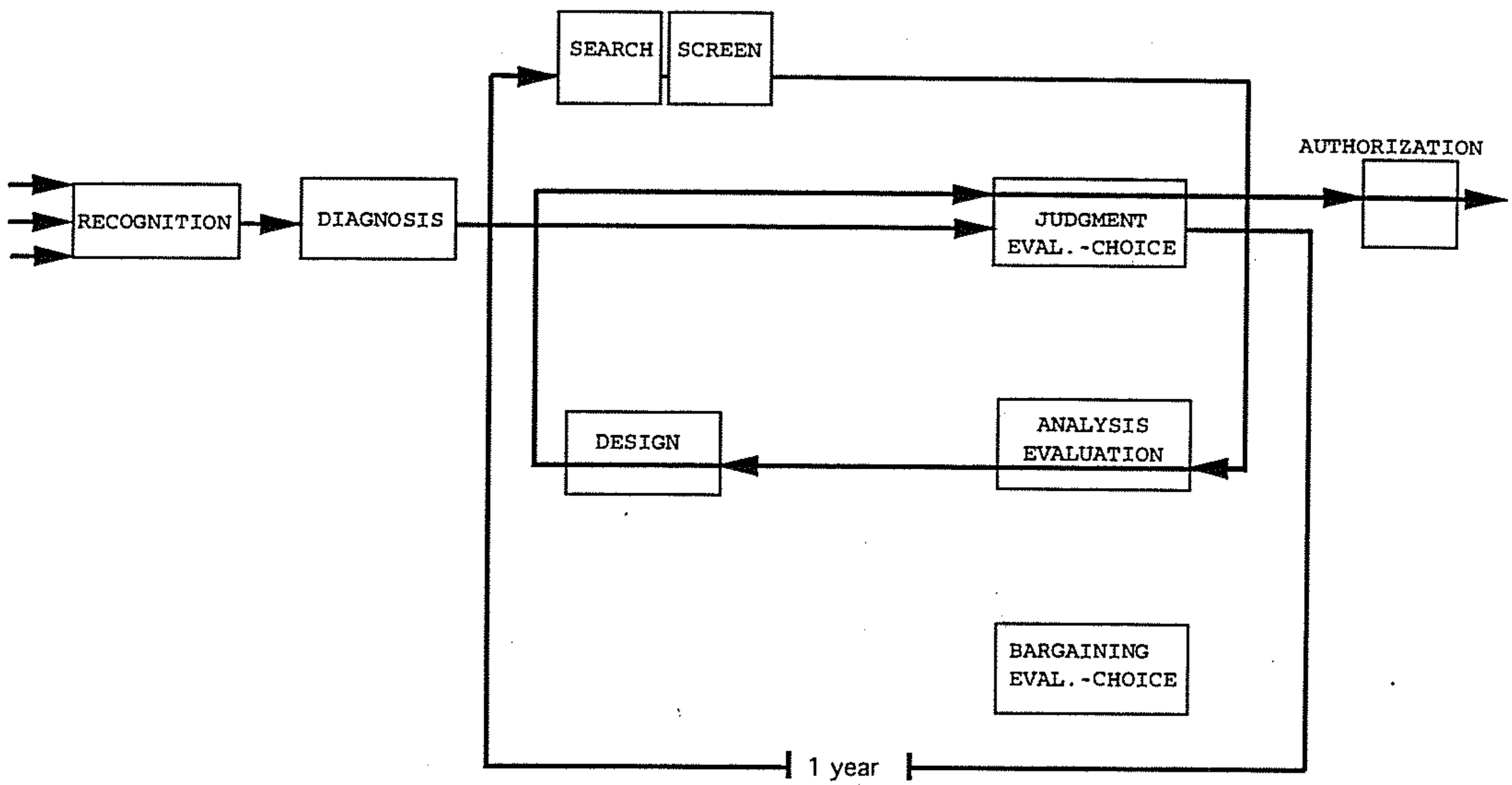
Hierarchic fleets will likely engage in proactive decision behavior with an emphasis on long-term solutions. Decision factors will include non-economic considerations as well as rigid analyses. In some cases, corporate image benefits may provide the necessary impetus for purchasing AFVs. Such considerations bear on decisions made at the higher levels of an organization where the AFV issue will be shaped. Hierarchic fleets are the most likely to leap-frog over near-term transitional options in favor of more promising long-term alternatives. They also have the ability to make and implement decisions expeditiously and, because decisions are not necessarily implemented uniformly (like bureaucratic fleets), the inability of a single fleet site (or department) to use a particular vehicle type will not jeopardize the whole AFV program.

### 8.3 Example of an AFV Purchase within the Hierarchic Decision-Making Structure

The hypothetical decision process, depicted in Figure 8.2, begins when the company's public relations personnel is advised by the fleet manager of a special promotion by the local utility company to sell electric and natural gas vehicles (recognition routine). The situation is evaluated by the public relations manager as a means for improving the company's public image (diagnosis routine). The decision is then put before the vice-president who concurs with the public relations manager's recommendation to pursue AFVs (judgment choice). A passive search begins but interest wanes in the wake of a severe budget crisis within the organization.

Approximately one year later, it becomes clear that AFV purchase mandates are eminent. The search resumes but this time AFV information is actively sought and collected (search routine). AFV solutions which are not practical from a fleet operations perspective are dismissed on the advice of the fleet manager (screen routine). The remaining options are then evaluated on an economic basis (analysis evaluation). A refueling station is designed for on-site refueling of AFVs (design routine) and a second judgment decision is made to proceed with purchasing the recommended AFV (judgment choice). After a rubber stamp authorization from the financial department (authorization routine), the alternative fuel vehicles are purchased.

Figure 8.2: An Example Hierarchic Fleet Decision Process



# Chapter 9

## The Democratic Decision-Making Structure

### 9.1 Characteristics of the Democratic Decision-Making Structure

Fleets with democratic decision-making structures are relatively small and often belong to small organically structured organizations. Comprising only 5% of the survey respondents in this study, democratic fleets are the least common fleet type. However, democratic decision-making fleets may have been undersampled in our survey due to the fact that fleets with less than ten vehicles were precluded from the sampling frame.

Democratic decision-making is highly decentralized and very informal. It is a "diffuse" process that involves several individuals at different organizational levels, departments, and sometimes even geographic locations (Connolly 1977; Shumway et al. 1975). No individual is in a position to single-handedly commit the organization to a particular course of action. Technical knowledge, management savvy, and administrative experience come from several individuals who all influence the decision outcome. Although one individual may ultimately be held responsible for the decision, there is no single decisioumaker, per se. Shumway et al. (1975) compare the situation to identifying the 'real' car maker in an automobile manufacturing plant: "there may exist a final approval authority on the part of some one person, but that authority is no more determinant of the automobile than is the one person who tightens the first bolt".

Competing interests often create a situation where one member can be satisfied only at the expense of another. In these situations the decision group essentially acts as a "political coalition" where conflicts are resolved through bargaining and compromise (Cyert and March 1963). Solutions seldom reflect the preferences of any one coalition member and the decision groups themselves tend to be transitory, changing with decisions (Cyert and March 1959). In order to resolve problems in a reasonable time frame, the coalition does not engage in "optimizing behavior" but rather accepts the first alternative acceptable to all members (Tosi 1975). Mintzberg (1979) notes that in this type of decision-making structure power is "distributed among managers and non-managers at all the levels of the hierarchy, according to the nature of the different decisions to be made". Each member of the decision group is presumed competent to contribute to the solution by virtue of his or her training and no single member can outvote or override the judgment of other members (Connolly 1977).

An organization may form an ad hoc committee to deal with a problem or it may simply seek a quorum of those most affected by the issue. Thompson and Tuden (1987) argue that such decision units can reach solutions using four different strategies -- computation, judgment, compromise, or inspiration. A computational strategy is a technical assessment of the problem appropriate when actions and consequences are well-understood; a collective judgment (e.g., majority vote) is used when there is no consensus regarding causation; decisions by compromise (achieved through bargaining and political maneuvering) is necessary when there is disagreement about possible outcomes; and when there is disagreement about both causation and outcome, the decision situation requires inspiration (which usually results in avoiding the issue completely).

Often the aims of one decisionmaker directly conflict with those of another because their objectives are closely tied to the goals of their respective departments (Tosi 1975). Decisionmakers also use their position to gain power or political leverage for the next decision which may be more important to them. As information is obtained each decisionmaker may distort, filter, and edit it to suit his/her own needs. This gamesmanship, used to "enhance or protect one's self-interest" (Allen et al. 1979), often leads to intergroup conflict and delay tactics.

Who gains and who loses in the democratic fleet decision compromise depends much on the distribution of power amongst the coalition members. Distribution of power within the democratic decision structure is complicated. Real or perceived knowledge of the decision issue is the most effective means of empowerment; therefore, individuals with the greatest vested interest generally become the most knowledgeable on the subject (Pfeffer 1981). This gives them considerable leverage in the decision process. Individuals with the greatest knowledge of the situation are usually the most successful at co-opting other coalition members (Pfeffer 1981). This is especially true in the initial stages when coalition members are sometimes confused, undecided, or perhaps even indifferent. A forceful advocate at the start of the decision process is often the most critical factor in determining the eventual outcome (Fahey 1981).

Democratic decision structures favor simple solutions or sometimes avoiding a decision altogether. A cost analysis is seldom conducted and, if so, usually as a means of persuasion in the negotiation process, to gain time in an atmosphere of indecision, or for a posteriori justification of a decision already made (Bower 1970; Hickson et al. 1986; Langley 1990). Searches for viable solutions are usually conducted at the individual level and are very cursory. Seldom do those solutions require any major 'design' changes. The final choice is usually a compromise that is satisfactory to all coalition members but preferred by none. Although the democratic decision-making structure is widely recognized (Mintzberg 1979; Pfeffer 1981; Shrivastava and Grant 1985), it is the most difficult to define because of its dynamic and unstable nature.

### 9.2 Implications for the AFV Purchase Decision

Democratic decision-making fleets present an interesting case for alternative fuel vehicles. The drive to purchase an AFV could start at the bottom of the organization in this decision environment where opinions of subordinates are weighed heavily. If the decision is initiated at the lower levels, the proposal may have to be sold to individuals one at a time up the organizational hierarchy. This will likely require an "idea champion" (Daft 1992) within the organization who would first have to recognize the solution and then convince others of its merits. Often with new equipment purchases, the individual who has the most contact with outside information sources and who is most involved in acquiring and communicating this information is the most influential in the decision process (Pfeffer and Salancik 1978). The democratic decision structure is conducive to early recognition and diagnosis of the AFV issue due to the fact that many individuals throughout the organization have the power to initiate decision action.

However, just as one individual can carry the AFV issue up to the top of the organization in this decision structure, so too can one individual keep it from being resolved. Again this individual could be a low level employee looking out for his/her best interest as opposed to promoting ideas that benefit the organization. For instance, a mechanic who is uncomfortable working on a particular type of AFV could be very effective at persuading other decisionmakers to dismiss that AFV from the solution set. This is especially true if the mechanic is perceived to be the most knowledgeable about alternative fuel vehicles.

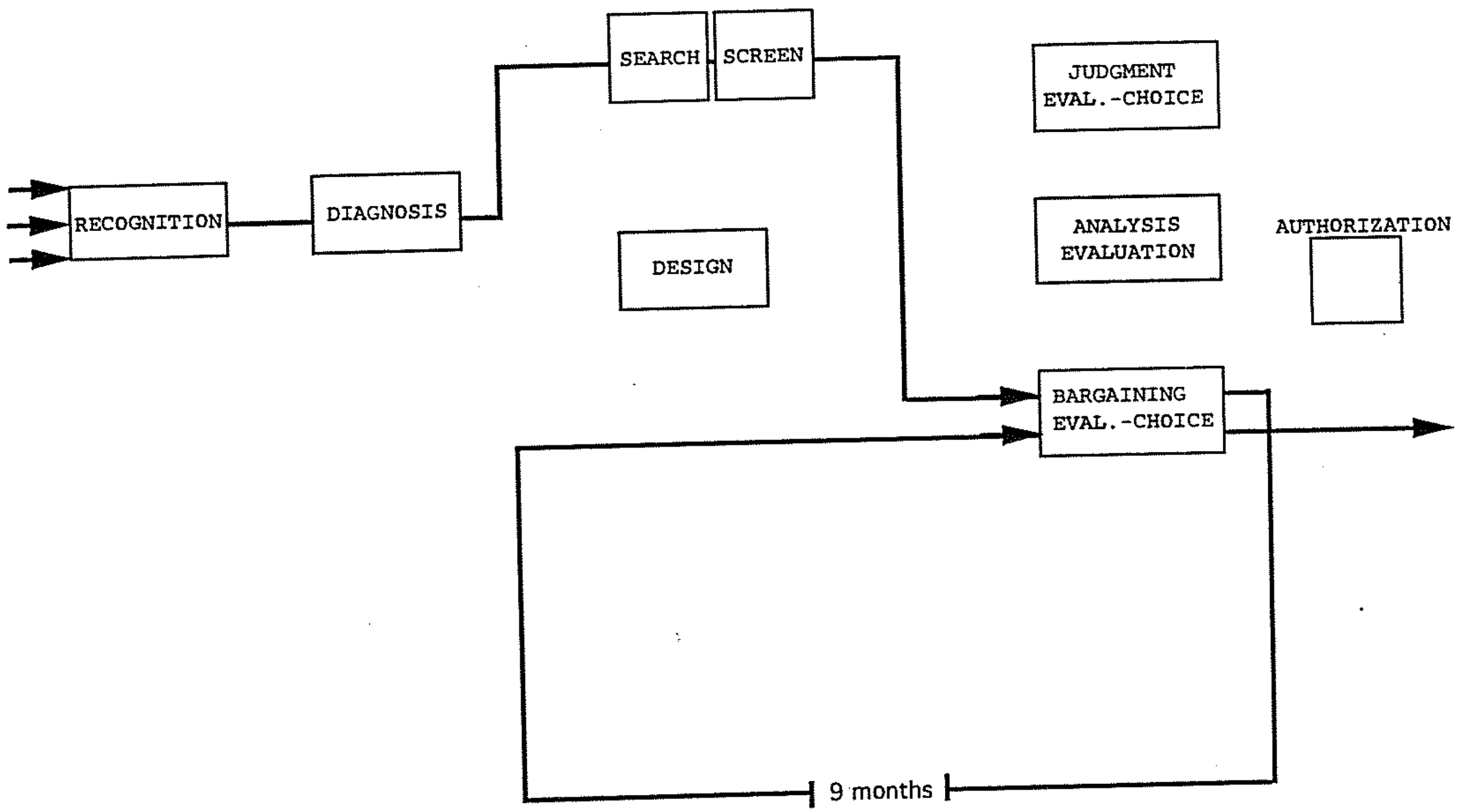
In the democratic decision-making structure, AFV issues may be recognized early and quickly elevated to decision action, however, the dynamics of group decision-making usually result in long delays and little action. Internal conflicts and competing interests inherent to democratic fleet structures are not conducive to reaching optimal solutions, especially in a timely manner. Debates often digress to trivial bickering and the final AFV solution will unlikely be anyone's first choice but rather the one that meets with the least resistance. Consequently, democratic fleets will not likely be the first to enter the AFV market. The AFV solution that is eventually chosen will be a compromise and one that results in only minimal change from the status quo.

## 9.3 Example of an AFV Purchase within the Democratic Decision-Making Structure

In this example, illustrated in Figure 9.1, alternative fuel vehicles are brought to the attention of the organization by an employee who owns an electric vehicle (recognition routine). This employee co-opts enough individuals to support the purchase of an AFV (diagnosis routine). A smal group of decisionmakers is formed consisting of those who are most interested or would be most impacted by the proposal. Each has done a small amount of research on AFVs and have formulated their own opinions regarding suitable alternatives. Some have searched for more specific solutions based on this background research (search routine).

The initial debate amongst decisionmakers centers around the cost of incorporating AFVs intc the fleet (bargaining routine). During this time certain options are dismissed due to high costs. However, no alternative is found acceptable to the majority of decisionmakers. The debate continues for several months but much of the initial interest and enthusiasm is lost. Eventually the issue is dropped. Several months later the debate is re-ignited (bargaining routine) due to a special offer on methanol vehicles and the installation of a local methanol public refueling station. The offer is accepted by majority vote and a methanol vehicle is purchased.

Figure 9.1: An Example Democratic Fleet Decision Process



# Chapter 10

## Summary and Conclusions

### 10.1 Summary of Findings

The organizational context of fleet decision-making is a strong explanatory factor of fleet purchase behavior. Two principal variables which describe fleet decision-making within this organizational context are centralization and formalization. These two variables are used in this study to distinguish four categories of fleets based on their decision-making structure (Table 10.1). The AFV purchase behavior of these four fleet types is summarized below.

#### 10.1.1 Fleet Typology

Autocratic decision-making structures are common amongst fleets belonging to small entrepreneurial businesses. The decision structure is informal and highly centralized. The sole decisionmaker, usually a business owner or high ranking executive, relies on intuition and personal judgment to resolve problems. Typically, the search for a solution is narrow and one option dominates from the outset. There is an emphasis on solutions with relatively short payback periods, especially those which have been proven successful elsewhere. Decision outcomes are usually consistent and highly integrated with company goals. The main drawback is that these outcomes are usually bound by the cognitive abilities of a single decisionmaker.

The bureaucratic decision structure is highly-formalized and very decentralized. It is common amongst public institutions and government agencies. Official rules and standard operating procedures dictate the decision process. Centralization gives way to formal procedures and precedents. The decision process is initiated only after the problem falls outside the parameters monitored by the system. However, once initiated, several individuals and departments become involved in the decision process. Problem resolution

# Table 10.1: Characteristics of the Four Decision-making Structures

| | Autocratic | Bureaucratic | Hierarchic | Democratic |
|---|---|---|---|---|
| Decision-making Characteristics | Few management systems are used, decision-making is highly personalized and judgmental. | Decision-making is decentralized with greater emphasis on rules and procedures. | Highly centralized with support from computational analysis and subordinates. | Resolution reached through political bargaining and compromise. Conflict is legitimate and expected. |
| Problem Familiarization | Problem scope is restricted by cognitive limits of management. | Reactionary: Problems recognized when they disrupt standard operating procedures | Proactive, opportunity seeking: Solutions can come before problems. | Diversity of decision-makers results several different interpretations of problem. |
| Solution Development | Only a few solns considered. Emphasis is on solutions with short-term paybacks<br>One solution usually dominates from the outset. | Problem resolution emphasizes previous solutions. Focus is on immediate circumstances. | Oriented towards long-term forward-looking solns. | Solutions constantly changing to fit a diverse needs. Outcome shaped by vested interests and/or political power. |
| Decisionmakers | One key high-ranking manager/owner forms solution set with little or no aid from others. | Several departments are involved and much authorization required. | Only one or two high-ranking decisionmakers. | A coalition of individuals from throughout the organization influence the decision outcome. |
| Type of Analysis | Analysis is limited to judgmental or intuitive evaluations. | Computational evaluative techniques used, especially cost-benefit analysis. | Computational analysis but non-economic factors also play a role. | Analytical techniques may or may not be used. Different aspects of problem evaluated by different decisionmakers. |

begins with reviewing solutions successfully implemented by the organization in the past. Cost-benefit analyses and other analytical evaluations are often used to compare alternatives. Although several levels of authorization and approval are necessary before action is taken, outcomes usually entail only incremental changes and address only the problem at hand.

The hierarchic decision structure is differentiated by a high degree of both centralization and formalization. The decision process is relatively sophisticated in that it entails both judgment evaluations and computational analysis. It is, therefore, the ideal structure for the adoption of AFVs which offer long-term savings through reduced operating costs and/or non-economic attributes. In most cases advice and input from throughout the organization play an important role in the decision process. How that information reaches the decisionmakers can be a key factor in determining the decision outcome.

The democratic decision-making structure is diffuse, very decentralized, and highly informal. Several individuals from all levels of the organization are directly involved in the decision process. At the core of the decision structure are highly political "coalitions" of decisionmakers (Cyert and March 1963). Solutions are arrived at through bargaining and compromise. Decisionmakers sometimes have conflicting goals or different interpretations of the same situation. Politics often play an larger role in the decision process than objective evaluation of the data. Consequently, outcomes seldom reflect the preferences of any one coalition member. Instead of reaching optimal solutions the decisionmakers settle for the first solution that satisfies all coalition members. Although the fleet issue can be quickly carried into action by an "idea champion" (Daft 1992), the dynamics of group decision-making usually result in long delays. Preservation of the status quo is inherent to this structure and elected solutions usually invoke only minor incremental change.

Analysis of the survey data also revealed two decision sub-structures within the bureaucratic and hierarchic decision-making structures. These sub-structures are similar in that both indicate an even greater reliance on formal procedures and detailed cost analysis. In addition, fleets within these sub-categories tend to be geographically dispersed with several different operating sites. However, fleet decisions are made at one central headquarters and implemented locally at the individual sites.

### 10.1.2 Classification Model and Decision Process Model

The typology presented in this dissertation differentiates fleets based on their fundamental decision-making structure. Such distinctions are instrumental to developing the AFV fleet market because they enable the formulation of fair effective AFV policies and marketing strategies. However, the typology is of little use without a means of categorizing fleets. In order to operationalize the typology, a classification model was estimated for the future categorization of fleets. The classification model enables a practical means of fitting fleets into the typology using readily available information instead of detailed descriptions of decision-making behavior. Two types of models were estimated for this purpose, a logit model and a discriminant analysis model.

Logit model results indicate that factors such as the type of business, general fleet composition, organizational size, and fleet size are good proxies for a fleet's decision-making structure. The best performing logit model had a $\rho^2$ - value of 0.182, although there is good reason to believe that model fit can be vastly improved by using more specific data. Careful scrutiny of the t-statistics reveals that the variables which best explain category differences correspond with findings from the focus group sessions and one-on-one interviews. These include the size and type of organization along with the structure, size, and composition of the fleet itself. The discriminant analysis model also performed satisfactorily correctly classifying 41% of the cases. However, certain categories performed much better including autocratic fleets with 85% correct classification.

In addition to the classification models, a model of the fleet decision process was proposed in order to address the second research objective of developing a means for systematically assessing AFV fleet purchase behavior under different implementation scenarios. This model shows the various phases and routines which comprise the decision-making process (Mintzberg et al. 1976). It provides possible decision routes upon which the AFV decision can be projected. The decision process model enables one to break the AFV decision into its components in order to better understand how different fleet types will likely progress through each stage. It helps identify where the AFV decision will be made within the organization, who will influence the decision, and how the decision process will progress. Each fleet type will likely react differently at the various stages of the decision process. The ability to anticipate these reactions enables one to determine the best strategies for implementing AFVs and to tailor these strategies to specific fleet types.

The main components of the model -- the identification, development, and selection phases -- are discussed in terms of the fleet AFV purchase decision. Factors that are likely to affect the AFV decision process, such as external pressures and internal interrupts, are identified and discussed. The nature of the AFV decision, the circumstances under which it is made, and the fleets decision-making structure will each have a significant impact on the decision process. These factors are examined using the model to illustrate example decision processes for each fleet type.

A critical factor in the AFV decision process is the stimuli that evoke action. So far AFV interest has resulted from opportunities such as vehicle rebates, tax breaks, and subsidies offered by utility companies and government agencies. However, that may soon change as approaching deadlines for purchase mandates lend new urgency to the issue. The AFV issue will soon be treated by many fleets as a problem or, perhaps, even a crisis. An AFV decision undertaken as an opportunity allows more time to investigate the options. However, as the urgency of the situation increases, the decision process becomes more streamlined. Fewer alternatives are considered, less analysis is conducted, and less time is devoted to finding the optimal solution. Decisionmakers will increasingly revert to copying AFV solutions from other fleets and the vehicle of choice will become that which can be inserted directly into the fleet quickly and without disruption.

Another factor that can dictate the decision process is the nature of the decision. A premise of this study is that the AFV fleet decision will be a *strategic* issue. It will reflect an organization's commitment to alternative fuel vehicles. The decision will be strategic in the sense that it will determine future courses of action, involve considerable resources, impact a significant portion of the organization, and occupy the thinking of upper management. This perspective is different than previous research and promotional strategies that treat the AFV issue more as a routine vehicle purchase.

## 10.2 Practical Implications and Conclusions

The principal strategy to induce AFV fleet purchases has been command-and-control style regulations. Their effectiveness is questionable. An accounting of fleet vehicles affected by the 1990 Clean Air Act Amendments (CAAA) conducted by the U.S. Environmental Protection Agency (EPA 1991) showed that 86,000 of the new light-duty vehicles purchased in 1998 by businesses nationwide should be "clean-fuel vehicles" (CFVs). The total number of light-duty CFVs in operation as a result of the CAAA is expected to reach 1 million by the year 2010. One million CFVs will have a negligible impact on air quality and energy diversity given the fact that approximately 45 million vehicles will be operating in these same non-attainment areas (Davis 1995; EPA 1991). Moreover, many of these CFVs will offer only marginal emission reductions and energy security benefits (because many will be conventional automobiles with advanced pollution controls operating on reformulated gasoline). Increasing political pressures could further compromise the effectiveness of regulatory mandates through delays, revisions, or even complete revocation (e.g., the rollback of the California ZEV program).

In order to capture a greater share of the potential AFV fleet market and maximize air quality benefits, a more comprehensive multi-faceted approach is needed. Implementation strategies should promote not just AFVs but those AFVs which offer the greatest emission reductions. Efforts must also be made to sell AFVs to fleets not targeted by legislative purchase mandates such as those which have less than ten vehicles or do not centrally refuel. The successful implementation of AFVs in these fleets will depend largely on how well AFV purchase incentives can be matched with organizational priorities and the extent to which specific AFV attributes can be matched with the decisionmakers who value them. Knowledge of a fleet's decision-making structure provides the insights necessary to make these matches.

Results from the statewide survey conducted for this research show that 29% of all business vehicles in the sample belong to fleets with hierarchic decision-making structures (the survey did not include fleets with less than 10 vehicles). Assuming the national fleet composition resembles that of California, approximately 1 million business vehicles nationwide reside in fleets (10 or more vehicles) with hierarchic decision structures. These fleets are the best candidates for purchasing advanced alternative fuel vehicles. For the most part, they utilize sophisticated cost analyses and are capable of equating future operating cost savings to present dollar values. This enables AFVs with higher purchase prices (e.g., electric vehicles) to compete with less expensive gasoline vehicles which generally have higher operating costs. Hierarchic decision-making fleets also have the capacity to analyze other less-explicit costs. Most are capable of calculating the equivalent monetary value of potential AFV benefits such as marketable emission credits, preferential parking benefits, HOV lane restriction exemptions, and mandatory worktrip reduction credits.

Although most hierarchic fleets are able to conduct detailed cost analyses, they are not bound by those results. Non-quantitative incentives can also play an important role in the AFV purchase decision. Top amongst these is the potential to enhance the corporation's image. Hierarchic fleet decisionmakers are generally very receptive to the possibility of being recognized as an environmentally-conscious company. In some cases, corporate image benefits may be reason enough for an organization to purchase alternative fuel vehicles.

The overall configuration and composition of hierarchic fleets is also well-suited for using AFVs. Most fleets with hierarchic decision structures have relatively large diverse fleets. Such fleets can more readily accommodate AFVs that have certain operating restrictions (e.g., limited range) because there are more opportunities for vehicle substitution and for matching travel tasks with specific vehicles. Fleet sites are also fairly autonomous so decisions made at the top of the organization can be implemented on a case-by-case hasis. Therefore, an entire organization does not have to forego using a specific AFV because one fleet site is unable to use it. Finally, the fact that hierarchic fleets typically have large operating budgets means they are better able to absorb the risk associated with introducing new technologies.

The above reasons make organizations with hierarchic fleets the ideal target for initial sales of alternative fuel vehicles. AFV life-cycle costs, market-based incentives, and corporate image will be important considerations in the hierarchic fleet decision process. Any one of these three factors alone could persuade a hierarchic fleet to purchase alternative fuel vehicles. Moreover, sales efforts need only to focus on one or two decisionmakers within the organization.

Because their decision structure is conducive to innovative change, hierarchic fleets provide one of the best targets (along with government agencies) for sales of more advanced AFVs. Hierarchic fleets will be at the forefront of the AFV fleet market. They often engage in proactive decision behavior that emphasizes long-term solutions. For the most part, they will approach AFV acquisitions as a forward-looking commitment towards a full transition to cleaner vehicles. Therefore, they are most likely to leap-frog over near-term transitional AFV options which offer only marginal air quality benefits in favor of more promising long-term solutions.

Autocratic fleets also present a tantalizing market prospect for AFVs, however, most of these fleets are not covered by AFV purchase mandates or currently targeted by AFV sales campaigns. Autocratic fleets represent 10% of the respondents and 8% of all the business vehicles in the California fleet survey. Scaled to the national level, this represents approximately 350,000 vehicles. However, this figure excludes vehicles in fleets with less than 10 units. It is hypothesized that the majority of these smaller fleets (most of which belong to small businesses) have autocratic decision-making structures. In the U.S. approximately 3 million vehicles reside in fleets with 4 to 9 units and presumably several thousand more are in even smaller fleets (Bobit, 1995).

It is a mistake to dismiss relatively small fleets with autocratic decision-making structures as prospective AFV purchasers. The sole decisionmaker in the autocratic fleet structure behaves much like a consumer in the private sector shopping for a new vehicle. Purchase price is the most important consideration (at least for selecting the initial choice set) but personal preferences and past experiences also weigh heavily in the decision. Although these three purchase criteria do not favor first generation AFVs, each can be mitigated through various means. The most effective way is by reducing initial equipment costs through subsidies for vehicle conversions, tax breaks for AFV purchases, low interest vehicle loans, and vehicle rebates. Good warranties from AFV manufacturers, a wide network of AFV service stations, quick repair times, and a strong partnership with

AFV dealerships will also go a long way towards increasing AFV purchases amongst autocratic fleets.

In general, the autocratic fleets participating in this study were the least knowledgeable about AFVs. They had the greatest misconceptions regarding AFV safety, performance, reliability, and costs. They also seemed least likely to invest in vehicles which were not made by one of the major automobile manufacturers. These fleets have the most to gain from strategies which include educating fleet purchasers about the attributes of AFVs. Such informational campaigns should be redirected to not only include autocratic fleets but to target them.

Organizations with autocratic fleets generally have close ties to their respective communities. A common sentiment expressed by these fleet decisionmakers is a desire to give something back to the community. In this study much of the interest in AFVs by autocratic fleet decisionmakers stemmed from the desire to "do what's right and best for the community" (by improving air quality). On the other hand, this same group was the most vocally opposed to regulatory mandates because they felt that such measures generally hurt small business more than larger companies.

In the absence of significant upfront economic incentives, autocratic fleets will likely be a follower rather than a leader in the AFV market. They will rely heavily on the recommendations of fleets which have already adopted AFVs, especially those fleets with which they are familiar (even more so if they know the fleet operator personally). However, once they decide to take action, autocratic fleets can react quickly. The decision process is very streamlined because each stage of the decision process is implicitly carried in the mind of the decisionmaker. Efforts to introduce AFVs into autocratic fleets are best spent educating autocratic fleet decisionmakers about AFVs and invoking measures which help defray upfront equipment costs.

Bureaucratic fleets also present a large potential AFV market segment but require a much different marketing approach. Fleets with bureaucratic decision-making structures represent approximately 27% of all business fleets in this survey but 37% of all business fleet vehicles. Extrapolating to the national level, it is estimated that bureaucratic decision-making fleets account for approximately 1.3 million business vehicles (excluding those in fleets with less than 10 vehicles). Such a disproportionately large number of vehicles purchased by relatively few fleets is normally a preferable arrangement from a marketing perspective. However, the bureaucratic decision-making structure is not conducive to innovative change. Strict adherence to pre-established guidelines does not promote or encourage movement away from the status quo.

In general, the bureaucratic fleet AFV decision will be reactive and initiated only when normal operations are disrupted. For many bureaucratic fleets, it appears that AFV purchase mandates will provide the necessary disruption. AFV selection will likely be limited to those vehicles that can be simply inserted into the fleet without major changes (e.g., flexible-fuel methanol vehicles). This generally precludes the cleaner more advanced AFV technologies which have more significant operating restrictions.

Business fleets with bureaucratic decision-making structures present an interesting challenge to AFV advocates. Because the decision process is highly decentralized, there is no single individual who can be targeted within the organization for sales purposes. Moreover, individual fleet sites within the same organization are generally not evaluated on an individual basis, thus implementation of AFVs will most likely result from company-wide policies. Perhaps the biggest challenge will be getting bureaucratic fleets not subject to purchase mandates to recognize AFVs as a viable alternative to petroleum-fueled vehicles. Because of their inherently risk-averse nature, the decision to investigate AFVs will likely be reactive and pursued only if it provides a solution to a problem or crises monitored by the system. Until some threshold of need is reached, these fleets may view AFVs as a solution without a problem.

However, there is a large subset within the bureaucratic fleet population which, despite having the same decision structure, will respond much differently to AFVs. Government fleets and fleets belonging to electric and natural gas utility companies are, and will continue to be, leaders in the AFV fleet market. These fleets are relatively very large accounting for 52% of all bureaucratic fleet vehicles in this study but only 38% of all bureaucratic fleets. In fact, this underestimates the actual number of government fleets with bureaucratic decision structures since the survey did not include state and federal fleets.

The high public profiles of government fleets, along with the fact that they are specifically targeted by AFV rules and regulations, will ensure their role as leaders in AFV market development. Utility companies will also be out front in AFV market development as they try to promote new uses for their products (natural gas and electricity). AFV purchases by government agencies will include forward-looking technologies which provide the most significant air quality and energy benefits. Although acquisition costs are an important consideration amongst government agencies and utility companies looking to implement AFVs, public scrutiny can be even more persuasive.

Finally, fleets with democratic decision-making structures -- 5% of the fleets in this study (4% of all business vehicles) -- are the least predictable. A knowledgeable AFV advocate within the decision coalition could quickly elevate the AFV issue to the level of debate. However, the political nature of the decision-making structure makes it difficult to determine what will happen next. AFV promoters could be very influential in this decision process by providing members of the decision-making team who are AFV proponents the information needed to co-opt additional supporters. Again, the most critical stage in the decision process is getting the decisionmakers to recognize the need for AFVs. Because most democratic fleets are small and belong to organizations not covered by AFV purchase mandates, they are generally uninformed or unaware of AFV options. However, if educated and provoked with strong incentives, democratic fleets will purchase alternative fuel vehicles in significant numbers.

# References

AGA/NGVC. (1991). "Natural Gas Vehicle Fleet Market Study." The American Gas Association and the Natural Gas Vehicle Coalition, prepared by Easton Consultants, Inc.

Aguilar, F. J. (1967). *Scanning the Business Environment*, Macmillan, New York.

Allen, R. W., Madison, D. L., Porter, L. W., Renwick, P. A., and Mayes, B. T. (1979). "Organizational Politics: Tactics and Characteristics of Its Actors." *California Management Review*(22), 77-83.

Allison, G. T. (1971). *Essence of Decision*, Little, Brown, Boston.

Anderberg, M. R. (1973). *Cluster Analysis for Applications*, Academic Press, Inc., New York.

Bartels, P. H., Bahr, G. F., Calhoun, D. W., and Wied, G. L. (1970). "Cell Recognition by Neighborhood Grouping Technique in TICAS." *Acta Cytology*, 14(6), 313-324.

Ben-Akiva, M., and Lerman, S. R. (1991). *Discrete Choice Analysis: Theory and Application to Travel Demand*, The MIT Press, Cambridge.

Berg, M. (1984). "Electric Vehicles in Commercial Sector Applications: A Study of Market Potential and Vehicle Requirements." *Prepared for the Electric Power Research Institute*, Institute for Social Research, University of Michigan.

Berg, M. (1985). "The Potential Market for Electric Vehicles: Results from a National Survey of Commercial Fleet Operators." *Transportation Research Record*(No. 1049), 70-78.

Bobit. (annual). *Automotive Fleet: Fact Book*, Bobit Publishing, Redondo Beach.

Botzow, H. S. D. (1968). *Automotive Fleet Management*, Wiley, New York.

Bower, J. L. (1970). *Managing the Resource Allocation Process: A Study of Corporate Planning and Investment*, Division of Research, Harvard Business School, Boston.

Braybrooke, D., and Lindblom, C. E. (1963). *A Strategy of Decision: Policy Evaluation as a Social Process*, Free Press, New York.

Brigham, J., and Brown, D. W. (1980). *Policy Implementation*, Sage Publications, Inc., Beverly Hills.

CEC. (1992). "Local Government Fleet Survey Results." California Energy Commission, Sacramento.

Chaudier, A. (1989). *The Runzheimer Guide to Fleet Management*, Runzheimer International, Northbrook.

Chaudier, A. (1993). "Business Fleet Refueling Assessment." *GRI-93/0026*, Runzheimer International.

Cohen, M. D. (1972). "A Garbage Can Model of Organizational Choice." *Administrative Science Quarterly*, 17(March), 1-25.

Connolly, T. (1977). "Information Processing and Decision Making in Organizations." New Directions in Oganizational Behavior, St. Clair Press, Chicago.

Cooke, P. N. C., and Woodard, F. H. (1986). *Controlling Company Car Costs*, Gower, Brookfield.

Cramer, J. S. (1991). *The Logit Model An Introduction for Economists*, Hodder & Stoughton, London.

Cyert, R. M., and March, J. G. (1959). "A Behavioral Theory of Organizational Objectives." Modern Organization Theory, M. Haire, eds., John Wiley and Sons, New York.

Cyert, R. M., and March, J. G. (1963). *A Behavioral Theory of the Firm*, Prentice-Hall, Inc., Englewood Cliffs.

Daft, R. L. (1992). *Organization Theory and Design*, West Publishing Company, St. Paul.

Davis, S. C. (1995). *Transportation Energy Data Book*, 15th edition, Oak Ridge National Laboratory, Oak Ridge.

DOE. (1993). "First Interim Report of the Federal Fleet Conversion Task Force." , Office of Scientific and Technical Information, Oak Ridge.

Dolce, J. (1984). *Fleet Management*, McGraw-Hill, Inc., New York.

Dubin, J. A., and Rivers, R. D. (1988). *SST Users Guide and Reference Manual.*

EIA. (1994). "Alanta Private Fleet Survey." *Monthly Energy Review*(December), 6-8.

EPA. (1991). "Estimated Number of Fleet Vehicles Affected by the Clean Fuel Fleet Program." *Docket A-91-25* , Ann Arbor.

EPA. (1993). "Conditional Approval of California's Substitute Program for the Clean-Fuel Fleet Program." *Federal Register*, 58(87), 27253-27255.

ETFUCTI. (1990). "Fleet Assessment for Opportunities to Effectively Deploy Light Duty Alternative Fuel Vehicles." Energy Task Force of Urban Consortium for Technology Initiatives, Detroit.

Everitt, B. (1980). *Cluster Analysis*, Halsted Press, New York.

Fahey, L. (1981). "On Strategic Management Decision Processes." *Strategic Management Journal*, 2, 43-66.

FHWA. (1992). "Summary of Travel Trends: 1990 Nationwide Personal Transportation Survey." Federal Highway Adiministration, Washington, D.C.

Fredrickson, J. W. (1986). "The Strategic Decision Process and Organizational Structure." *Academy of Management Review*, 11(2), 280-297.

Glaser, B., and Strauss, A. (1967). *The Discovery of Grounded Theory*, Aldine Publishing, Hawthorne.

Golob, T. F., Torous, J., Brownstone, D., Crane, S., Bunch, D. S., and Bradley, M. "Commercial Fleet Demand for Alternative-fuel Vehicles: Results from a Stated-Choice Survey of 2,000 Fleet Operators in California." *Seventh World Conference on Transportation Research*, Sydney Australia.

Golob, T. F., Torous, J., and Crane, S. (1995b). "Precursors of Demand for Alternative-Fuel Vehicles: Results from a Survey of 2,000 Fleet Sites in California." *Environmental Vehicles '95: Proceedings of the January 23-25 Conference, Dearborn Michigan.*

Greene, D. L. (1983). "A Note on Implicit Consumer Discounting of Automobile Fuel Economy: Reviewing the Available Evidence." *Transportation Research*, 17B(6), 491-499.

GRI. (1993). "Business Fleet Refueling Assessment." Gas Research Institute, Chicago.

Hickson, D. J., Butler, R. J., Cray, D., Mallory, G. R., and Wilson, D. C. (1986). *Top Decisions: Strategic Decision-Making in Organizations*, Basil Blackwell Ltd., Oxford.

Howell, J. M., and Higgins, C. A. (1990). "Champions of Technology Innovation." *Administrative Science Quarterly*, 35, 317-341.

Hu, P. S., and Wang, M. Q. (1996). "State Vehicle Fleets and Their Potential Acquistion of Alternative Fueled Vehicles Under EPACT 507." Oak Ridge National Laboratory, Oak Ridge.

Hu, P. S., Wang, M. Q., Vyas, A., Mintz, M., and Davis, S. C. (1996). "Potential Coverage of Alternative Fuel Industries Under EPACT Section 501."

Inkson, J. H. K., Pugh, D. S., and Hickson, D. J. (1970). "Organization, Context and Structure: An Abbreviated Replication." *Administrative Science Quarterly*, 318-329.

James, L. R., and Jones, A. P. (1976). "Organizational Structure: A Review of Structural Dimensions and Their Conceptual Relationships with Individual Attitudes and Behavior." *Organizational Behavior and Human Performance*, 16, 74-113.

Kleindorfer, P. R., Kunreuther, H. C., and Schoemaker, P. J. (1993). *Decision Sciences: An Integrative Perspective*, Cambridge University Press, Cambridge.

LADWP/SCE. (1989). "Electric Vehicle Los Angeles Area Market Analysis Fleet Study." *79170*, Los Angeles Department of Water and Power, Southern California Edison.

Langley, A. (1990). "Patterns in the Use of Formal Analysis in Strategic Decisions." *Organization Studies*(November), 17-45.

Lindblom, C. E. (1959). "The Science of "Muddling Through"." *Public Administration Review*, 19(2), 79-88.

Mader, J., Brunner, J., and Bevilacqua, O. "Electric Vehicle Commercialization." *The 9th International Electric Vehicle Symposium*, Toronto, EVS88-P10.

March, J., and Simon, H. (1958). *Organizations*, John Wiley and Sons, New York.

March, J. G., and Shapira, Z. (1992). "Behavioral Decision Theory and Organizational Decision Theory." Decision Making: Alternatives to Rational Choice Models, M. Zey, ed., Sage Publications, Newbury Park, 273-303.

Mazmanian, D. A., and Sabatier, P. A. (1983). *Implementation and Public Policy*, Scott, Foresman and Company, Glenview.

McFadden, D., Train, K., and Tye, W. B. (1977). "An Application of Diagnostic Tests for the Independence from Irrelevant Alternatives Property of the Multinomial Logit Model." *Transportation Research Record*(637), 39-46.

Mechanic, D. (1964). "Sources of Power of Lower Participants in Complex Organizations." New Perspectives in Organization Research, W. W. Cooper, H. J. Leavitt, and M. W. Shelly, eds., John Wiley and Sons, Inc., New York, 606.

Miau, S. P., Hu, P. S., and Young, J., R. (1992). "Fleet Vehicles in the United States: Composition, Operating Characteristics, and Fueling Practices." *ORNL-6717*, Oak Ridge National Laboratory, Oak Ridge.

Mintzberg, H. (1979). *The Structuring of Organizations*, Prentice-Hall, Inc., Englewood Cliffs.

Mintzberg, H., Raisinghani, D., and Theoret, A. (1976). "The Structure of "Unstructured" Decision Processes." *Administrative Science Quarterly*, 21(2), 246-275.

MVMA. (annual). "MVMA Motor Vehicle : Facts and Figures." Motor Vehicle Manufacturers Association, Detroit.

NAFA. (1991). "NAFA's 1991 Model Year New Vehicle Aquisition Survey Results." National Association of Fleet Administrators, *Fleet Executive*(February), 28-42.

NAFA. (1992). "NAFA's Member Attitude Survey." National Association of Fleet Administrators, *Fleet Executive*(August).

NAFA. (1993). "Good Marks for Methanol Flex-Fuel Cars But Fueling Infrastructure Unsatisfactory." National Association of Fleet Administrators, *Fleet Executive*(March), 6-26.

NAFA. (annual-a). "NAFA's New Vehicle Acquisition Survey Results." National Association of Fleet Administrators, *Fleet Executive.*

NAFA. (annual-b). "NAFA's Used Vehicle Marketing Survey." National Association of Fleet Administrators, *Fleet Executive.*

NAFA. (annual-c). "Vehicle Use Policies and Procedures Survey Results." National Association of Fleet Administrators, *Fleet Executive.*

Patterson, T. T. (1969). *Management Theory*, Business Publications Ltd.

Pettigrew, A. M. (1972). "Information Control as a Power Resource." *Sociology*, 188-204.

Pfeffer, J. (1981). *Power in Organizations*, Pitman Publishing, Marshfield.

Pfeffer, J., and Salancik, G. (1978). *The External Control of Organizations: A Resource Dependence Perspective*, Harper and Row Publishers, New York.

Pugh, D. S., Hickson, D. F., Hinings, C. R., and C., T. (1968). "Dimensions of Organization Structure." *Administrative Science Quarterly*, 13(June), 65-105.

Pugh, D. S., Hickson, D. J., and Hinings, C. R. (1969). "An Empirical Taxonomy of Structures of Work Organizations." *Administrative Science Quarterly*, 1969a, 115-126.

Quinn, J. B. (1980). *Strategies for Change: Logical Incrementalism*, Richard D. Irwin, Inc., Homewood.

Recker, W., and Golob, T. (1979). "A Non-Compensatory Model of Transportation Behavior Based on Sequential Consideration of Attributes." *Transportation Research*, 13B, 269-280.

Runzheimer, I. (1991). "Survey and Analysis of Business Car Policies and Costs 1991-1992." Runzheimer International Ltd., Rochester.

Runzheimer, I. (1993). "Survey and Analysis of Business Car Policies and Costs." *10th edition.*, Runzheimer International Ltd., Rochester.

Runzheimer, I. (1995). "Special Summary Report: 1994 AFV Strategist Survey." Runzheimer International Ltd., Rochester.

SCGC. (1990). "Vehicle Fleet Managers Survey: Characteristics of Vehicle Fleets and Alternative Fuel Usage and Preferences." Southern California Gas Company.

Scott, W. R. (1981). *Organizations: Rational, Natural and Open Systems*, Prentice-Hall, Englewood Cliffs.

SDG&E. (1992). "SDG&E Electric and Natural Gas Market Study." San Diego Gas and Electric Company.

Shonka, D. (1980). "An Analysis of the NAFA Fleet Data Base: Passenger Cars Only." *BNL 51301*, Brookhaven National Laboratory, Upton.

Shonka, D. B. (1978). "Characteristics of Automotive Fleets in the United States 1966-1977." *ORNL-TM-6449*, Oak Ridge National Laboratory.

Shrivastava, P., and Grant, J. H. (1985). "Empirically Derived Models of Strategic Decision-making Processes." *Strategic Management Journal*, 6, 97-113.

Shumway, C. R., Maher, P. M., Baker, M. R., Souder, W. E., Rubenstein, A. H., and Gallant, A. R. (1975). "Diffuse Decision-Making in Hierarchical Organizations: An Empirical Examination." *Management Science*, 21(6), 697-707.

Simon, H. A. (1957). *Administrative Behavior*, Macmillan, New York.

Sobel, K. L. (1980). "Travel Demand Forecasting by Using the Nested Multinomial Logit Model." *Transportation Research Record*(775), 48-55.

Sokal, R. R., and Michener, C. D. (1958). "A Statistical Method for Evaluating Systematic Relationships." *University of Kansas Science Bulletin*, 38, 1409-1438.

Steinbruner, J. D. (1974). *The Cybernetic Theory of Decision*, Princeton University Press, Princeton.

Tardiff, T. J. (1976). "A Note on Goodness-of-Fit Statistics for Probit and Logit Models." *Transportation*, 5, 377-388.

Thompson, J. D., and Tuden, A. (1987). "Strategies, Structures, and Processes of Orgnanizational Decision." Comparative Studies in Administration, Management, and Technology, A. P. Brief, ed., Garland Publishing, Inc., New York, 224.

Tosi, H. L. (1975). *Theories of Organizations*, St. Clair Press, Chicago.

Tversky, A. (1972). "Elimination by Aspects: A Theory of Choice." *Psychological Review*, 84, 281-299.

UIG. (1985). "Vehicle Fleets in the South Coast Basin: Results of a Survey Performed for the South Coast Air Quality Managemet District." Urban Innovations Group, Los Angeles.

Vyas, A. D., and Wang, M. (1996). "Potential Impacts of the Energy Policy Act on Electricity and Natural Gas Provider Fleets." *forthcoming in Transportation Research.*

Wagner, J. R. (1979). "Vehicle Attributes Constraining EV Applicability in Fleets." *BNL 51099*, Brookhaven National Laboratory, Upton.

Wagner, J. R. (1980). "A Method for Estimating Technological Penetration Rates in Commercial Automobile Fleets." *BNL 51312*, Brookhaven National Laboratory.

# Appendix A

## Sacramento Area Focus Group Participants (3 groups)

City of Sacramento
McClatchey Newspaper
Federal Express
A. Teichert & Son
Sierra Pacific Fleet
Moore Brothers
Alex Engardt Co.
Pacific Gas & Electric
Snider Leasing Co.
Elk Grove Unified School District
Lynn Edwards Corporation
Sacramento Municipal Utility District
CALTRANS
University of California, Davis
American Environmental
Folsom Chevrolet Fleet Leasing
Sacramento Valley Crane Service
Aerojet Solid Propulsion

## Los Angeles Area Focus Group Participants (4 groups)

Allianz Insurance
API Security
SDI Industries
Sunkist Growers
Hamer Fleet Leasing
Westreco
Polytechnic School
R&G Sloan
Northridge Hospital
Hewlett Packard
Teledyne
Tower Media
Westec Security
Bergan Bruinswig
Comarco
Trans America
Encino Lock and Key
Ralph M. Parsons
D.M.J.M.
Crenshaw Lumber
Armor Transport
Computer Sciences Corporation
L. A. Department of Water & Power
Valley Presbyterian Hospital
L. A. Regional Transit District
Farmers Insurance Group
West Covina Fleet Leasing
Federal Express
Mission Service
AM West
M.B. Catering
Fine Art Shipping
California Moving and Storage
Six Flags Magic Mountain
Fume-a-Pest
San Fernando Police
Worldwide Church of God
Reynolds Corporation
Bank of America
Integrated Decision System
Pinkertons Inc.

## Sacramento Area One-on-One Interview Participants

| | |
|---|---|
| Paratransit, Inc. | University of California, Davis |
| Federal Express | Belwin/Swanson Cleaners |
| Sacramento Bee | St. Marks United Methodist Church |
| Sutter Hospital | Caldwell and Brown Consultants |
| City of Davis | Aeroject Solid Propulsion |
| Kaiser Permanente | Blue Diamond Almonds |

## Los Angeles Area One-on-One Interview Participants

| | |
|---|---|
| City of Los Angeles | National Medical Enterprises |
| Wheels, Inc. | University of California, Los Angeles |
| Air Conditioning Co. Inc. | Bohemian Distributing Co. |
| 7-Up Bottling Co. | California Air Resources Board |
| American Red Cross | City of Burbank |

# Appendix B

### - UNIVERSITY OF CALIFORNIA FLEET STUDY -

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO • SANTA BARBARA • SANTA CRUZ

1. Suppose you were evaluating an Alternative Fuel Vehicle for your site. How important would each of the following concerns be? *(Please answer even if you don't have current plans to buy an Alternative Fuel Vehicle. Check* "NA" *if you have no opinion.)*

| | Very Important | Somewhat Important | Not Very Important | Not At All Important | NA |
|---|---|---|---|---|---|
| •The vehicle is made by a *domestic* U.S. manufacturer: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The vehicle is assembled in a U.S. factory: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The resale value is comparable to a gasoline vehicle: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The vehicle provides "bankable" Clean Air credits: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The manufacturer provides an extended warranty: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The Clean Fuel Vehicle's image is associated with your organization: | ☐ | ☐ | ☐ | ☐ | ☐ |
| •The vehicle's purchase earns Trip Reduction Credits: | ☐ | ☐ | ☐ | ☐ | ☐ |

2. Has your organization used any fuel other than gasoline or diesel, that has since been discontinued? What was the fuel type and what happened. Add any other experience that might be relevant.

_______________________________________________

_______________________________________________

3. Do you think your organization is likely to acquire any Alternative Fuels Vehicles (AFV's) within the next year or two? *(Please check as many that apply)*

☐. Yes - an acquisition is likely at this site

☐. Yes - an acquisition is likely at another site

☐. No - not likely to make an acquisition

4. If the address where the vehicles are primarily operated from and/or parked is different than the address on the cover letter, please correct below:

Address: ______________________________

City: ____________ State: ______ Zip: ____________

5. The following questions ask about your fleet site from two perspectives: (1) vehicle <u>operations</u>; and (2) vehicle <u>registrations</u>. *(If your answer is the same for both questions, enter your response in both columns).*

| <u>Please list the number of vehicles you have in each of the following classes:</u> | Operated At Site | Registered At Site |
|---|---|---|
| CARS AND STATION WAGONS | ______ | ______ |
| MINIVANS | ______ | ______ |
| FULL SIZE VANS | ______ | ______ |
| COMPACT PICKUPS | ______ | ______ |
| FULL SIZE PICKUPS | ______ | ______ |
| SMALL AND MEDIUM SHUTTLE BUSES | ______ | ______ |
| TRUCKS 6,000-14,000 GVW | ______ | ______ |
| ALL OTHER VEHICLES | ______ | ______ |

6. How many <u>total</u> vehicles under 14,000 GVW are operated at your company's other fleet sites in California *(if any)*?

| SITE-NAME | VEHICLES UNDER 14,000 GVW |
|---|---|
| ______ | ______ |
| ______ | ______ |
| ______ | ______ |
| ______ | ______ |

*(Please use the back of this page if more space is needed)*

7. How does your organization use the FULL SIZE PICKUPS operated at your site? Please estimate how many vehicles are used for each of the following purposes. Assign them according to how they are primarily used: in other words, although some vehicles might be used for multiple purposes, please avoid "double counting".

FULL SIZE PICKUPS

| VEHICLE USAGE | # OF THIS TYPE OF VEHICLES | AVERAGE ANNUAL MILEAGE THIS TYPE | HOW OFTEN DO VEHICLES EXCEED 250 MILES PER ROUND TRIP - THIS USE: Always | Sometimes | Rarely | Never |
|---|---|---|---|---|---|---|
| •PRODUCT SERVICE & MAINTENANCE | ______ | ______ | ☐ | ☐ | ☐ | ☐ |
| •Other uses: ______ | ______ | ______ | ☐ | ☐ | ☐ | ☐ |

8. Where do you perform maintenance and repairs for these FULL SIZE PICKUPS ? (*please check one*)

☐, On-site, or at another facility owned by this organization

☐, Contracted to an outside garage or lessor

☐, Other (*specify*): ______

9. At what mileage, and/or time in service do you usually replace these FULL SIZE PICKUPS?

•Mileage ______ and/or •Years ______ •Other: ______

10. When replacing FULL SIZE PICKUPS, how many are typically acquired in one year? ______

11. When you replace these FULL SIZE PICKUPS, what percent are:

•Sold to brokers or auto auctions ______%
•Returned to the lessor ______%
•Sold privately, or to employees ______%
•Scrapped ______%
•Other (*write in*): ______ ______%

TOTAL 100%

12. When new FULL SIZE PICKUPS are acquired what percent are:

•Lease Only ______%
•Direct purchase ______%
•Lease/Purchase ______%

TOTAL 100%

## FUTURE VEHICLE CHOICES AND USAGE

These questions ask about gasoline, diesel, and alternative-fuel vehicles that *might* be available in the future. The vehicles you will see are invented for study purposes and are not predictions of the future. The fuels being studied are:

Gasoline or diesel, which are not distinguished. Future vehicles using these fuels might have reduced tailpipe emissions, compared to present vehicles. Operating costs may be different in the future.

CNG (*compressed natural gas*) vehicles could be refueled on-site or at service stations where CNG could be available in the future. Employees that drive certain vehicles home might also be able to refuel them at home, if their homes are plumbed for natural gas and if home-refuel units are purchased. Some (*dual-fuel*) CNG vehicles equipped with two tanks could also run on gasoline.

Methanol (*flexible fuel*) vehicles are assumed to be able to run on gasoline if methanol is not available.

Electric vehicles could be charged at the fleet site, or they could be recharged at future electric service stations. Employees that drive vehicles home could charge them there. The hypothetical costs of recharging during the day and at night would generally be different. Electric vehicles would require periodic battery replacement. This would be considered as part of the operating cost.

In the following questions you will be asked to assume that you are about to replace all of the FULL SIZE PICKUPS and in your fleet. Please select replacements from the three hypothetical choices. You might choose all of your vehicles to be of the same type, or you could select a mix of vehicle types.

You are also asked to consider whether or not you would adopt the option of on-site refueling for the vehicles you select. For CNG vehicles, there is a "slow fill" option and a "fast fill" option.

When answering, assume that all features not listed (*such as warranties and safety features*) are the same for all hypothetical vehicles.

19. Imagine that it is sometime in the future when Alternative Fuel Vehicles are widely available as indicated below. Assume that you must now replace your entire fleet of FULL SIZE PICKUPS by using the three types of FULL SIZE PICKUPS described in the table below.

FULL SIZE PICKUPS

| Fuel Type | Gasoline | Methanol | Electric |
|---|---|---|---|
| Dual Fuel Ability | | Can also run on gasoline. | Runs on Electricity only |
| Capital Cost Per Vehicle | $15,000 | $17,000 | $14,000 (includes recharge unit and battery replacement plan) |
| Vehicle Range | 300 miles | 250 miles on methanol | 60 miles on full charge |
| Operating Costs (Fuel and Maintenance) | 8 cents per mile | 11 cents per mile | 6 cents per mile for overnight recharging. 20 cents per mile for daytime recharging. |
| On-Site Refueling | On-site refueling not available | Not Applicable | Recharging unit comes with each vehicle for on-site use. |
| Refueling Time | Not Applicable | Not Applicable | 4 Hrs. for full charge |
| Service Station Refueling | Gasoline available at current stations | 7 methanol stations for every 10 gasoline stations. | 1 recharge station for every 10 gasoline stations |
| Refueling Time | 7 min. to fill empty tank | 7 min. to fill empty tank | 20 min. for full charge |
| Home Refueling | Not Available. | Not Available. | Can recharge at home overnight. |
| Total Vehicles on the Road in California | 100,000 in all classes | 10,000 in all classes | 50,000 in all classes |
| Tailpipe Emissions | 60% of new 1993 gasoline car emissions | 60% of new 1993 gasoline car emissions | Zero tailpipe emissions |

How would you replace your entire fleet of FULL SIZE PICKUPS from the three vehicle choices described in the preceeding table? Under each fuel type indicate the number of vehicles you would require for each use.

Replacement of FULL SIZE PICKUPS

| VEHICLE USAGE | Gasoline | Methanol | Electric |
|---|---|---|---|
| PRODUCT SERVICE & MAINTENANCE | ______ | ______ | ______ |
| Other uses: ____________ | ______ | ______ | ______ |
| Total: | ______ | ______ | ______ |

If you ruled out any vehicle type in the above table, please describe why: ______________________________

## OPINIONS ABOUT VEHICLE CHARACTERISTICS

21. When you made the vehicle choices (preceeding page(s)), which of the following characteristics did you consider to be relevant?

| Characteristic | Considered | Did Not Consider |
|---|---|---|
| Dual Fuel Ability | ☐ | ☐ |
| Capital Cost Per Vehicle | ☐ | ☐ |
| Vehicle Range | ☐ | ☐ |
| Operating Costs (Fuel and Maintenance) | ☐ | ☐ |
| On-Site Refueling | ☐ | ☐ |
| Refueling Time | ☐ | ☐ |
| Service Station Refueling | ☐ | ☐ |
| Refueling Time | ☐ | ☐ |
| Home Refueling | ☐ | ☐ |
| Total Vehicles on the Road in California | ☐ | ☐ |
| Tailpipe Emissions | ☐ | ☐ |

## OPINIONS ABOUT ELECTRIC AND CNG VEHICLES

22. Finally, we would like to get your opinion in general about two alternative fuels. For each of the following statements please indicate your opinion by checking the appropriate box . . .

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Electric vehicles are as reliable as gasoline fueled vehicles: | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electric vehicles are a key to solving air pollution in California: | ☐ | ☐ | ☐ | ☐ | ☐ |
| Electric vehicles are as safe as a conventional gasoline vehicle: | ☐ | ☐ | ☐ | ☐ | ☐ |
| Compressed natural gas vehicles are as reliable as gasoline fueled vehicles: | ☐ | ☐ | ☐ | ☐ | ☐ |
| Natural gas vehicles are a key to solving air pollution in California: | ☐ | ☐ | ☐ | ☐ | ☐ |
| Natural gas vehicles are as safe as conventional gasoline vehicles: | ☐ | ☐ | ☐ | ☐ | ☐ |

## ORGANIZATIONAL DECISION MAKING

23. The next few items ask about decision making in your organization. Suppose that you had to make an important fleet decision that had significant cost implications or resulted in substantial changes in fleet operations. *(Deciding to install on-site refueling facilities or invest in alternative fuel vehicles might be examples of important decisions)*.

Which of the following would apply?

| | True | False | NA |
|---|---|---|---|
| •Formal written rules or specific fleet policy guide fleet decisions: | ☐ | ☐ | ☐ |
| •Detailed cost analyses are used: | ☐ | ☐ | ☐ |
| •Final choices are usually made after formally soliciting bids: | ☐ | ☐ | ☐ |
| •Decisions are usually made with the judgment of 1 or 2 individuals without much involvement from others: | ☐ | ☐ | ☐ |
| •Decisions are made at the upper management levels: | ☐ | ☐ | ☐ |
| •Very little authorization or approval is necessary: | ☐ | ☐ | ☐ |
| •Decisions are made centrally at headquarters, but implemented at individual fleet sites: | ☐ | ☐ | ☐ |

## FINAL ITEMS

24. Are any of your vehicles self insured?

FULL SIZE PICKUPS yes☐. no☐.

25. Did you participate in the phone questionnaire yes☐. no☐.

26. Check here if you want a copy of the study results *(Make sure that we have your correct address)* yes☐. no☐.

27. Please indicate if it would be OK to release your name to your local utility company. They may want to include you in either:

(A) A companion study, with an on-site visit to evaluate the physical requirements for future electric vehicle charging stations, or yes☐. no☐.

(B) An electric vehicle trials fleet program. yes☐. no☐.

**THANK YOU VERY MUCH FOR YOUR HELP!**

Please feel free to add any comments about Alternative Fuel Vehicles or this study on the back of this page. A return postage paid envelope has been provided: Institute of Transportation Studies, University of California - Irvine, CA 92717.

```
                    QUESTIONNAIRE WITH LOGIC & SKIP PATTERNS
                    ----------------------------------------
                           (09:53:10  13 DEC 1993)

QUESTIONNAIRE = FLEET
VERSION : 9.0

*****************************
*        CODE BOX :         *
*                           *
* LT = LESS THAN     ( < )  *
* GT = GREATER THAN  ( > )  *
* EQ = EQUALS        ( = )  *
* NE = NOT EQUAL TO  ( # )  *
*****************************


WELCOME TO THE FLEET TELEPHONE SURVEY!

***************************************************************
1. ENTER ITS ID #
***************************************************************
2. LOCATION OF REGISTRATION SITE:

   1. CALIFORNIA - WITH 'INC/CORP/CO'

   2. CALIFORNIA - NO 'INC/CORP/CO'

   3. OUT OF STATE - WITH 'INC/CORP/CO'

   4. OUT OF STATE - NO 'INC/CORP/CO'
***************************************************************
3. IS THIS <SITE-NAME> AT <SITE-ADDRESS> ?

    1. YES
    2. SAME CO BUT NEW ADDRESS
    3. NO ANSWER
    4. BUSY SIGNAL
    5. ANSWERING MACHINE/VOICE MAIL
    6. CALLBACK
    7. NOT FAMILIAR WITH COMPANY, BAD NUMBER
    8. NOT QUALIFIED RESPONDENT
    9. LANGUAGE BARRIER
   10. DISCONNECTED NUMBER
   11. REFUSED
   12. NO NUMBER

   SKIP AFTER  Q3    IF Q<3> GE "3" THEN GO 96

***************************************************************
4. ARE THE CARS, VANS AND TRUCKS REGISTERED AT <SITE-ADDRESS>
   PRIMARILY FOR . . . ?

   1. COMMERCIAL / BUSINESS USE, OR

   2. PERSONAL USE

   SKIP BEFORE Q4    IF Q<2> EQ "1" THEN GO 5
   SKIP BEFORE Q4    IF Q<2> EQ "3" THEN GO 5
   SKIP AFTER  Q4    IF Q<4> EQ "2" THEN GO 96
***************************************************************
5. I'M TRYING TO REACH THE PERSON WHO IS RESPONSIBLE FOR THE VEHICLES
   THAT ARE REGISTERED AT THIS ADDRESS.  WHO WOULD THAT BE ?

   SKIP BEFORE Q5    IF Q<2> GT "2" THEN GO 6

***************************************************************
```

6. I'M TRYING TO REACH THE PERSON WHO IS RESPONSIBLE FOR THE VEHICLES THAT ARE REGISTERED IN THE STATE OF CALIFORNIA. WHO WOULD THAT BE ?

SKIP BEFORE Q6 IF Q<2> LT "3" THEN GO 7

*************************************************************
7. IS THIS PERSON LOCATED AT THIS SITE ?

(IF YES, CAN YOU PLEASE CONNECT ME ?)

1. YES
2. NO

SKIP AFTER Q7 IF Q<7> EQ "1" THEN GO 9

*************************************************************
8. WHAT IS THEIR PHONE NUMBER AREA CODE FIRST ?

SKIP AFTER Q8 IF Q<7> EQ "2" THEN GO 96

*************************************************************
9. THE UNIVERSITY OF CALIFORNIA IS CONDUCTING A STATEWIDE STUDY WITH 2,000 FLEET MANAGERS TO ASSESS THEIR OPINIONS ABOUT FUTURE CLEAN FUEL VEHICLES. THIS UNIVERSITY STUDY IS FUEL NEUTRAL AND POLICY NEUTRAL. IT WILL ONLY TAKE ABOUT TEN MINUTES, AND WE WILL MAIL YOU A SUMMARY OF THE SURVEY RESULTS WHEN THE STUDY IS COMPLETED. CAN YOU HELP ME OUT ?

1. CONTINUE NOW
2. FAX LETTER & CALL BACK TODAY
3. RE-MAIL LETTER

(DON'T READ PRE-CODED RESPONSES)

SKIP AFTER Q9 IF Q<9> EQ "2" THEN GO 91
SKIP AFTER Q9 IF Q<9> EQ "3" THEN GO 92

*************************************************************
10. DO YOU OPERATE VEHICLES AT THIS LOCATION ?

1. YES
2. NO

SKIP BEFORE Q10 IF Q<2> GT "2" THEN GO 11

*************************************************************
11. DO YOU OPERATE VEHICLES AT ANY LOCATION IN CALIFORNIA ?

1. YES
2. NO

SKIP BEFORE Q11 IF Q<2> LT "3" THEN GO 12
SKIP AFTER Q11 IF Q<11> EQ "2" THEN GO 96

*************************************************************
12. DO YOU OPERATE VEHICLES AT MORE THAN ONE SITE IN CALIFORNIA ?

1. YES
2. NO

SKIP AFTER Q12 IF Q<12> EQ "2" THEN GO 16

************************************************************
13. IS THIS THE HEADQUARTERS LOCATION FOR THIS ORGANIZATION ?

1. YES

2. NO

SKIP AFTER Q13 IF Q<12> EQ "1"
AND Q<13> EQ "1" THEN GO 16

************************************************************
14. CAN YOU GIVE ME THE NAME AND DIRECT PHONE NUMBER FOR THE PERSON AT HEADQUARTERS WHO IS RESPONSIBLE FOR THE VEHICLES ?

(IF ANSWER IS 'NO' ASK TO SPEAK TO SOMEONE WHO CAN PROVIDE THIS INFORMATION. KEEP GOING UNTIL ALL POSSIBILITIES EXHAUSTED BEFORE CODING AS A 'NO')

1. YES

2. NO

SKIP AFTER Q14 IF Q<14> EQ "2" THEN GO 96

************************************************************
15. ENTER CORRECT PERSON'S NAME AND PHONE NUMBER

SKIP AFTER Q15 IF Q<12> EQ "1" THEN GO 96

************************************************************
16. THE FIRST PART OF OUR SURVEY FOCUSES ON FLEET VEHICLE OPERATIONS. ARE YOU THE PERSON WHO CAN ANSWER QUESTIONS RELATED TO YOUR SITE'S VEHICLE INVENTORY, HOW THE VEHICLES ARE USED, APPROXIMATE MILEAGE, AND SO ON?

1. YES
2. YES, BUT NOT FOR ALL VEHICLES (PROBE ADDITIONAL NAMES IF APPROPRIATE)
3. NO (PROBE, AND GET NAMES OF APPROPRIATE CONTACTS)

SKIP AFTER Q16 IF Q<16> EQ "1" THEN GO 19
SKIP AFTER Q16 IF Q<16> EQ "3" THEN GO 94

************************************************************
17. WHICH VEHICLES CAN YOU ANSWER QUESTIONS FOR ?
************************************************************
18. CAN YOU PLEASE DESCRIBE THE VEHICLES YOU DON'T HAVE INFORMATION ON, AND TELL ME WHO COULD ANSWER QUESTIONS ABOUT THEM ?
************************************************************
19. FIRST, I NEED TO ASK A FEW QUICK QUESTIONS ABOUT YOUR FLEET AND ORGANIZATION_ ABOUT HOW MANY STREET LICENSED FLEET VEHICLES ARE OPERATED BY YOUR ORGANIZATION AT THIS SITE?
************************************************************
20. NOW, ABOUT YOUR ORGANIZATION: IS IT A FOR-PROFIT COMPANY, NOT-FOR-PROFIT, OR A GOVERNMENT AGENCY?

1. FOR PROFIT
2. NOT FOR PROFIT
3. A GOVERNMENT AGENCY
4. DON'T KNOW
5. REFUSED
6. OTHER (SPECIFY) (OTHER LINE = 102)

SKIP AFTER Q20 IF Q<20> NE "3" THEN GO 22

************************************************************
21. ARE YOU PART OF LOCAL GOVERNMENT, COUNTY GOVERNMENT, STATE, OR FEDERAL?

1. LOCAL
2. COUNTY

3. STATE
4. FEDERAL
5. DON'T KNOW
6. REFUSED

SKIP AFTER Q21 IF Q<20> EQ "3"
AND Q<19> LT "10" THEN GO 27
SKIP AFTER Q21 IF Q<20> EQ "3" THEN GO 29

**************************************************************
22. WHAT DOES THIS ORGANIZATION DO? DO YOU PROVIDE A SERVICE, OR SELL, OR MANUFACTURE SOMETHING?

1. FINANCE, INSURANCE, REAL ESTATE
2. MANUFACTURING
3. CONSTRUCTION, MINING
4. UTILITY
5. BUSINESS SERVICES
6. TRANSPORTATION
7. FINANCIAL INSTITUTION
8. EDUCATIONAL INSTITUTION
9. RETAIL TRADE / DEALER
10. CONTRACTOR / CONSULTANT
11. WHOLESALE TRADE / DISTRIBUTION
12. OTHER
13. DON'T KNOW
14. REFUSED (OTHER LINE = 104)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************
23. WHAT TYPE OF PRODUCTS OR SERVICE DOES YOUR ORGANIZATION MAKE OR PROVIDE ?
**************************************************************
24. WHAT BUSINESS DOES YOUR FLEET SUPPORT IF DIFFERENT THAN THE ORGANIZATION AS A WHOLE ?
**************************************************************
25. WHAT TYPE OF PRODUCT, OR SERVICES DOES YOUR ORGANIZATION MAKE OR PROVIDE AT THIS FLEET'S LOCATION ?
**************************************************************
26. HOW MANY FULL-TIME EMPLOYEES ARE THERE IN YOUR ENTIRE ORGANIZATION ?

1. 0 - 20
2. 21 - 100
3. 101 - 500
4. OVER 500
5. DON'T KNOW
6. REFUSED

**************************************************************
27. DOES YOUR ORGANIZATION HAVE ANY OTHER FLEET SITES IN CALIFORNIA?

1. YES
2. NO
3. NOT SURE
4. REFUSED

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

SKIP BEFORE Q27 IF Q<19> GE "10" THEN GO 29
SKIP AFTER Q27 IF Q<19> LT "10"
AND Q<27> NE "1" THEN GO 96
SKIP AFTER Q27 IF Q<19> LT "10"
AND Q<27> EQ "1" THEN GO 28

**************************************************************
28. CAN YOU GIVE US INFORMATION ON HOW TO CONTACT ANY OTHER SITES IN YOUR ORGANIZATION? YOU INDICATED THAT YOU OPERATE <SITE-VEH-COUNT> FLEET VEHICLES OUT OF YOUR SITE. IN OUR STUDY WE ARE ATTEMPTING TO CONTACT FLEET SITES THAT OPERATE TEN OR MORE VEHICLES.

SKIP AFTER Q28 GO 96

**************************************************************
29. ARE YOU AWARE OF ANY LEGISLATION THAT REQUIRES YOUR ORGANIZATION TO USE ALTERNATIVE FUEL VEHICLES ?

1. YES
2. NO
3. NOT SURE
4. REFUSED

SKIP AFTER Q29 IF Q<29> EQ "2" THEN GO 31
SKIP AFTER Q29 IF Q<29> EQ "4" THEN GO 31

************************************************************

30. CAN YOU NAME THE AGENCY OR LEGISLATION THAT MANDATES THIS ?

1. CALIFORNIA AIR RESOURCES BOARD (CARB)
2. NATIONAL ENERGY POLICY ACT (NEPA)
3. SACRAMENTO AIR QUALITY DISTRICT (SAQD)
4. CLEAN AIR ACT
5. SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (AQMD)
6. OTHER
7. NO
8. REFUSED (OTHER LINE = 105)

(DON'T READ PRE-CODED RESPONSES)

************************************************************

31. ARE THERE ANY FLEET VEHICLES AT YOUR SITE TODAY THAT RUN ON A FUEL OTHER THAN GASOLINE OR DIESEL? (IF YES, WHICH ONES ?)

1. ETHANOL
2. METHANOL
3. COMPRESSED NATURAL GAS (CNG)
4. DUAL OR BI-FUEL (CNG/GAS)
5. DUAL OR BI-FUEL (METHANOL/GAS)
6. ELECTRICITY
7. REFORMULATED GASOLINE
8. PROPANE (LPG)
9. OTHER
10. NO
11. DONT KNOW
12. REFUSED (OTHER LINE = 114)

(DON'T READ PRE-CODED RESPONSES)

SKIP AFTER Q31 IF Q<31> GE "10" THEN GO 50

************************************************************

32. HOW MANY VEHICLES ARE OPERATED ON ETHANOL ?

SKIP BEFORE Q32 IF Q<31> NE "1" THEN GO 34

************************************************************

33. FOR THE VEHICLES OPERATING ON ETHANOL, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 120)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************

34. HOW MANY VEHICLES ARE OPERATED ON METHANOL ?

SKIP BEFORE Q34 IF Q<31> NE "2" THEN GO 36

**************************************************************

35. FOR THE VEHICLES OPERATING ON METHANOL, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 121)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************

36. HOW MANY VEHICLES ARE OPERATED ON COMPRESSED NATURAL GAS ?

SKIP BEFORE Q36 IF Q<31> NE "3" THEN GO 38

**************************************************************

37. FOR THE VEHICLES OPERATING ON COMPRESSED NATURAL GAS, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 122)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************

38. HOW MANY VEHICLES ARE OPERATED ON DUAL FUEL (CNG / GAS) ?

SKIP BEFORE Q38 IF Q<31> NE "4" THEN GO 40

**************************************************************

39. FOR THE VEHICLES OPERATING ON DUAL FUEL (CNG / GAS), WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 123)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

****************************************************************
40. HOW MANY VEHICLES ARE OPERATED ON DUAL FUEL (METHANOL / GAS) ?

SKIP BEFORE Q40 IF Q<31> NE "5" THEN GO 42

****************************************************************
41. FOR THE VEHICLES OPERATING ON DUAL FUEL (METHANOL / GAS), WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 124)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

****************************************************************
42. HOW MANY VEHICLES ARE OPERATED ON ELECTRICITY ?

SKIP BEFORE Q42 IF Q<31> NE "6" THEN GO 44

****************************************************************
43. FOR THE VEHICLES OPERATING ON ELECTRICITY, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 125)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

****************************************************************
44. HOW MANY VEHICLES ARE OPERATED ON REFORMULATED GASOLINE ?

SKIP BEFORE Q44 IF Q<31> NE "7" THEN GO 46

****************************************************************
45. FOR THE VEHICLES OPERATING ON REFORMULATED GASOLINE, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 126)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************
46. HOW MANY VEHICLES ARE OPERATED ON PROPANE ?

SKIP BEFORE Q46 IF Q<31> NE "8" THEN GO 48

**************************************************************
47. FOR THE VEHICLES OPERATING ON PROPANE, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 127)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************
48. HOW MANY VEHICLES ARE OPERATED ON <<OTHER>> ?

SKIP BEFORE Q48 IF Q<31> NE "9" THEN GO 50

**************************************************************
49. FOR THE VEHICLES OPERATING ON <<OTHER>>, WHAT BODY TYPE ARE THEY ?

1. CAR AND STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL / MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 GVW
8. OTHER
9. DON'T KNOW
10. REFUSED (OTHER LINE = 128)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************
50. WHAT IS THE LIKELIHOOD THAT ONE OR MORE ALTERNATIVE FUEL VEHICLES WILL BE PURCHASED FOR THIS LOCATION WITHIN THE NEXT TWO YEARS ? WOULD YOU SAY IT IS . . . ?

1. EXTREMELY LIKELY
2. VERY LIKELY
3. SOMEWHAT LIKELY
4. NOT VERY LIKELY
5. NOT AT ALL LIKELY

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.]

SKIP AFTER Q50 IF Q<50> GE "4" THEN GO 52

**************************************************************
51. WHAT FUEL OR FUELS WILL MOST LIKELY OPERATE THE ALTERNATIVE FUEL VEHICLES

YOU ARE CONSIDERING FOR YOUR SITE ?

1. METHANOL
2. ETHANOL
3. CNG
4. PROPANE
5. ELECTRICITY
6. OTHER
7. DON'T KNOW
8. REFUSED (OTHER LINE = 115)

(DON'T READ PRE-CODED RESPONSES)

************************************************************
52. HAVE YOU READ OR SEEN ANY INFORMATION ABOUT ALTERNATIVE FUEL VEHICLES IN THE LAST SIX MONTHS ?

1. YES

2. NO

3. NOT SURE

SKIP AFTER Q52 IF Q<52> NE "1" THEN GO 55

************************************************************
53. WHAT IS THE PRIMARY SOURCE YOU USE TO LEARN ABOUT ALTERNATIVE FUELS FROM?

1. PRESS
2. TRADE SHOWS
3. UTILITY COMPANIES
4. TRADE ASSOCIATIONS (LIKE NAFA)
5. TELEVISION
6. GENERAL CONVERSATION
7. PERSONAL EXPERIENCE
8. VISITED OEM OR SHOWROOM
9. DIRECT MAIL
10. OTHER
11. DON'T KNOW
12. NONE
13. REFUSED (OTHER LINE = 129)

(DON'T READ PRE-CODED RESPONSES)

SKIP AFTER Q53 IF Q<53> GE "11" THEN GO 55

************************************************************
54. WHERE ELSE DO YOU LEARN ABOUT ALTERNATIVE FUEL VEHICLES FROM?

1. PRESS
2. TRADE SHOWS
3. UTILITY COMPANIES
4. TRADE ASSOCIATIONS (LIKE NAFA)
5. TELEVISION
6. GENERAL CONVERSATION
7. PERSONAL EXPERIENCE
8. VISITED OEM OR SHOWROOM
9. DIRECT MAIL
10. OTHER
11. DON'T KNOW
12. REFUSED (OTHER LINE = 116)

(DON'T READ PRE-CODED RESPONSES)

************************************************************
55. NOW I'M GOING TO LIST SOME VEHICLE BODY TYPES AND ASK YOU IF YOU OPERATE THEM AT YOUR SITE.

DO YOU OPERATE CARS AND STATION WAGONS ?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

************************************************************
56. MINIVANS?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

57. FULL SIZE VANS?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

58. COMPACT PICKUPS?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

59. FULL SIZE PICKUPS?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

60. SMALL / MEDIUM SHUTTLE BUSES?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

61. TRUCKS 6,000 - 14,000 LBS GVW ?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

62. TRUCKS GVW > 14,000 LBS.?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

*************************************************************

63. DO YOU OPERATE OTHER STREET-LICENSED VEHICLE CLASSES THAT WE DIDN'T MENTION?

1. YES (SPECIFY OTHER)
2. NO
3. REFUSED (OTHER LINE = 130)

*************************************************************

64. ARE THERE ANY OTHER STREET-LICENSED VEHICLE CLASSES THAT WE DIDN'T MENTION ?

1. YES (SPECIFY OTHER)
2. NO
3. DON'T KNOW
4. REFUSED (OTHER LINE = 131)

SKIP BEFORE Q64 IF Q<63> EQ "2" THEN GO 65

*************************************************************

65. DOES YOUR ORGANIZATION HAVE ANY OTHER FLEET SITES IN CALIFORNIA?

1. YES
2. NO

3. DON'T KNOW
4. REFUSED

```
SKIP BEFORE Q65  IF Q<55> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<55> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<56> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<56> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<57> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<57> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<58> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<58> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<59> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<59> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<60> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<60> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<61> EQ "1" THEN GO 67
SKIP BEFORE Q65  IF Q<61> EQ "4" THEN GO 67
SKIP BEFORE Q65  IF Q<62> NE "1" THEN GO 67
SKIP AFTER  Q65  IF Q<65> NE "1" THEN GO 96
```

************************************************************

66. CAN YOU GIVE US INFORMATION ON HOW TO CONTACT OTHER SITES IN YOUR ORGANIZATION?

SKIP AFTER Q66 IF Q<65> EQ "1" THEN GO 96

************************************************************

67. OK, GETING YOUR VEHICLES CATEGORIZED PROPERLY IS CRITICAL TO OUR SURVEY SO I'M GOING TO READ BACK THE LIST OF VEHICLES TO CONFIRM THAT I'VE RECORDED THEM PROPERLY. PLEASE TELL ME IF MY LIST IS CORRECT OR IF I NEED TO ADD OR DELETE A CATEGORY.

(RECODE ANSWERS BELOW IGNORING 'OTHER' CATEGORIES)

1. CARS/STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL/MEDIUM SHUTTLE BUSSES
7. TRUCKS 6,000 - 14,000 LBS GVW

************************************************************

68. <VEH-CLASS-LIST W/O OTHERS & BIG TRUCKS>

THIS STUDY IS FOCUSED ON STREET LEGAL CARS, VANS AND TRUCKS UNDER 14,000 LBS GVW. WITHIN THIS CONSTRAINT WHICH OF YOUR VEHICLE CATEGORIES HAS THE MOST VEHICLES ?

1. CARS & STATION WAGONS
2. MINIVANS
3. FULL SIZE VANS
4. COMPACT PICKUPS
5. FULL SIZE PICKUPS
6. SMALL/MEDIUM SHUTTLE BUSES
7. TRUCKS 6,000 - 14,000 GVW
8. DON'T KNOW
9. REFUSED

************************************************************

69. APPROXIMATELY HOW HANY <SP-VEH-CLASS1> DO YOU HAVE AT YOUR SITE ?

************************************************************

70. NOW I'D LIKE TO BRIEFLY ASK YOU ABOUT YOUR <SP-VEH-CLASS1>.

WHAT DO YOU USE YOUR <SP-VEH-CLASS1> FOR IN YOUR FLEET?

************************************************************

71. AND, DO YOUR <SP-VEH-CLASS1> STAY ON THE PREMISES AT NIGHT OR GO HOME WITH EMPLOYEES?

1. STAY ON PREMISES
2. GO HOME WITH EMPLOYEES
3. MIXED / GO HOME AND STAY
4. NEVER PARK AT NIGHT

5. OTHER
6. DON'T KNOW
7. REFUSED (OTHER LINE = 119)

***************************************************************

72. I HAVE THE SAME TWO QUESTIONS ABOUT YOUR <SP-VEH-CLASS2> AND THEN I AM ALMOST DONE.

WHAT DO YOU USE YOUR <SP-VEH-CLASS2> FOR IN YOUR FLEET?

***************************************************************

73. AND, DO YOUR <SP-VEH-CLASS2> STAY ON THE PREMISES AT NIGHT OR GO HOME WITH EMPLOYEES?

1. STAY ON PREMISES
2. GO HOME WITH EMPLOYEES
3. MIXED / GO HOME AND STAY
4. NEVER PARK AT NIGHT
5. OTHER
6. DON'T KNOW
7. REFUSED (OTHER LINE = 101)

***************************************************************

74. NOW I'D LIKE TO ASK A FEW OTHER QUESTIONS ABOUT YOUR FLEET SITE. DO YOU CURRENTLY HAVE AN ON-SITE REFUELING FACILITY AT THIS SITE?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

SKIP AFTER Q74 IF Q<74> EQ "1" THEN GO 78

***************************************************************

75. HAVE YOU EVER HAD ONE IN THE PAST?

1. YES
2. NO
3. DON'T KNOW
4. REFUSED

SKIP AFTER Q75 IF Q<75> EQ "1" THEN GO 78

***************************************************************

76. ALTHOUGH YOU HAVEN'T HAD ON-SITE REFUELING, IS IT PHYSICALLY POSSIBLE TO INSTALL SUCH A FACILITY AT YOUR SITE?

1. YES

2. NO

3. DON'T KNOW

4. REFUSED

SKIP AFTER Q76 IF Q<76> NE "2" THEN GO 78

***************************************************************

77. WHY ISN'T IT POSSIBLE TO INSTALL ON-SITE REFUELING ?

***************************************************************

78. BEFORE FINISHING UP, I HAVE ANOTHER QUESTION ABOUT YOUR ORGANIZATION. other THAN YOUR SITE, HOW MANY other FLEET SITES DOES YOUR ORGANIZATION OPERATE in california?

***************************************************************

79. COULD YOU ROUGHLY ESTIMATE THE TOTAL NUMBER OF FLEET VEHICLES IN YOUR whole ORGANIZATION THAT ARE operated in California?

1. LESS THAN 10
2. 10 - 24
5. 100 - 299
6. 300 - 999

3. 25 - 49

4. 50 - 99

7. 1000 - 5000

8. > 5000

9. DON'T KNOW

10. REFUSED

SKIP BEFORE Q79 IF Q<78> LT "1" THEN GO 80

**************************************************************

80. WHICH OF THE FOLLOWING BEST DESCRIBES THE TRAVEL PATTERNS OF YOUR FLEET VEHICLES ?

1. LOCAL
2. STATE-WIDE
3. REGIONAL MULTI-STATE
4. NATION-WIDE
5. INTERNATIONAL
6. DON'T KNOW
7. REFUSED

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

**************************************************************

81. I'D ALSO LIKE TO ASK ABOUT FLEET DECISION MAKING AT THIS SITE. SUPPOSE THAT ALL FLEET VEHICLES AT YOUR SITE MUST BE REPLACED TOMORROW, AND THAT SOMEONE IN YOUR ORGANIZATION MUST DECIDE WHICH NEW VEHICLES TO PURCHASE. WHO FROM THE FOLLOWING LIST OF PEOPLE WOULD MOST LIKELY CHOOSE THE NEW VEHICLES?

1. YOU, PERSONALLY
2. SOMEONE ELSE AT YOUR SITE
3. SOMEONE AWAY FROM YOUR SITE
4. YOU CHOOSE SOME VEHICLES, BUT NOT OTHERS
5. OTHER (OTHER LINE = 103)
6. REFUSES TO ANSWER ADDITIONAL QUESTIONS

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

SKIP AFTER Q81 IF Q<81> EQ "6" THEN GO 96

**************************************************************

82. WE HAVE SOME ADDITIONAL QUESTIONS ON BOTH FLEET OPERATIONS AND ABOUT DECISION MAKING THAT WE WOULD LIKE TO SEND BY MAIL (BECAUSE THEY ARE EASIER TO FILL OUT ON PAPER). ON OPERATIONS, WE ASK A FEW MORE QUESTIONS ABOUT YOUR <SP-VEH-CLASS1> (AND <SP-VEH-CLASS2>) AND HOW THEY ARE USED. ON DECISION MAKING, WE ASK ONE OR TWO HYPOTHETICAL VEHICLE REPLACEMENT QUESTIONS. THE DECISION QUESTIONS ASSUME THE PERSON GIVING THE ANSWERS IS KNOWLEDGEABLE ABOUT HOW YOU USE YOUR <SP-VEH-CLASS1> (AND <SP-VEH-CLASS2>).

1. RESPONDENT CAN ANSWER BOTH
2. RESPONDENT CAN ANSWER <SP-VEH-CLASS1> ONLY
3. RESPONDENT CAN ANSWER <SP-VEH-CLASS2> ONLY
4. SOMEONE ELSE WOULD ANSWER BOTH
5. REFUSES TO ANSWER ADDITIONAL QUESTIONS

SKIP AFTER Q82 IF Q<82> EQ "1" THEN GO 83
SKIP AFTER Q82 IF Q<82> EQ "2" THEN GO 84
SKIP AFTER Q82 IF Q<82> EQ "3" THEN GO 86

SKIP AFTER Q82 IF Q<82> EQ "4" THEN GO 88
SKIP AFTER Q82 IF Q<82> EQ "5" THEN GO 96

*************************************************************

83. GREAT! BASED ON YOUR PREVIOUS ANSWERS I ALREADY HAVE WHAT I NEED TO SEND YOU A SHORT CUSTOMIZED SURVEY IN THE MAIL. COULD I PLEASE GET YOUR MAILING ADDRESS? IT WILL ALSO INCLUDE A SMALL GIFT TO THANK YOU FOR HELPING US WITH OUR FLEET STUDY.

    1. RECORD MAILING ADDRESS (SPECIFY OTHER)
    2. REFUSES (OTHER LINE = 106)

SKIP AFTER Q83 IF Q<82> EQ "1" THEN GO 96

*************************************************************

84. OK. I CAN SEND YOU A SHORT CUSTOMIZED SURVEY IN THE MAIL (ALONG WITH << GIFT/$ >> THANKING YOU FOR YOUR HELP IN OUR STUDY). WOULD IT BE POSSIBLE FOR YOU TO GET THE CORRECT PERSON TO ANSWER THE DECISION QUESTION ON <SP-VEH-CLASS1>? OR WOULD IT BE BEST FOR ME TO SEND THAT PERSON A SEPARATE QUESTIONNAIRE AFTER YOU HAVE FILLED OUT YOURS?

    1. RESPONDENT CAN HANDLE ALL OF IT (GET MAILING ADDRESS)
    2. GET TWO MAILING ADDRESSES (RESPONDENT'S AND ONE OTHER)
    3. REFUSES (OTHER LINE = 107)

SKIP AFTER Q84 IF Q<84> NE "2" THEN GO 96

*************************************************************

85. MAILING ADDRESS OF OTHER PERSON?

    1. OTHER ADDRESS (OTHER LINE = 108)

SKIP AFTER Q85 IF Q<82> EQ "2" THEN GO 96

*************************************************************

86. OK. I CAN SEND YOU A SHORT CUSTOMIZED SURVEY IN THE MAIL (ALONG WITH <<GIFT/$>> THANKING YOU FOR YOUR HELP IN OUR STUDY). WOULD IT BE POSSIBLE FOR YOU TO GET THE CORRECT PERSON TO ANSWER THE DECISION QUESTION ON <SP-VEH-CLASS2>? OR WOULD IT BE BEST FOR ME TO SEND THAT PERSON A SEPARATE QUESTIONNAIRE AFTER YOU HAVE FILLED OUT YOURS?

    1. RESPONDENT CAN HANDLE ALL OF IT (GET MAILING ADDRESS)
    2. GET TWO MAILING ADDRESSES (RESPONDENT'S AND ONE OTHER)
    3. REFUSES (OTHER LINE = 109)

SKIP AFTER Q86 IF Q<86> NE "2" THEN GO 96

*************************************************************

87. MAILING ADDRESS OF OTHER PERSON?

    1. OTHER ADDRESS (OTHER LINE = 110)

SKIP AFTER Q87 IF Q<82> EQ "3" THEN GO 96

*************************************************************

88. OK. I CAN SEND YOU A SHORT CUSTOMIZED SURVEY IN THE MAIL (ALONG WITH <<GIFT/$>> THANKING YOU FOR YOUR HELP IN OUR STUDY). WOULD IT BE POSSIBLE FOR YOU TO GET THE CORRECT PERSON TO ANSWER THE DECISION QUESTIONS? OR WOULD IT BE BEST FOR ME TO SEND THAT PERSON A SEPARATE QUESTIONNAIRE AFTER YOU HAVE FILLED OUT YOURS?

    1. RESPONDENT CAN HANDLE ALL OF IT (GET MAILING ADDRESS)
    2. GET TWO MAILING ADDRESSES (RESPONDENT'S AND ONE OTHER)
    3. REFUSES (OTHER LINE = 111)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

SKIP AFTER Q88 IF Q<88> NE "2" THEN GO 96

************************************************************
89. YOU WILL BE ABLE TO RECEIVE A SUMMARY OF PROJECT RESULTS, IF DESIRED, AND WE WANTED TO KNOW IF THERE IS SOME SPECIFIC QUESTION THAT YOU WOULD LIKE US TO ASK FLEET MANAGERS ON THIS TOPIC THAT WOULD BE OF MOST INTEREST TO YOU AND YOUR ORGANIZATION ?
************************************************************
90. MAILING ADDRESS OF OTHER PERSON?

1. OTHER ADDRESS (OTHER LINE = 112)

(READ PRE-CODED RESPONSES - EXCEPT FOR 'DON'T KNOW', 'REFUSED', ETC.)

SKIP AFTER Q90 IF Q<82> EQ "4" THEN GO 96

************************************************************
91. WOULD YOU PLEASE GIVE ME YOUR FAX NUMBER AREA CODE FIRST :

SKIP AFTER Q91 GO 96

************************************************************
92. WILL YOU PLEASE GIVE ME YOUR CORRECT MAILING ADDRESS :

SKIP AFTER Q92 GO 96

************************************************************
93. NAMES OF APPROPRIATE CONTACTS AT SITES WITH FLEET VEHICLES:

1. OTHER (OTHER LINE = 117)

(DON'T READ PRE-CODED RESPONSES)

SKIP AFTER Q93 GO 96

************************************************************
94. ENTER CONTACT NAME (FIRST NAME, LAST NAME, TITLE)
************************************************************
95.

ENTER PHONE NUMBER (### ### ####)
************************************************************
96. [ END OF CATI TELEPHONE SURVEY ]
************************************************************
136. ENTER SURVEYOR FIRST & LAST NAME, SPELLED CORRECTLY !!
************************************************************
157. TERMINATION STATUS :

1. REFUSED, DON'T CALL BACK

2. CALL BACK & START AT BEGINING

3. CALL BACK & CONTINUE FROM LAST Q

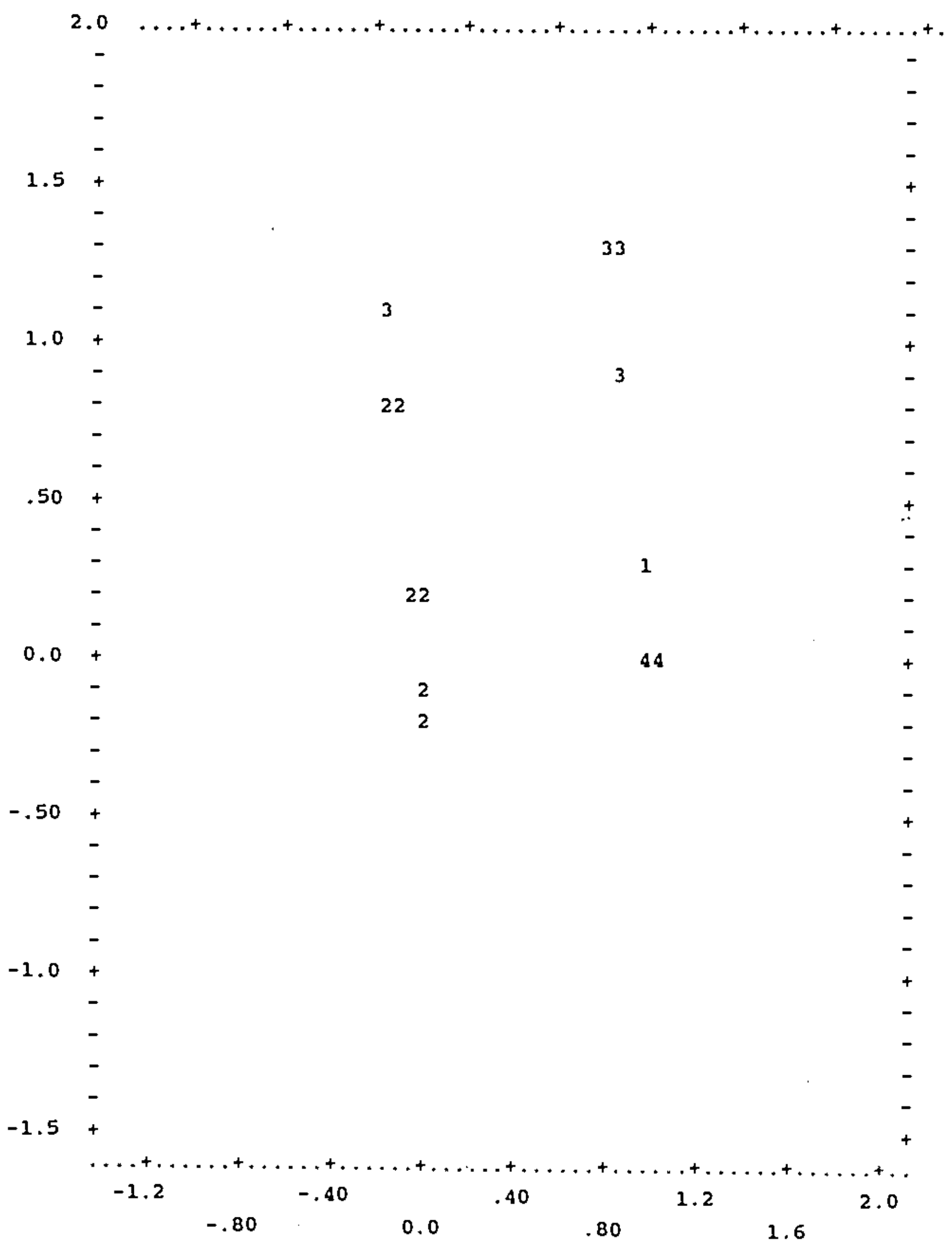
4. NOT QUALIFIED RESPONDENT
************************************************************
THANK YOU FOR COMPLETING THE FLEET SURVEY!

# Appendix C

## BMDP Clustering Procedure

<u>Scatter Plot for All Four Categories</u>

```
NUMBER OF CASES . . . . . . . .    2013
REPORT ON CASES WITH POSITIVE WEIGHT
-----------------------------------
```




PLANE THROUGH THE CENTERS OF CLUSTERS 1, 2, 3, AND 4.

CLUSTER MEANS

|  | SIZE | M209 | M210 | M211 | M212 |
|---|---|---|---|---|---|
| A | 198. | 1.0000 | 1.0000 | 0.9091 | 1.0000 |
| B | 862. | 0.8501 | 0.0000 | 0.8696 | 0.0286 |
| D | 319. | 0.0000 | 0.9789 | 0.9033 | 0.3716 |
| H | 634. | 1.0000 | 1.0000 | 0.9084 | 0.0000 |
| GRAND MEAN |  | 0.7743 | 0.5696 | 0.8911 | 0.1690 |

## Scatter Plot for Hierarchic Subgroups

```
NUMBER OF CASES . . . . . . . .      634
REPORT ON CASES WITH POSITIVE WEIGHT
-----------------------------------
        .+.....+.....+.....+.....+.....+.....+.....+.....+....
        -                                                    -
   0    +                  2  2          1  1                +
        -                                                    -
        .+.....+.....+.....+.....+.....+.....+.....+.....+....
       -1.2          -.40          .40           1.2          2.0
              -.80          0.0           .80           1.6

             LINE THROUGH THE CENTERS OF BOTH CLUSTERS
```

CLUSTER MEANS

|  | SIZE | M207 | M208 | M209 | M210 | M211 | M212 |
|---|---|---|---|---|---|---|---|
| H1 | 296. | 1.0000 | 0.9054 | 1.0000 | 1.0000 | 0.9020 | 0.0000 |
| H2 | 338. | 0.0000 | 0.7337 | 1.0000 | 1.0000 | 0.9201 | 0.0000 |
| GRAND MEAN |  | 0.4669 | 0.8139 | 1.0000 | 1.0000 | 0.9117 | 0.0000 |

## Scatter Plot for Bureaucratic Subgroups

```
NUMBER OF CASES . . . . . . . . .    862
REPORT ON CASES WITH POSITIVE WEIGHT
-----------------------------------
         .+......+......+......+......+......+......+......+......+.....
         -                                                             -
     0   +                  1111111          2222222                   +
         -                                                             -
         .+......+......+......+......+......+......+......+......+.....
        -1.2          -.40          .40          1.2          2.0
               -.80          0.0          .80          1.6

             LINE THROUGH THE CENTERS OF BOTH CLUSTERS
```

CLUSTER MEANS
-------------

| | SIZE | M207 | M208 | M209 | M210 | M211 | M212 | M213 |
|---|---|---|---|---|---|---|---|---|
| B1 | 435. | 0.6782 | 0.9356 | 0.8391 | 0.0000 | 0.9287 | 0.0207 | 1.0000 |
| B2 | 427. | 0.5176 | 0.8759 | 0.8595 | 0.0000 | 0.8103 | 0.0375 | 0.0000 |
| GRAND MEAN | | 0.5986 | 0.9060 | 0.8492 | 0.0000 | 0.8701 | 0.0290 | 0.5046 |

# Appendix D

## Discriminant Analysis for Model Structure 2

MEANS OF USED VARIABLES IN USED GROUPS

| | | H1 | H2 | B1 | B2 | A | D |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| PROFIT | 275 | 0.8052 | 0.8519 | 0.6293 | 0.5170 | 0.9176 | 0.7618 |
| NONPROF | 276 | 0.0390 | 0.0500 | 0.0647 | 0.1134 | 0.0323 | 0.0690 |
| LOCGOV | 277 | 0.1385 | 0.0827 | 0.2457 | 0.2857 | 0.0323 | 0.1379 |
| NUMEMP | 290 | 2.3593 | 2.1635 | 3.0345 | 2.5714 | 1.9211 | 2.4953 |
| TOTVEH | 313 | 61.8485 | 69.8019 | 335.3880 | 236.3674 | 35.1255 | 128.0188 |
| LNTOT | 315 | 3.4155 | 3.2183 | 4.1594 | 3.7750 | 3.1738 | 3.6269 |
| BUY | 319 | 74.1818 | 80.0288 | 66.7069 | 79.0136 | 82.8136 | 73.7429 |
| TYPE2 | 280 | 0.0736 | 0.0904 | 0.0603 | 0.0975 | 0.0860 | 0.0784 |
| TYPE3 | 281 | 0.0563 | 0.0962 | 0.0216 | 0.0567 | 0.1039 | 0.0282 |
| TYPE4 | 282 | 0.0216 | 0.0135 | 0.0345 | 0.0408 | 0.0108 | 0.0157 |
| TYPE5 | 283 | 0.1515 | 0.1346 | 0.1293 | 0.0658 | 0.1541 | 0.1693 |
| CARWAG | 291 | 0.2035 | 0.1673 | 0.3103 | 0.2698 | 0.2186 | 0.2571 |
| MINIVAN | 292 | 0.0519 | 0.0231 | 0.0345 | 0.0385 | 0.0323 | 0.0439 |
| FULLVAN | 293 | 0.1255 | 0.1096 | 0.1336 | 0.1111 | 0.1362 | 0.1191 |
| CPICK | 294 | 0.1429 | 0.1519 | 0.1121 | 0.1156 | 0.1147 | 0.1348 |
| FSPICK | 295 | 0.3290 | 0.4115 | 0.2586 | 0.3401 | 0.3369 | 0.3417 |
| VEHOTHER | 303 | 1.6061 | 0.9577 | 2.7284 | 1.3175 | 0.6918 | 1.6426 |
| V12 | 230 | 0.8701 | 0.9462 | 0.7284 | 0.8617 | 0.9462 | 0.8088 |
| LOCAL | 304 | 0.8571 | 0.8615 | 0.8578 | 0.8662 | 0.8423 | 0.8495 |
| L_BUY | 320 | 10.1688 | 10.8308 | 11.5345 | 8.3447 | 8.1362 | 9.8433 |

STANDARD DEVIATIONS OF USED VARIABLES IN USED GROUPS

| | | H1 | H2 | B1 | B2 | A | D |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| PROFIT | 275 | 0.3969 | 0.3555 | 0.4840 | 0.5003 | 0.2755 | 0.4267 |
| NONPROF | 276 | 0.1939 | 0.2182 | 0.2464 | 0.3174 | 0.1770 | 0.2538 |
| LOCGOV | 277 | 0.3462 | 0.2757 | 0.4314 | 0.4523 | 0.1770 | 0.3454 |
| NUMEMP | 290 | 0.9806 | 0.8479 | 1.2409 | 1.0090 | 0.7963 | 1.1268 |
| TOTVEH | 313 | 174.3715 | 467.4444 | 1350.9854 | 2430.2080 | 48.5686 | 407.5375 |
| LNTOT | 315 | 1.0888 | 1.0947 | 1.5926 | 1.2580 | 0.8581 | 1.4034 |
| BUY | 319 | 41.7627 | 38.1381 | 45.5820 | 39.0697 | 35.2925 | 41.9848 |
| TYPE2 | 280 | 0.2617 | 0.2870 | 0.2386 | 0.2970 | 0.2809 | 0.2692 |
| TYPE3 | 281 | 0.2310 | 0.2951 | 0.1455 | 0.2315 | 0.3057 | 0.1658 |
| TYPE4 | 282 | 0.1458 | 0.1154 | 0.1829 | 0.1981 | 0.1033 | 0.1244 |
| TYPE5 | 283 | 0.3593 | 0.3416 | 0.3363 | 0.2481 | 0.3617 | 0.3756 |
| CARWAG | 291 | 0.4034 | 0.3736 | 0.4636 | 0.4444 | 0.4141 | 0.4377 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MINIVAN | 292 | 0.2224 | 0.1503 | 0.1829 | 0.1927 | 0.1770 | 0.2052 |
| FULLVAN | 293 | 0.3321 | 0.3127 | 0.3410 | 0.3146 | 0.3436 | 0.3244 |
| CPICK | 294 | 0.3507 | 0.3593 | 0.3161 | 0.3202 | 0.3192 | 0.3420 |
| FSPICK | 295 | 0.4709 | 0.4926 | 0.4388 | 0.4743 | 0.4735 | 0.4750 |
| VEHOTHER | 303 | 2.5632 | 1.8773 | 3.1236 | 2.3996 | 1.4831 | 2.6453 |
| V12 | 230 | 0.3369 | 0.2259 | 0.4457 | 0.3456 | 0.2260 | 0.3939 |
| LOCAL | 304 | 0.3507 | 0.3457 | 0.3501 | 0.3408 | 0.3651 | 0.3581 |
| L_BUY | 320 | 28.7262 | 29.2305 | 30.4447 | 25.9837 | 24.7201 | 27.5345 |

COEFFICIENTS FOR GROUP H1
-----------------------------

QUADRATIC TERM

| | | PROFIT | NONPROF | LOCGOV | NUMEMP | TOTVEH | LNTOT | BUY | TYPE2 | TYPE3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 275 | 276 | 277 | 290 | 313 | 315 | 319 | 280 | 281 |
| PROFIT | 275 | 36.2661 | | | | | | | | |
| NONPROF | 276 | 34.9524 | 48.1966 | | | | | | | |
| LOCGOV | 277 | 33.5730 | 33.4428 | 36.3030 | | | | | | |
| NUMEMP | 290 | -0.2747 | -0.6797 | -0.1301 | 0.8499 | | | | | |
| TOTVEH | 313 | 0.0090 | 0.0092 | 0.0083 | 0.0007 | 0.0000 | | | | |
| LNTOT | 315 | 0.2774 | 0.1310 | -0.1884 | -0.3169 | -0.0025 | 0.8421 | | | |
| BUY | 319 | 0.0105 | 0.0073 | 0.0036 | -0.0018 | -0.0000 | 0.0014 | 0.0005 | | |
| TYPE2 | 280 | -0.5027 | 0.5335 | 0.4227 | -0.3563 | 0.0005 | -0.0453 | 0.0011 | 8.1735 | |
| TYPE3 | 281 | -0.0637 | 0.8299 | 0.7384 | -0.0981 | 0.0010 | -0.1871 | 0.0027 | 1.3492 | 11.0813 |
| TYPE4 | 282 | -1.8780 | -3.8058 | -0.6082 | 0.1964 | -0.0002 | 0.0144 | -0.0046 | 0.6167 | 0.6478 |
| TYPE5 | 283 | -1.4291 | -0.9031 | -0.3617 | 0.1553 | -0.0005 | 0.0211 | 0.0017 | 0.8700 | 0.8377 |
| CARWAG | 291 | 1.3090 | 0.6229 | 1.1810 | -0.4105 | -0.0007 | 0.0643 | 0.0095 | 0.0626 | 0.0036 |
| MINIVAN | 292 | -0.0711 | -0.0310 | 0.2631 | -0.2609 | -0.0006 | 0.1573 | 0.0122 | -0.3745 | 0.3572 |
| FULLVAN | 293 | 0.4699 | -0.5405 | 0.5900 | -0.3476 | -0.0002 | 0.1883 | 0.0045 | 0.1747 | 0.2459 |
| CPICK | 294 | 2.6074 | 1.7825 | 2.1939 | -0.1777 | 0.0003 | 0.1780 | -0.0001 | 0.3944 | 0.0079 |
| FSPICK | 295 | -0.4872 | -1.1551 | -0.2134 | 0.0460 | -0.0011 | 0.1041 | 0.0001 | -0.1175 | -1.3585 |
| VEHOTHER | 303 | -0.2001 | -0.1125 | -0.1210 | -0.0458 | -0.0002 | -0.0169 | 0.0004 | -0.0566 | -0.1091 |
| V12 | 230 | -0.8603 | -1.8763 | -1.1309 | 0.5885 | -0.0010 | 0.0984 | -0.0062 | -1.2038 | -1.3742 |
| LOCAL | 304 | 1.0239 | 0.2923 | 0.2087 | 0.0364 | 0.0004 | -0.0958 | 0.0021 | -0.0543 | 0.6663 |
| L_BUY | 320 | 0.0072 | 0.0024 | 0.0049 | -0.0029 | -0.0000 | 0.0010 | 0.0004 | [illegible] | -0.0043 |

```
                 TYPE4        TYPE5        CARWAG       MINIVAN      FULLVAN      CPICK
FSPICK      VEHOTHER    V12
                   282          283          291          292          293          294
295         303         230

TYPE4     282     26.0171
TYPE5     283      1.4099       4.6543
CARWAG    291      0.6737      -0.1734       6.5935
MINIVAN   292      0.6897       0.5586       3.7540      13.5857
FULLVAN   293      0.7559      -0.7959       3.8472       3.5482       7.9070
CPICK     294     -1.7255      -0.9055       3.6477       3.2719       3.6966       7.5674
FSPICK    295      0.6071       0.1074       3.5068       3.4230       3.4426       3.3941
5.2031
VEHOTHER 303      -0.1649      -0.0656      -0.0076       0.0844      -0.0318       0.0329
0.0158      0.1074
V12       230     -0.7813      -0.4920       0.0539       0.1956      -0.1140       0.1344
0.2997      0.2543      6.1810
LOCAL     304     -0.8917      -0.4149       0.1000       0.0326       0.1335       0.2682
-0.2492      0.0445      0.2081
L_BUY     320      0.0033      -0.0004       0.0193       0.0105       0.0109       0.0089
0.0058      -0.0006     -0.0078


                 LOCAL        L_BUY
                   304          320

LOCAL     304      4.4098
L_BUY     320      0.0020       0.0010


LINEAR TERM       73.9218      65.7426      65.6407       1.7004       0.0028       4.7212
0.0988      -3.1378      -1.8030
                  -4.3672      -1.8861      10.3214       9.6106       8.4035      13.1842
7.0620       0.1558      12.0637
                   9.6047       0.0879

CONSTANT =    -58.613


COEFFICIENTS FOR GROUP H2
------------------------------

QUADRATIC TERM

                 PROFIT       NONPROF      LOCGOV       NUMEMP       TOTVEH       LNTOT        BUY
TYPE2       TYPE3
                   275          276          277          290          313          315
319         280         281

PROFIT    275     34.4911
NONPROF   276     33.7471      44.4577
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LOCGOV | 277 | 33.4089 | 33.7621 | 40.2404 | | | | | | |
| NUMEMP | 290 | -0.1321 | -0.4687 | -0.4490 | 1.0412 | | | | | |
| TOTVEH | 313 | -0.0003 | -0.0002 | -0.0002 | -0.0000 | 0.0000 | | | | |
| LNTOT | 315 | 0.4802 | 0.5025 | 0.0757 | -0.2749 | -0.0005 | 0.6747 | | | |
| BUY | 319 | 0.0036 | -0.0050 | -0.0057 | 0.0028 | 0.0000 | -0.0012 | 0.0007 | | |
| TYPE2 | 280 | -0.5947 | 0.3697 | 0.4514 | -0.4002 | 0.0003 | 0.1372 | 0.0011 | 6.8481 | |
| TYPE3 | 281 | -0.8722 | -0.6126 | -0.0102 | 0.1998 | 0.0000 | 0.0424 | -0.0010 | 0.8570 | 6.4680 |
| TYPE4 | 282 | -0.9870 | -1.7742 | 0.0307 | 0.0258 | 0.0001 | -0.1515 | -0.0061 | 0.7949 | 0.9922 |
| TYPE5 | 283 | -0.9090 | -0.3686 | 0.0070 | 0.1332 | 0.0003 | -0.1663 | 0.0034 | 0.9081 | 0.8366 |
| CARWAG | 291 | 0.2604 | -0.7276 | -0.4264 | -0.2030 | -0.0005 | 0.2075 | 0.0056 | -0.2445 | 0.3368 |
| MINIVAN | 292 | 2.7601 | 1.0758 | 3.3889 | -0.1671 | 0.0001 | 0.0065 | 0.0087 | 0.9071 | 0.7383 |
| FULLVAN | 293 | 0.1718 | -0.8133 | 0.0890 | -0.0649 | -0.0001 | 0.1895 | 0.0010 | 0.3058 | 0.6728 |
| CPICK | 294 | 1.1251 | 0.4462 | 0.8475 | -0.0143 | -0.0003 | 0.3295 | -0.0049 | 0.3336 | 0.3967 |
| FSPICK | 295 | 0.9233 | 1.0374 | 0.8166 | -0.0241 | -0.0001 | 0.0489 | -0.0022 | 0.2598 | -0.2784 |
| VEHOTHER | 303 | -0.0086 | 0.1043 | 0.2086 | -0.0666 | -0.0001 | -0.0832 | -0.0002 | -0.0401 | -0.0104 |
| V12 | 230 | 0.8011 | 0.6718 | 1.9359 | 0.7690 | -0.0003 | -0.2481 | -0.0027 | -0.1658 | 0.2391 |
| LOCAL | 304 | 0.4760 | 1.0339 | 0.4453 | 0.0131 | 0.0003 | -0.0966 | -0.0033 | 0.4622 | 0.1612 |
| L_BUY | 320 | 0.0113 | 0.0042 | 0.0100 | 0.0013 | 0.0000 | -0.0015 | 0.0006 | 0.0025 | 0.0045 |

| | | TYPE4 | TYPE5 | CARWAG | MINIVAN | FULLVAN | CPICK | FSPICK | VEHOTHER | V12 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 282 | 283 | 291 | 292 | 293 | 294 | 295 | 303 | 230 |
| TYPE4 | 282 | 38.4050 | | | | | | | | |
| TYPE5 | 283 | 0.8963 | 4.7830 | | | | | | | |
| CARWAG | 291 | -0.4606 | -0.0920 | 7.0139 | | | | | | |
| MINIVAN | 292 | 0.2697 | 0.3130 | 3.9224 | 26.4191 | | | | | |
| FULLVAN | 293 | -0.5861 | -0.4516 | 3.8469 | 3.9339 | 8.5142 | | | | |
| CPICK | 294 | -0.4678 | -0.4960 | 3.7998 | 3.8918 | 3.9419 | 7.3676 | | | |
| FSPICK | 295 | -0.7798 | 0.0655 | 3.6392 | 3.6827 | 3.6710 | 3.7474 | 5.0264 | | |
| VEHOTHER | 303 | -0.0756 | -0.0336 | -0.0105 | -0.0063 | 0.0209 | 0.0039 | 0.1010 | 0.1920 | |
| V12 | 230 | -0.4068 | 0.0480 | -0.0835 | 1.2150 | -0.0091 | 0.2417 | 0.3782 | 0.2736 | 11.4842 |
| LOCAL | 304 | -0.0272 | 0.1977 | -0.2577 | -0.6480 | -0.1572 | -0.3629 | 0.2262 | 0.1279 | 0.5151 |

```
L_BUY     320       0.0020       0.0054       0.0071       0.0119       0.0022      -0.0020
-0.0004      -0.0001       0.0092


                  LOCAL        L_BUY
                    304          320

LOCAL     304      4.5095
L_BUY     320     -0.0024       0.0012


LINEAR TERM       74.1016      71.6683      70.6491       4.0965      -0.0028       3.1845
0.1285       0.9309       2.0723
                  -4.0412       0.4191       8.6269      15.5176       8.7054      10.7574
10.4093       0.3264      26.7765
                   8.9687       0.1654

CONSTANT =    -67.535


COEFFICIENTS FOR GROUP B1
------------------------------

QUADRATIC TERM

                  PROFIT      NONPROF      LOCGOV      NUMEMP      TOTVEH      LNTOT       BUY
TYPE2        TYPE3
                     275          276         277         290         313         315
319          280          281

PROFIT    275     11.4778
NONPROF   276      9.8305     17.9985
LOCGOV    277      8.6440      8.8150     10.9325
NUMEMP    290     -0.1450     -0.0801     -0.2565      0.5029
TOTVEH    313     -0.0001     -0.0001     -0.0001     -0.0000      0.0000
LNTOT     315      0.4668      0.5661      0.2741     -0.1102     -0.0002      0.3770
BUY       319      0.0120      0.0089      0.0028      0.0012     -0.0000     -0.0009
0.0004
TYPE2     280     -1.3140     -0.7351      0.0619     -0.1156      0.0001     -0.1180
0.0052       9.9324
TYPE3     281     -1.8067     -0.5621      0.1602      0.1561     -0.0001      0.0508
-0.0034      1.5657      27.2139
TYPE4     282     -1.5005     -1.5407     -0.1491      0.1020     -0.0010      0.1329
-0.0023      1.0339       1.5010
TYPE5     283     -1.5622     -0.5913     -0.0258      0.1241     -0.0002     -0.0074
0.0029       1.3739       1.2971
CARWAG    291      1.0902     -0.1797      0.5601     -0.1953      0.0001     -0.0007
0.0087      -0.3072      -0.5241
MINIVAN   292      0.1956     -1.8758      0.3655     -0.0893     -0.0002      0.3897
0.0050      -0.7908       0.2160
FULLVAN   293     -0.3317     -0.6266     -0.2708     -0.2092     -0.0000      0.0468
0.0033      -0.2643       0.3538
```

```
CPICK    294       0.3842      -0.1743       0.0368      -0.0375       0.0000       0.0484
-0.0011      -0.8202      -0.2912
FSPICK   295       0.6855      -0.4064      -0.4325      -0.0417       0.0000       0.0300
-0.0004      -0.3120      -1.8446
VEHOTHER 303      -0.2396      -0.1500       0.0520      -0.0644      -0.0000      -0.0350
0.0000       0.1148       0.1153
V12      230       0.0906      -0.7783      -0.1911       0.1522      -0.0001       0.0314
-0.0003      -0.4236       0.4229
LOCAL    304       1.0746       0.2992      -0.2402       0.1463       0.0002       0.0410
0.0045       0.0887       0.8684
L_BUY    320       0.0069       0.0105       0.0052      -0.0002      -0.0000       0.0000
0.0003      -0.0050      -0.0271


                TYPE4        TYPE5        CARWAG       MINIVAN      FULLVAN      CPICK
FSPICK       VEHOTHER     V12
                    282          283          291          292          293          294
295          303          230

TYPE4    282      18.9847
TYPE5    283       1.7354       5.6962
CARWAG   291      -0.3836      -0.5295       5.4810
MINIVAN  292       0.3602      -0.1637       3.7595      19.2969
FULLVAN  293       0.3322      -0.0698       3.5936       3.7184       7.4515
CPICK    294      -1.3648      -1.7861       3.5569       3.7008       3.4735       8.5048
FSPICK   295      -0.9956      -0.3211       3.5393       3.5009       3.4430       3.5069
5.8735
VEHOTHER 303      -0.0164       0.0951      -0.0288      -0.0492       0.0278      -0.0491
0.0066       0.0928
V12      230      -0.6019       0.0205       0.0520       0.4957      -0.1765       0.0614
0.3551       0.0777       2.9529
LOCAL    304       0.3076      -0.0896       0.2319      -0.6658      -0.2667      -0.4951
-0.0159      -0.0680       0.3558
L_BUY    320       0.0023       0.0037       0.0003      -0.0030      -0.0080      -0.0069
-0.0100      -0.0002      -0.0041


                LOCAL        L_BUY
                    304          320

LOCAL    304       4.8913
L_BUY    320       0.0030       0.0008


LINEAR TERM        25.6555      22.1351      18.2375       1.8975      -0.0015       2.9934
0.0924       -1.5835       1.2843
                   -0.8167       0.2746       9.0016       9.8714       5.2085       5.7862
7.7690       -0.4673       6.4214
                   11.7876       0.0568

CONSTANT =    -32.503
```

COEFFICIENTS FOR GROUP B2

------------------------------

QUADRATIC TERM

| | | PROFIT 275 | NONPROF 276 | LOCGOV 277 | NUMEMP 290 | TOTVEH 313 | LNTOT 315 | BUY 319 | TYPE2 280 | TYPE3 281 |
|---|---|---|---|---|---|---|---|---|---|---|
| PROFIT | 275 | 8.1478 | | | | | | | | |
| NONPROF | 276 | 6.5344 | 11.1206 | | | | | | | |
| LOCGOV | 277 | 5.9907 | 5.9164 | 8.1171 | | | | | | |
| NUMEMP | 290 | -0.0575 | -0.1415 | -0.1227 | 0.6874 | | | | | |
| TOTVEH | 313 | -0.0001 | -0.0000 | 0.0000 | 0.0000 | 0.0000 | | | | |
| LNTOT | 315 | 0.2612 | 0.2510 | -0.0634 | -0.1963 | -0.0001 | 0.5124 | | | |
| BUY | 319 | 0.0024 | -0.0012 | -0.0038 | 0.0024 | -0.0000 | -0.0004 | 0.0006 | | |
| TYPE2 | 280 | -1.4965 | -0.3064 | 0.0200 | -0.3084 | 0.0000 | 0.1182 | 0.0094 | 7.2439 | |
| TYPE3 | 281 | -1.5956 | -0.3404 | 0.0465 | 0.3574 | 0.0001 | -0.2646 | 0.0034 | 1.4114 | 11.1086 |
| TYPE4 | 282 | -1.0348 | -2.7650 | 0.1355 | 0.2178 | 0.0000 | -0.1942 | -0.0016 | 0.8560 | 1.0428 |
| TYPE5 | 283 | -1.6003 | -0.9113 | -0.0928 | 0.1788 | 0.0000 | 0.0322 | 0.0138 | 1.6604 | 1.5466 |
| CARWAG | 291 | 0.5175 | 0.1269 | -0.1300 | -0.0795 | -0.0000 | -0.0579 | 0.0057 | -0.4599 | 0.2170 |
| MINIVAN | 292 | 0.7729 | -0.2318 | 1.1550 | -0.1557 | 0.0000 | -0.0932 | 0.0169 | -0.0800 | 0.7509 |
| FULLVAN | 293 | 0.6198 | -0.0297 | 0.6667 | -0.0353 | -0.0000 | 0.1567 | 0.0041 | -0.2834 | 0.3394 |
| CPICK | 294 | 0.8650 | 0.3556 | 0.7521 | 0.0513 | -0.0000 | 0.0300 | 0.0050 | 0.1263 | 0.1717 |
| FSPICK | 295 | 0.2595 | 0.0389 | -0.1398 | 0.0354 | -0.0000 | 0.0234 | 0.0034 | -0.1149 | -0.1887 |
| VEHOTHER | 303 | -0.0963 | -0.0212 | 0.0467 | -0.0547 | 0.0000 | -0.0431 | 0.0004 | -0.0187 | 0.0639 |
| V12 | 230 | 0.2688 | 0.1293 | 0.4254 | 0.0254 | -0.0000 | 0.1861 | -0.0007 | 0.1946 | -0.3310 |
| LOCAL | 304 | 1.0390 | 0.6552 | -0.0622 | -0.0073 | -0.0000 | 0.0551 | 0.0003 | 0.1929 | 0.7804 |
| L_BUY | 320 | 0.0016 | -0.0013 | -0.0034 | 0.0010 | -0.0000 | 0.0018 | 0.0005 | 0.0043 | -0.0037 |

| | | TYPE4 282 | TYPE5 283 | CARWAG 291 | MINIVAN 292 | FULLVAN 293 | CPICK 294 | FSPICK 295 | VEHOTHER 303 | V12 230 |
|---|---|---|---|---|---|---|---|---|---|---|
| TYPE4 | 282 | 14.5915 | | | | | | | | |
| TYPE5 | 283 | 1.3607 | 9.7062 | | | | | | | |

```
CARWAG   291      0.2286      0.1949      6.3739
MINIVAN  292      1.0308      1.2947      4.4276     18.2224
FULLVAN  293     -0.4666     -0.0915      4.0784      4.2864      8.8296
CPICK    294      0.3851      0.1592      4.2419      4.3496      4.2023      8.6248
FSPICK   295     -0.4144      0.1120      4.2376      4.0850      4.1018      4.1442
5.7523
VEHOTHER 303     -0.1030     -0.0380     -0.0428      0.0151      0.0058     -0.0583
0.0498     0.1157
V12      230      0.0251     -0.2121     -0.3684     -0.1646      0.0568     -0.1864
-0.2159     0.1354     4.6409
LOCAL    304     -0.7946     -1.0226     -0.4724     -0.7627      0.2735     -0.0197
-0.1992     0.0153      0.2479
L_BUY    320     -0.0031      0.0060      0.0139      0.0128      0.0099      0.0126
0.0121     -0.0001      0.0021


                  LOCAL       L_BUY
                    304         320

LOCAL    304      5.0991
L_BUY    320      0.0006      0.0012


LINEAR TERM       17.4692     14.6043     11.4216      2.1913     -0.0008      3.3800
0.1244      1.3709      1.5786
                 -2.3030      1.4948      7.7366     10.0787     11.5929     10.8457
9.0072     -0.0660     10.3595
                 10.4379      0.1417

CONSTANT =    -33.773


COEFFICIENTS FOR GROUP A
------------------------------

QUADRATIC TERM

                  PROFIT     NONPROF      LOCGOV      NUMEMP      TOTVEH       LNTOT        BUY
TYPE2       TYPE3
                    275         276         277         290         313         315
319         280         281

PROFIT   275     38.0665
NONPROF  276     37.8852     55.6004
LOCGOV   277     36.1795     36.7728     51.8845
NUMEMP   290     -0.0841     -0.7121     -0.6277      1.0481
TOTVEH   313      0.0688      0.0681      0.0727      0.0005      0.0007
LNTOT    315     -1.7375     -1.4018     -2.1918     -0.1660     -0.0289      1.9370
BUY      319      0.0088      0.0033     -0.0004     -0.0006     -0.0000     -0.0009
0.0007
TYPE2    280     -1.4615     -0.4648     -0.3345     -0.6999     -0.0072      0.4569
0.0050     7.4577
TYPE3    281     -0.2729      0.5100      0.4790     -0.1289      0.0027      0.0329
-0.0020      0.9806      5.8938
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TYPE4 | 282 | -3.0113 | -8.9501 | -1.9014 | 0.4704 | -0.0104 | 0.1798 | -0.0050 | 0.2909 | 0.4941 |
| TYPE5 | 283 | -0.2141 | 0.1783 | 0.6477 | -0.1494 | 0.0048 | 0.0375 | 0.0026 | 1.0269 | 0.8249 |
| CARWAG | 291 | -0.1278 | -1.2260 | -0.6303 | -0.2050 | -0.0083 | 0.3009 | 0.0083 | 0.4032 | 0.6976 |
| MINIVAN | 292 | -3.7461 | -3.8571 | -2.6328 | -0.5201 | -0.0314 | 1.2411 | -0.0048 | 1.2548 | 0.9122 |
| FULLVAN | 293 | -0.0361 | -0.8242 | -0.0887 | 0.0368 | -0.0014 | 0.1239 | -0.0018 | 0.3004 | 0.7804 |
| CPICK | 294 | 1.2110 | -0.0370 | 1.0638 | 0.0359 | 0.0019 | 0.1608 | -0.0005 | 0.0125 | 0.5186 |
| FSPICK | 295 | 0.5341 | 0.2084 | 0.7235 | -0.0568 | -0.0003 | 0.0793 | -0.0044 | 0.1751 | 0.4318 |
| VEHOTHER | 303 | -0.2648 | -0.0968 | -0.1769 | -0.0794 | -0.0031 | 0.0078 | 0.0003 | -0.1491 | -0.0224 |
| V12 | 230 | -4.6595 | -6.2173 | -3.0954 | 0.8961 | -0.0056 | -0.0177 | -0.0030 | -0.6307 | -0.4318 |
| LOCAL | 304 | 0.8981 | 1.8652 | 0.1335 | 0.0713 | 0.0028 | -0.1303 | 0.0045 | -0.0921 | 0.3257 |
| L_BUY | 320 | 0.0079 | 0.0118 | -0.0073 | -0.0010 | 0.0000 | -0.0010 | 0.0007 | 0.0059 | -0.0019 |

| | | TYPE4 282 | TYPE5 283 | CARWAG 291 | MINIVAN 292 | FULLVAN 293 | CPICK 294 | FSPICK 295 | VEHOTHER 303 | V12 230 |
|---|---|---|---|---|---|---|---|---|---|---|
| TYPE4 | 282 | 51.2636 | | | | | | | | |
| TYPE5 | 283 | 0.5337 | 4.4060 | | | | | | | |
| CARWAG | 291 | 1.7649 | -0.1196 | 5.9760 | | | | | | |
| MINIVAN | 292 | 2.2659 | -1.2682 | 3.9684 | 21.6122 | | | | | |
| FULLVAN | 293 | 0.1955 | -0.4376 | 3.2575 | 3.5577 | 7.0312 | | | | |
| CPICK | 294 | 1.6551 | -0.2246 | 3.3265 | 3.4112 | 3.3180 | 7.8078 | | | |
| FSPICK | 295 | 0.8554 | 0.0855 | 3.1681 | 3.2996 | 3.2092 | 3.2574 | 4.7246 | | |
| VEHOTHER | 303 | 0.0993 | -0.1835 | -0.0062 | 0.2202 | 0.0704 | 0.0116 | 0.0711 | 0.2941 | |
| V12 | 230 | 4.5705 | -0.0932 | 0.7834 | 2.2207 | 0.1109 | 0.4716 | -0.0209 | 0.1008 | 12.2114 |
| LOCAL | 304 | -1.0434 | -0.0310 | -0.3369 | -0.7765 | -0.0524 | -0.4100 | -0.3611 | 0.1132 | -0.1659 |
| L_BUY | 320 | -0.0054 | 0.0033 | 0.0049 | -0.0212 | -0.0060 | -0.0038 | -0.0049 | -0.0019 | -0.0081 |

| | | LOCAL 304 | L_BUY 320 |
|---|---|---|---|
| LOCAL | 304 | 4.1213 | |
| L_BUY | 320 | 0.0130 | 0.0015 |

```
LINEAR TERM      61.9134     59.6371     55.2875      4.0276     -0.0093      6.2433
0.1428      -1.3913     1.4474
                  5.4622      1.1306      9.4142      5.6090      7.1055     10.2916
6.5193      -0.1769    16.6067
                  8.6255      0.1408

CONSTANT =    -56.682


COEFFICIENTS FOR GROUP D
------------------------------

QUADRATIC TERM

                  PROFIT     NONPROF      LOCGOV      NUMEMP      TOTVEH       LNTOT        BUY
TYPE2         TYPE3
                     275         276         277         290         313         315
319           280          281

PROFIT   275      18.4709
NONPROF  276      17.3438     24.6903
LOCGOV   277      16.6089     16.7022     20.3902
NUMEMP   290       0.2931     -0.0136      0.0501      0.6870
TOTVEH   313       0.0018      0.0022      0.0015      0.0001      0.0000
LNTOT    315       0.0537     -0.0130     -0.2323     -0.2485     -0.0008      0.5500
BUY      319       0.0063      0.0014      0.0026      0.0003     -0.0000     -0.0008
0.0005
TYPE2    280      -1.2866     -0.5329     -0.0523     -0.5766      0.0001      0.0889
-0.0001      8.1441
TYPE3    281      -1.3000     -0.3381      0.0879     -0.2773     -0.0002      0.0801
-0.0083      1.1152     19.3443
TYPE4    282      -1.5685     -0.8440     -0.6302      0.0935     -0.0011      0.0371
-0.0126      0.7326      1.3290
TYPE5    283      -0.9984     -0.6275     -0.1368      0.0232     -0.0000     -0.0050
0.0021      0.8167      0.8076
CARWAG   291      -0.0474     -0.5917     -0.7992     -0.2882     -0.0004      0.1804
0.0055      0.0702      0.5439
MINIVAN  292       0.5549     -0.1676      0.8910     -0.5066     -0.0002      0.1935
0.0026     -0.0456      1.1782

FULLVAN  293      -0.4389     -1.2170     -0.4515     -0.2124     -0.0010      0.2529
0.0008      0.3828      1.1779
CPICK    294       0.4709      0.0498      0.1992      0.0705     -0.0002      0.0644
0.0024      0.1991      0.9109
FSPICK   295      -0.2248     -0.2401     -0.4937     -0.1762     -0.0002      0.0708
-0.0027      0.1119      0.3287
VEHOTHER 303      -0.1621     -0.1094      0.0503     -0.0576     -0.0002     -0.0406
0.0016      0.0690      0.0297
V12      230      -0.2193     -0.6628     -0.3488      0.1151     -0.0007      0.0127
0.0005     -0.0700     -0.3476
LOCAL    304       0.7057      0.5130      0.0458      0.0257     -0.0001      0.1066
-0.0023     -0.1596      0.1654
L_BUY    320       0.0049      0.0043      0.0068      0.0014     -0.0000     -0.0017
0.0004     -0.0141      0.0006
```

TYPE4 TYPE5 CARWAG MINIVAN FULLVAN CPICK
FSPICK VEHOTHER V12
282 283 291 292 293 294
295 303 230

TYPE4 282 34.5743
TYPE5 283 0.8621 4.1185
CARWAG 291 0.6225 0.1555 7.2432
MINIVAN 292 0.7699 -0.2417 5.1941 17.0028
FULLVAN 293 0.4025 -0.1095 5.0720 5.1147 9.4633
CPICK 294 0.7008 -0.9190 4.8515 5.0006 4.9904 8.9682
FSPICK 295 0.3704 0.0222 4.9769 5.0610 4.9077 4.8628
6.4921
VEHOTHER 303 -0.2489 0.0009 -0.0116 0.1075 -0.0089 0.0314
0.0738 0.1235
V12 230 0.2832 0.0847 0.3738 0.6222 -0.0539 0.1054
0.5102 0.2258 3.9595
LOCAL 304 0.1770 0.1415 0.2029 -0.1386 -0.2663 -0.3350
-0.0877 -0.0177 0.1463
L_BUY 320 -0.0026 0.0039 0.0055 0.0065 0.0004 0.0038
0.0003 0.0015 0.0023

LOCAL L_BUY
304 320

LOCAL 304 4.1057
L_BUY 320 -0.0010 0.0010

LINEAR TERM 37.9893 33.4533 31.5911 1.7944 -0.0037 2.7162
0.0854 -2.8190 -1.5378
-1.6908 0.5992 11.4437 11.7176 9.2168 11.3395
9.5694 0.2035 8.0991
8.7424 0.0887

CONSTANT = -36.814

QUADRATIC CLASSIFICATION MATRIX
------------------------------

| GROUP | PERCENT CORRECT | FREQ. | NUMBER OF CASES CLASSIFIED INTO GROUP - H1 | H2 | B1 | B2 | A | D |
|---|---|---|---|---|---|---|---|---|
| H1 | 27.3 | 231 | 63 | 12 | 9 | 9 | 115 | 23 |
| H2 | 9.4 | 520 | 47 | 49 | 12 | 18 | 350 | 44 |
| B1 | 22.0 | 232 | 52 | 7 | 51 | 19 | 49 | 54 |
| B2 | 16.8 | 441 | 96 | 17 | 28 | 74 | 147 | 79 |
| C | 81.0 | 279 | 17 | 8 | 2 | 7 | 226 | 19 |
| D | 26.6 | 319 | 45 | 19 | 21 | 15 | 134 | 85 |
| TOTAL | 27.1 | 2022 | 320 | 112 | 123 | 142 | 1021 | 304 |

PERCENTAGE MISCLASSIFIED = 72.90
ERROR RATE (COUNTING PRIOR PROB.) = 72.90 PERCENT

WILKS TEST OF EQUALITY OF GROUP MEANS
-----------------------------------

| | | | |
|---|---|---|---|
| U-STATISTIC (WILKS LAMBDA) | 0.73309 | DEGREES OF FREEDOM | 20 5 2016 |
| APPROXIMATE F-STATISTIC | 6.40503 | DEGREES OF FREEDOM | 100 9747.08 |
| P-VALUE FOR F-STATISTIC = | 0.00000 | | |

PAIRWISE TEST OF EQUALITY OF GROUP MEANS
-------- ---- -- -------- -- ----- -----

F VALUES
- ------

| | | H1 1 | H2 2 | B1 3 | B2 4 | A 5 | D 6 |
|---|---|---|---|---|---|---|---|
| H1 | 1 | 0.0000 | | | | | |
| H2 | 2 | 1.9496 | 0.0000 | | | | |
| B1 | 3 | 5.2353 | 14.6563 | 0.0000 | | | |
| B2 | 4 | 4.9407 | 12.1783 | 5.1761 | 0.0000 | | |
| C | 5 | 3.2208 | 1.7916 | 15.4972 | 12.8300 | 0.0000 | |
| D | 6 | 0.8747 | 4.4873 | 4.3695 | 4.9689 | 5.5137 | 0.0000 |

NUMERATOR DEGREES OF FREEDOM = 20

DENOMINATOR DEGREES OF FREEDOM
----------- ------- -- -------

| | | H1 1 | H2 2 | B1 3 | B2 4 | A 5 | D 6 |
|---|---|---|---|---|---|---|---|
| H1 | 1 | 441 | | | | | |
| H2 | 2 | 730 | 1019 | | | | |
| B1 | 3 | 442 | 731 | 443 | | | |
| B2 | 4 | 651 | 940 | 652 | 861 | | |
| C | 5 | 489 | 778 | 490 | 699 | 537 | |
| D | 6 | 529 | 818 | 530 | 739 | 577 | 617 |

PROBABILITY VALUES
----------- ------

| | | H1 1 | H2 2 | B1 3 | B2 4 | A 5 | D 6 |
|---|---|---|---|---|---|---|---|
| H1 | 1 | 1.0000 | | | | | |
| H2 | 2 | 0.0078 | 1.0000 | | | | |
| B1 | 3 | 0.0000 | 0.0000 | 1.0000 | | | |
| B2 | 4 | 0.0000 | 0.0000 | 0.0000 | 1.0000 | | |
| C | 5 | 0.0000 | 0.0179 | 0.0000 | 0.0000 | 1.0000 | |
| D | 6 | 0.6202 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000 |

TEST OF HOMOGENEITY OF COVARIANCE MATRICES
---- -- ----------- -- ---------- --------

-2*RHO*LOG(LAMBDA) = 7501.3  DF = 1050  P-VALUE = 0.00000

REFERENCE: ANDERSON, T. W. (1984), AN INTRODUCTION TO
MULTIVARIATE STATISTICAL ANALYSIS, PAGES 419-420.

## Discriminant Analysis for Model Structure 2

MEANS OF USED VARIABLES IN USED GROUPS

| | | H 1 | B 2 | A 3 |
|---|---|---|---|---|
| PROFIT | 275 | 0.8375 | 0.5557 | 0.9176 |
| NONPROF | 276 | 0.0466 | 0.0966 | 0.0323 |
| LOCGOV | 277 | 0.0999 | 0.2719 | 0.0323 |
| NUMEMP | 290 | 2.2237 | 2.7311 | 1.9211 |
| TOTVEH | 313 | 67.3555 | 270.5023 | 35.1255 |
| LNTOT | 315 | 3.2789 | 3.9075 | 3.1738 |
| BUY | 319 | 78.2304 | 74.7711 | 82.8136 |
| TYPE2 | 280 | 0.0852 | 0.0847 | 0.0860 |
| TYPE3 | 281 | 0.0839 | 0.0446 | 0.1039 |
| TYPE4 | 282 | 0.0160 | 0.0386 | 0.0108 |
| TYPE5 | 283 | 0.1398 | 0.0877 | 0.1541 |
| CARWAG | 291 | 0.1784 | 0.2838 | 0.2186 |
| MINIVAN | 292 | 0.0320 | 0.0371 | 0.0323 |
| FULLVAN | 293 | 0.1145 | 0.1189 | 0.1362 |
| CPICK | 294 | 0.1491 | 0.1144 | 0.1147 |
| FSPICK | 295 | 0.3862 | 0.3120 | 0.3369 |
| VEHOTHER | 303 | 1.1571 | 1.8039 | 0.6918 |
| V12 | 230 | 0.9228 | 0.8158 | 0.9462 |
| LOCAL | 304 | 0.8602 | 0.8633 | 0.8423 |
| L_BUY | 320 | 10.6272 | 9.4443 | 8.1362 |

STANDARD DEVIATIONS OF USED VARIABLES IN USED GROUPS

| | | H 1 | B 2 | A 3 |
|---|---|---|---|---|
| PROFIT | 275 | 0.3691 | 0.4973 | 0.2755 |
| NONPROF | 276 | 0.2109 | 0.2956 | 0.1770 |
| LOCGOV | 277 | 0.3000 | 0.4453 | 0.1770 |
| NUMEMP | 290 | 0.8947 | 1.1156 | 0.7963 |
| TOTVEH | 313 | 400.6781 | 2120.5146 | 48.5686 |

| | | | | |
|---|---|---|---|---|
| LNTOT | 315 | 1.0960 | 1.3934 | 0.8581 |
| BUY | 319 | 39.3533 | 41.8083 | 35.2925 |
| TYPE2 | 280 | 0.2794 | 0.2786 | 0.2809 |
| TYPE3 | 281 | 0.2774 | 0.2065 | 0.3057 |
| TYPE4 | 282 | 0.1255 | 0.1929 | 0.1033 |
| TYPE5 | 283 | 0.3470 | 0.2830 | 0.3617 |
| CARWAG | 291 | 0.3831 | 0.4512 | 0.4141 |
| MINIVAN | 292 | 0.1760 | 0.1893 | 0.1770 |
| FULLVAN | 293 | 0.3186 | 0.3239 | 0.3436 |
| CPICK | 294 | 0.3565 | 0.3185 | 0.3192 |
| FSPICK | 295 | 0.4872 | 0.4637 | 0.4735 |
| VEHOTHER | 303 | 2.1315 | 2.7522 | 1.4831 |
| V12 | 230 | 0.2671 | 0.3880 | 0.2260 |
| LOCAL | 304 | 0.3470 | 0.3438 | 0.3651 |
| L_BUY | 320 | 29.0588 | 27.6221 | 24.7201 |

QUADRATIC DISCRIMINANT ANALYSIS

COEFFICIENTS FOR GROUP H
-------------------------------

QUADRATIC TERM

| | | PROFIT | NONPROF | LOCGOV | NUMEMP | TOTVEH | LNTOT | BUY | TYPE2 | TYPE3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 275 | 276 | 277 | 290 | 313 | 315 | 319 | 280 | 281 |
| PROFIT | 275 | 33.4194 | | | | | | | | |
| NONPROF | 276 | 32.4545 | 43.5182 | | | | | | | |
| LOCGOV | 277 | 31.8322 | 31.8926 | 36.8707 | | | | | | |
| NUMEMP | 290 | -0.2021 | -0.5195 | -0.3066 | 0.9414 | | | | | |
| TOTVEH | 313 | 0.0000 | 0.0001 | 0.0001 | 0.0000 | 0.0000 | | | | |
| LNTOT | 315 | 0.6626 | 0.6530 | 0.2310 | -0.2706 | -0.0005 | 0.6669 | | | |
| BUY | 319 | 0.0066 | -0.0001 | -0.0009 | 0.0009 | 0.0000 | -0.0004 | 0.0006 | | |
| TYPE2 | 280 | -0.7179 | 0.1932 | 0.1958 | -0.3699 | 0.0003 | 0.1070 | 0.0009 | 7.0946 | |
| TYPE3 | 281 | -0.8523 | -0.5145 | -0.0011 | 0.1235 | 0.0001 | 0.0183 | -0.0006 | 0.9047 | 7.2604 |
| TYPE4 | 282 | -1.0982 | -2.2539 | -0.1732 | 0.0788 | 0.0001 | -0.0885 | -0.0047 | 0.7361 | 0.9803 |
| TYPE5 | 283 | -0.9947 | -0.4881 | -0.0892 | 0.1341 | 0.0002 | -0.1124 | 0.0028 | 0.8822 | 0.8402 |
| CARWAG | 291 | 0.7321 | -0.1338 | 0.3375 | -0.2783 | -0.0004 | 0.1422 | 0.0072 | -0.1141 | 0.2535 |
| MINIVAN | 292 | 1.3170 | 0.4642 | 1.6979 | -0.1988 | 0.0000 | 0.0539 | 0.0108 | 0.3716 | 0.6142 |
| FULLVAN | 293 | 0.2696 | -0.6906 | 0.3309 | -0.1733 | -0.0001 | 0.1888 | 0.0023 | 0.2968 | 0.5450 |
| CPICK | 294 | 1.4990 | 0.8008 | 1.2613 | -0.0687 | -0.0002 | 0.2888 | -0.0031 | 0.3530 | 0.2714 |
| [illegible] | [illegible] | [illegible].6302 | 0.5437 | 0.6473 | -0.0088 | -0.0001 | 0.0455 | -0.0009 | 0.1647 | -0.4889 |

```
VEHOTHER 303      -0.0816       0.0102       0.0670      -0.0544      -0.0001      -0.0602
0.0002      -0.0400     -0.0384
V12       230     -0.0500      -0.5198       0.3338       0.6945      -0.0005      -0.1099
-0.0055     -0.6541     -0.2683
LOCAL     304      0.4954       0.6030       0.1707       0.0552       0.0003      -0.0882
-0.0013      0.2778      0.2227
L_BUY     320      0.0092       0.0029       0.0076      -0.0004       0.0000      -0.0004
0.0005       0.0004      0.0021


                 TYPE4         TYPE5        CARWAG       MINIVAN      FULLVAN      CPICK
FSPICK       VEHOTHER     V12
                    282           283          291          292          293          294
295          303          230

TYPE4     282     32.7454
TYPE5     283      0.9914       4.6809
CARWAG    291      0.0824      -0.0727       6.7636
MINIVAN   292      0.4191       0.4398       3.8951      19.7852
FULLVAN   293      0.0199      -0.5463       3.7725       3.7685       8.2349
CPICK     294     -0.8242      -0.5662       3.6885       3.6532       3.8214       7.3356
FSPICK    295     -0.3039       0.0532       3.5706       3.5859       3.5581       3.6552
4.9740
VEHOTHER 303      -0.1183      -0.0514      -0.0045       0.0461      -0.0044       0.0200
0.0619       0.1485
V12       230     -0.6527      -0.2526       0.1335       0.5921       0.0212       0.2492
0.3052       0.2782      8.5894
LOCAL     304     -0.2854       0.0182      -0.1253      -0.2703      -0.0690      -0.1978
0.0865       0.0840      0.3520
L_BUY     320      0.0029       0.0034       0.0115       0.0107       0.0050       0.0016
0.0014      -0.0002     -0.0009


                 LOCAL         L_BUY
                   304           320

LOCAL     304      4.3481
L_BUY     320     -0.0010       0.0011

LINEAR TERM       71.3761      67.1472      66.0914       3.1696      -0.0031       3.9600
0.1104      -0.8162      0.5493
                  -3.7440      -0.5081       9.7014      12.3927       8.6383      11.4641
9.4205       0.2782     18.6118
                   8.7442       0.1229

CONSTANT =    -60.925
```

COEFFICIENTS FOR GROUP B
------------------------------

QUADRATIC TERM

| | | PROFIT | NONPROF | LOCGOV | NUMEMP | TOTVEH | LNTOT | BUY | TYPE2 | TYPE3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 275 | 276 | 277 | 290 | 313 | 315 | 319 | 280 | 281 |
| PROFIT | 275 | 8.8634 | | | | | | | | |
| NONPROF | 276 | 7.2988 | 12.6137 | | | | | | | |
| LOCGOV | 277 | 6.5715 | 6.5665 | 8.6577 | | | | | | |
| NUMEMP | 290 | -0.0987 | -0.1050 | -0.1587 | 0.5938 | | | | | |
| TOTVEH | 313 | -0.0001 | -0.0000 | -0.0000 | 0.0000 | 0.0000 | | | | |
| LNTOT | 315 | 0.3287 | 0.3499 | 0.0557 | -0.1632 | -0.0001 | 0.4212 | | | |
| BUY | 319 | 0.0059 | 0.0023 | -0.0017 | 0.0019 | -0.0000 | -0.0008 | 0.0005 | | |
| TYPE2 | 280 | -1.3684 | -0.3689 | -0.0037 | -0.1841 | 0.0000 | 0.0351 | 0.0061 | 7.5694 | |
| TYPE3 | 281 | -1.6329 | -0.3689 | 0.0590 | 0.3072 | 0.0001 | -0.1672 | 0.0006 | 1.3991 | 13.5889 |
| TYPE4 | 282 | -1.0786 | -2.5526 | 0.0421 | 0.1449 | -0.0001 | -0.1717 | -0.0031 | 0.8519 | 1.1327 |
| TYPE5 | 283 | -1.5056 | -0.7195 | -0.0667 | 0.1373 | 0.0000 | -0.0207 | 0.0078 | 1.4322 | 1.4313 |
| CARWAG | 291 | 0.6801 | 0.0945 | 0.1078 | -0.1362 | -0.0000 | -0.0128 | 0.0064 | -0.4058 | -0.0133 |
| MINIVAN | 292 | 0.6897 | -0.5772 | 0.9253 | -0.1478 | -0.0000 | 0.1088 | 0.0115 | -0.3550 | 0.4321 |
| FULLVAN | 293 | 0.2890 | -0.2275 | 0.3670 | -0.1181 | -0.0000 | 0.1085 | 0.0035 | -0.2738 | 0.2930 |
| CPICK | 294 | 0.7756 | 0.2863 | 0.5779 | 0.0073 | -0.0000 | 0.0450 | 0.0017 | -0.1962 | -0.1073 |
| FSPICK | 295 | 0.3670 | -0.0230 | -0.1605 | -0.0148 | -0.0000 | 0.0429 | 0.0011 | -0.1880 | -0.6146 |
| VEHOTHER | 303 | -0.1506 | -0.0578 | 0.0476 | -0.0635 | 0.0000 | -0.0420 | 0.0003 | 0.0483 | 0.0904 |
| V12 | 230 | 0.2026 | -0.1362 | 0.1925 | 0.1043 | -0.0000 | 0.0918 | -0.0007 | -0.1256 | -0.1503 |
| LOCAL | 304 | 0.9370 | 0.4640 | -0.2186 | 0.0684 | -0.0000 | 0.0765 | 0.0021 | 0.1589 | 0.8379 |
| L_BUY | 320 | 0.0038 | 0.0023 | -0.0006 | 0.0004 | -0.0000 | 0.0006 | 0.0004 | 0.0000 | -0.0090 |

| | | TYPE4 | TYPE5 | CARWAG | MINIVAN | FULLVAN | CPICK | FSPICK | VEHOTHER | V12 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 282 | 283 | 291 | 292 | 293 | 294 | 295 | 303 | 230 |
| TYPE4 | 282 | 14.9698 | | | | | | | | |

```
TYPE5    283      1.0805      7.3678
CARWAG   291      0.1150     -0.1305      5.8098
MINIVAN  292      0.7994      0.5789      4.0626     18.1455
FULLVAN  293     -0.1489     -0.0327      3.8334      4.0688      8.1164
CPICK    294     -0.0767     -0.6931      3.8539      3.8971      3.8108      8.2760
FSPICK   295     -0.4872     -0.0394      3.8089      3.7516      3.7396      3.7580
5.5227
VEHOTHER 303     -0.0805      0.0197     -0.0313      0.0004      0.0122     -0.0448
0.0433      0.1013
V12      230     -0.1919     -0.0060     -0.1878      0.0828     -0.0822     -0.1161
-0.0227     0.1195      3.7193
LOCAL    304     -0.2295     -0.5032     -0.2004     -0.6964      0.0367     -0.1102
-0.1450     -0.0137     0.2675
L_BUY    320     -0.0024      0.0040      0.0075      0.0059      0.0012      0.0036
0.0022      -0.0001     -0.0006


                  LOCAL       L_BUY
                    304         320

LOCAL    304      4.8292
L_BUY    320      0.0018      0.0010

LINEAR TERM      19.3575     16.6096     12.9419      2.0242     -0.0008      2.8732
0.1031      0.0869      1.4659
                 -2.4162      0.7021      8.0009      9.9492      8.7577      8.8455
8.1266      -0.2273     8.1992
                 10.7776      0.0948

CONSTANT =    -30.754


COEFFICIENTS FOR GROUP A
-------------------------------

QUADRATIC TERM

                 PROFIT      NONPROF     LOCGOV      NUMEMP      TOTVEH      LNTOT       BUY
TYPE2       TYPE3
                    275         276         277         290         313         315
319         280         281

PROFIT   275     38.0665
NONPROF  276     37.8852     55.6004
LOCGOV   277     36.1795     36.7728     51.8845
NUMEMP   290     -0.0841     -0.7121     -0.6277      1.0481
TOTVEH   313      0.0688      0.0681      0.0727      0.0005      0.0007
LNTOT    315     -1.7375     -1.4018     -2.1918     -0.1660     -0.0289      1.9370
BUY      319      0.0088      0.0033     -0.0004     -0.0006     -0.0000     -0.0009
0.0007
TYPE2    280     -1.4615     -0.4648     -0.3345     -0.6999     -0.0072      0.4569
0.0050      7.4577
TYPE3    281     -0.2729      0.5100      0.4790     -0.1289      0.0027      0.0329
-0.0020     0.9806      5.8938
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TYPE4 | 282 | -3.0113 | -8.9501 | -1.9014 | 0.4704 | -0.0104 | 0.1798 | -0.0050 | 0.2909 | 0.4941 |
| TYPE5 | 283 | -0.2141 | 0.1783 | 0.6477 | -0.1494 | 0.0048 | 0.0375 | 0.0026 | 1.0269 | 0.8249 |
| CARWAG | 291 | -0.1278 | -1.2260 | -0.6303 | -0.2050 | -0.0083 | 0.3009 | 0.0083 | 0.4032 | 0.6976 |
| MINIVAN | 292 | -3.7461 | -3.8571 | -2.6328 | -0.5201 | -0.0314 | 1.2411 | -0.0048 | 1.2548 | 0.9122 |
| FULLVAN | 293 | -0.0361 | -0.8242 | -0.0887 | 0.0368 | -0.0014 | 0.1239 | -0.0018 | 0.3004 | 0.7804 |
| CPICK | 294 | 1.2110 | -0.0370 | 1.0638 | 0.0359 | 0.0019 | 0.1608 | -0.0005 | 0.0125 | 0.5186 |
| FSPICK | 295 | 0.5341 | 0.2084 | 0.7235 | -0.0568 | -0.0003 | 0.0793 | -0.0044 | 0.1751 | 0.4318 |
| VEHOTHER | 303 | -0.2648 | -0.0968 | -0.1769 | -0.0794 | -0.0031 | 0.0078 | 0.0003 | -0.1491 | -0.0224 |
| V12 | 230 | -4.6595 | -6.2173 | -3.0954 | 0.8961 | -0.0056 | -0.0177 | -0.0030 | -0.6307 | -0.4318 |
| LOCAL | 304 | 0.8981 | 1.8652 | 0.1335 | 0.0713 | 0.0028 | -0.1303 | 0.0045 | -0.0921 | 0.3257 |
| L_BUY | 320 | 0.0079 | 0.0118 | -0.0073 | -0.0010 | 0.0000 | -0.0010 | 0.0007 | 0.0059 | -0.0019 |

| | | TYPE4 | TYPE5 | CARWAG | MINIVAN | FULLVAN | CPICK | FSPICK | VEHOTHER | V12 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 282 | 283 | 291 | 292 | 293 | 294 | 295 | 303 | 230 |
| TYPE4 | 282 | 51.2636 | | | | | | | | |
| TYPE5 | 283 | 0.5337 | 4.4060 | | | | | | | |
| CARWAG | 291 | 1.7649 | -0.1196 | 5.9760 | | | | | | |
| MINIVAN | 292 | 2.2659 | -1.2682 | 3.9684 | 21.6122 | | | | | |
| FULLVAN | 293 | 0.1955 | -0.4376 | 3.2575 | 3.5577 | 7.0312 | | | | |
| CPICK | 294 | 1.6551 | -0.2246 | 3.3265 | 3.4112 | 3.3180 | 7.8078 | | | |
| FSPICK | 295 | 0.8554 | 0.0855 | 3.1681 | 3.2996 | 3.2092 | 3.2574 | 4.7246 | | |
| VEHOTHER | 303 | 0.0993 | -0.1835 | -0.0062 | 0.2202 | 0.0704 | 0.0116 | 0.0711 | 0.2941 | |
| V12 | 230 | 4.5705 | -0.0932 | 0.7834 | 2.2207 | 0.1109 | 0.4716 | -0.0209 | 0.1008 | 12.2114 |
| LOCAL | 304 | -1.0434 | -0.0310 | -0.3369 | -0.7765 | -0.0524 | -0.4100 | -0.3611 | 0.1132 | -0.1659 |
| L_BUY | 320 | -0.0054 | 0.0033 | 0.0049 | -0.0212 | -0.0060 | -0.0038 | -0.0049 | -0.0019 | -0.0081 |

| | | LOCAL | L_BUY |
|---|---|---|---|
| | | 304 | 320 |
| LOCAL | 304 | 4.1213 | |
| L_BUY | 320 | 0.0130 | 0.0015 |

```
LINEAR TERM      61.9134     59.6371     55.2875      4.0276     -0.0093      6.2433
0.1428     -1.3913      1.4474
                 5.4622      1.1306      9.4142      5.6090      7.1055     10.2916
6.5193     -0.1769     16.6067
                 8.6255      0.1408

CONSTANT =    -56.510
```

QUADRATIC CLASSIFICATION MATRIX
------------------------------

| GROUP | PERCENT CORRECT | FREQ. | NUMBER OF CASES CLASSIFIED INTO GROUP - H | B | A |
|---|---|---|---|---|---|
| A | 20.9 | 751 | 157 | 108 | 486 |
| B | 44.7 | 673 | 166 | 301 | 206 |
| C | 84.9 | 279 | 22 | 20 | 237 |
| TOTAL | 40.8 | 1703 | 345 | 429 | 929 |

PERCENTAGE MISCLASSIFIED = 59.19

ERROR RATE (COUNTING PRIOR PROB.) = 59.19 PERCENT

WILKS TEST OF EQUALITY OF GROUP MEANS
-------------------------------------

```
U-STATISTIC (WILKS LAMBDA)    0.76346   DEGREES OF FREEDOM   20    2 1700
APPROXIMATE F-STATISTIC      12.14339   DEGREES OF FREEDOM   40 3362.00
P-VALUE FOR F-STATISTIC =     0.00000
```

PAIRWISE TEST OF EQUALITY OF GROUP MEANS
-------- ---- -- -------- -- ----- -----

F VALUES
- ------

| | | H 1 | B 2 | A 3 |
|---|---|---|---|---|
| A | 1 | 0.0000 | | |
| B | 2 | 17.1348 | 0.0000 | |
| C | 3 | 2.5062 | 17.2881 | 0.0000 |

NUMERATOR DEGREES OF FREEDOM = 20

DENOMINATOR DEGREES OF FREEDOM
----------- ------- -- -------

| | | H 1 | B 2 | A 3 |
|---|---|---|---|---|
| A | 1 | 1481 | | |
| B | 2 | 1403 | 1325 | |
| C | 3 | 1009 | 931 | 537 |

PROBABILITY VALUES
----------- ------

| | | H 1 | B 2 | A 3 |
|---|---|---|---|---|
| A | 1 | 1.0000 | | |
| B | 2 | 0.0000 | 1.0000 | |
| C | 3 | 0.0003 | 0.0000 | 1.0000 |

TEST OF HOMOGENEITY OF COVARIANCE MATRICES
---- -- ----------- -- ---------- --------

-2*RHO*LOG(LAMBDA) = 5390.0 DF = 420 P-VALUE = 0.00000