LIFE STYLE AS A FACTOR IN EXPLAINING TRAVEL BEHAVIOR

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Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

at the

Massachusetts Institute of Technology

November, 1980
(i.e. February, 1981)

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Abstract

The purpose of this thesis is to explore the utilization of the concept of life style in travel behavior models. Life style is defined as a pattern of behavior which conforms to an individual's orientations toward household formation, participation in the labor force and utilization of leisure, and to the available resources.

The concept of life style is developed within a framework of a choice hierarchy in which individuals are assumed to make long term decisions which guide their preferred pattern of daily behavior or life style and, as such, their mobility and travel choices. Thus, it becomes a natural candidate for accounting for taste variations across individuals in models of travel choices. The hypothesis that life style is an improved representation of the traveller as compared with representation by independent cross-sectional socio-economic and demographic attributes is tested.

The operationalization of the concept is attempted within the framework of data commonly available to transportation planners. Using an array of variables indicative of life styles, groups of households are identified based on multi-dimensional similarity. The hypothesis that these life style groups have different tastes and preferences with regard to travel choice is tested by comparing the estimated coefficients of models of mode and destination choice for shopping trips among the groups, and the hypothesis that the life style concept is advantageous over other methods used to date is tested by comparing the performance of the travel models employing the life style concept and the other models.

The empirical results demonstrate that market segmentation based on the life style concept as defined in this study is an improved representation of travellers compared with some other segmentation schemes based on socio-economic characteristics. As life styles are expected to become important social differentiation traits, substituting for social class and status, the findings of this study offer a planning tool which is sensitive to newly emerging social processes such as the increase in women's participation in the labor force, increasing levels of education and others.

Beyond the improved accounting for taste variations among population groups, the study points at the relevance of life style groups as target groups for policies which may achieve desired transportation and environmental objectives. Also, some general conclusions about the use of market segmentation for travel demand analysis are pointed out.

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ACKNOWLEDGMENTS

Undertaking research on as vague a concept as life style requires two types of input from the outside: encouragement and criticism. A number of people have provided me with these along the period of this research.

Professor Marvin Manheim, who co-supervised this thesis, was a source of encouragement and support from the initial stages of the topic formulation through the final touches that this report required. Much criticism and fruitful discussion with him helped me stay on course. Professor Moshe Ben-Akiva, who also co-supervised the thesis, was extremely helpful in constructing the conceptual as well as the analytical segments of this study. To both I feel in debt.

Together with Professors Steven Lerman and David Segal, the members of my doctoral committee were very helpful in formulating some of the ideas brought forth in this thesis and critically commenting on earlier drafts, forcing me to exercise reasoning and precision.

A different source of invaluable inspiration was received from long discussions with fellow students and friends, Nicolaos Litinas and Sergio Gonzalez. Victor Prins and Robert Wolfe were of help in smoothing out my working relationships with the computer at the initial steps of analysis.

Still another form of assistance without which this thesis could not have been written was obtained from the administrative staff: Annie Cooper, Paula Adelman and Gil High, and the patient typing and retyping and retyping...by Linda Shevchuk.

To all I wish to extend my thanks.

John Hidinger, Director of the Environmental Protection Agency, Office of Transportation and Land Use Policy, Gary Hawthorne, Chief of the Transportation Branch, and Brian McLane of that office provided support, encouragement and interest in developing a sounder theoretical and empirical base for environmental policy decisions.

Finally, I would like to express my appreciation to my mother and my late father for enabling me to get to this point, and a special appreciation to three very dear people - Micky, Roy and Nir - who in a combined effort have allowed me to carry through this work and have proven that new life styles are emerging. This thesis is dedicated to them.

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"I see nobody on the road" said Alice.

"I only wish *I* had such eyes," the King remarked in a fretful tone. "To be able to see Nobody! And at that distance too! Why, its as much as *I* can do to see real people, by this light!"

All this was lost on Alice, who was still looking intently along the road, shading her eyes with one hand. "I see somebody now!" she exclaimed at last. "But he's coming very slowly - and what curious attitudes he goes into!" (For the messenger kept skipping up and down, and wriggling like an eel, as he came along, with his great hands spread out like fans on each side.)

"Not at all", said the King. "He's an Anglo Saxon Messenger - and those are Anglo Saxon attitudes."

Lewis Carrol, Through the Looking Glass
1871

Chapter 1: Introduction

This study is concerned with the representation of the human being in models of travel and behavior. Transportation planning and policy analysis today require a deeper understanding of the individual decision maker than in the period which ended in the mid 1960's. This is not to imply that in earlier periods the role of the individual traveller was unimportant, but, that the focus of the transportation profession has changed.

For a number of decades since the automobile's popularization, the focus of the transportation profession was on accomodating the automobile by means of construction of roads and parking facilities. The transportation system was viewed essentially as a physical system consisting of networks and flows. That physical system imposed a variety of external costs on the physical environment, on the social environment, and on the economic system. Only when these costs became apparent and significant in magnitude and involved political costs too, was the narrow view of the physical system substituted with a broader system view. The mutually reinforcing increases in demand and supply for automobile use reached an upper bound from which further increases involve costs which at least some segments of the population are unwilling to accept. From that point in time the need to treat the transportation system as a complex one, interrelated with the total activity pattern, with all modes and with all other contextual dimensions which are affected by it, became necessary (Manheim, 1976). Accomodating the automobile was no longer the single objective of transportation planning.

The broader perception of the transportation system emphasized, among other things, that it is the human beings who demand mobility and who make decisions on how to fulfill their mobility needs by certain travel choices. It also emphasized the increased role of social, as well as managerial issues, in transportation planning, two additional examples which stress the importance of the understanding of people, inseparable from the physical system.

The development of the behavioral travel demand modeling approach facilitated the pursuit of analysis which is consistent with the new perspective. The travel behavior of the individual member of a sample population is the basic building block of this approach. In general terms, the approach postulates that an individual's behavior is the outcome of a choice among alternative options he or she is facing. Two factors are assumed to influence the choices made: the characteristics of the alternatives and the characteristics of the decision maker.

This study concentrates on the latter, attempting to identify an efficient representation of the decision maker in travel demand models, where efficiency is seen as the ratio between the explanatory power and the cost of obtaining the desired representation. The difference in choices made by different decision makers who are facing identical choice situations or sets of alternatives are attributed to differences in their tastes and to some random errors. To reduce the random component it is necessary to account for the variations in tastes or preference in an efficient manner. Traditionally this was done by controlling a number of socio-economic attributes such as income, household size, etc., assuming

that these capture variations in tastes.

This study assumes that the capability of a small number of socio-economic and demographic attributes to efficiently account for taste variations is limited and that, instead, the complexity of the human being should be represented by a construct which builds upon socio-economic and other attributes and integrates some of the complexity to become a higher level factor. Life style is hypothesized to be such a high-level factor.

Life styles in the United States are becoming the differentiating traits among individuals, substituting the traditional differentiation by income class or social status. Consequently, they become the natural choice for differentiation in modeling behavior. Moreover, life style embodies some theoretical concepts which make it advantageous to the current methods of representing the decision makers, independently of the diversity of life styles in the social environment.

As support to the claim that life styles are changing and becoming increasingly important a review of current trends in the urban society of the United States is provided.

The remainder of this introduction describes why the concept of life style was chosen as the topic of this study. The last two sections of this introduction present the research structure and a summary of its findings.

1.1 Why Life Style?

Despite its widespread colloquial use the concept of life style has received relatively little attention by behavioral scientists and there is no universal definition of it, let alone a theory of its role in behavior.

Building upon a review of previous studies, life style in this study is understood to be the "pattern of behavior which conforms to the orientation an individual has to the roles of family member, worker and consumer of leisure and to the constrained resources available".*

The merits of this concept are discussed throughout this study. At this point, via a brief review of how the study topic evolved, we would like to emphasize its major advantages over simple low level socio-economic variables such as income, education, etc.

The emerging phenomenon of relocation of middle and upper income groups to or near the city centers was the initial interest of this study. Long awaited by urbanists and environmentalists, such a process is expected to be beneficial to the environment. Therefore, examining changes in travel behavior and its related impacts on the environment were of interest. In looking into the relocation phenomenon it became obvious that the only way to efficiently characterize the relocating population is by life style. Neither income, nor occupation and employment status, nor family status fully describe the relocators. Rather it is a certain combination of these and other attributes which is characteristic of the relocators. Consequently, the need to deal with such a composite descriptor became apparent.

But not only the increasing importance of life styles as social factors motivated the choice of this concept. Inherent in this concept is a different functional form of representing the decision maker which is synoptic and integrative and therefore is probably advantageous to the

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* This definition is developed in Section 4.2 below.

commonly used descriptors. Most prominent is the fact that life style is a current representation of a long-range behavioral choice. While observed socio-economic and demographic attributes in and of themselves are instantaneous and allow only cross-sectional inference, the concept of life style "collapses" future objectives or preferences into the current behavior and hence the latter can be viewed in a consistent framework. Further, it is capable of capturing not only interdependence of time but also the interdependence of an individual on others in his or her own household as well as outside it. Thus, life style is believed to provide some more insight into causal relationships in behavior.

This thesis is an initial exploration into the concept of life style and its operationalization for the purpose of behavioral modeling in transportation. Improvement of both the theory and its operationalization are believed to further demonstrate the relevance of the concept to behavior and provide an important tool for understanding travel and mobility in a pluralistic society.

1.2 Research Structure

As, despite its common use, the notion of life style is not strictly defined in the social sciences, it became necessary at the outset to deal with life style at the conceptual level. Only after the role of the concept in a behavioral framework was identified was it possible to embark on an empirical attempt to identify the effects of life style on travel behavior.

The research is presented in three parts. Part One provides an introduction and background. Part Two presents the theory and application

of the life style concept as developed in this study and Part Three presents the empirical tests of integrating life style in travel behavior models.

The remaining chapters of this first part deal with the motivation and the literature review. Three major arguments have motivated this study. First is the observed trends in the urban scene, specifically in the United States but elsewhere as well, which seem to affect the style of life. Second, we assume there is an increasing importance for understanding and accounting for taste variations in modeling travel and mobility behavior. Thirdly, we share the quest for identifying causal relationships in observed behavior.

Chapter 3 reviews the previous research of relevance to this study. This includes a broad review of the conceptualization and application of life style in different social sciences. A review of the methods for accounting for taste variations in existing travel demand models constitutes the second part of Chapter 3.

The first chapter of Part Two deals with the theoretical development of the theory of life style in the framework of behavior. This requires first identifying the dimensions of behavior, specifically spatial behavior and the methods by which social scientists deal with them. The life style concept is then developed as a concept which facilitates the broadening of the accounted-for interactions among the dimensions of behavior. Also presented are the research hypotheses.

Chapter 5 deals with the operationalization of the life style concept developed in Chapter 4. It presents the general approach, practical as

well as theoretical considerations, and the statistical methodology applied.

Chapter 6 presents the empirical analysis of identifying life style groups by the use of cluster analysis.

In Part Three we present a short review of the theory of disaggregate travel demand models and describe the model of joint choice of mode and destination for shopping trips chosen for testing the hypotheses of this study.

Chapter 8 presents the empirical analysis of integrating the life style concept in the travel demand model. This analysis serves two objectives. It is a test of the research hypotheses as well as a prototypical application of the concept of life style as we conceive it.

In Chapter 9 an assessment of the results is first presented, followed by policy implications which can be drawn from the use of the life style concept, and concluding with some suggestions for further research.

1.3 Summary of Findings

This study represents an attempt to "extend" the use of the currently available disaggregate travel demand choice model by improving the capability of accounting for variations across individual decision makers. This is done under the premise that the existing framework and the typically available data are to be used.

Reviewing the literature on life style, its meaning, and possible operational applications has revealed that this concept may be powerful enough to account for tastes and preferences of an individual in a manner

consistent over time, interpersonal relationships, and dependence and intrapersonal attributes.

A theory is developed which proposes that life style is a choice made by individuals through the joint making of life decisions, namely, the decision on family formation, the decision on participation in the labor force, and the orientation toward leisure. This joint choice is suggested to be an extension of the choice hierarchy (Ben Akiva, 1973) concept, relating to decisions which have longer time span than the mobility decisions.

The conceptual definition of life style developed in this thesis provides a new form of representing travellers in behavioral choice models. The major advantage of this concept is the condensation of a number of dimensions of behavior into a single entity. Most clearly this condensation applies to the temporal dimension: life styles are the current pattern of behavior which results from an individual's long term objectives and conforms to these objectives.

Data readily available for travel demand analysis is used to operationalize the concept of life style. Although this type of data is far from being ideal for this purpose, groups of households which are similar along combinations of demographic, socio-economic and, in some cases, time budgets, were identified and assumed to represent life style groups.

Using market segmentation based on these life style groups models for the choice of mode and destination for shopping trips were estimated and the performance of the models is compared with that using other market segmentation schemes. The segmentation by life style performed slightly better tha

a scheme based on life cycle and occupation segmentation. Limitation of data, in terms of sample size, prohibited extensive analysis of some of the life style groups which were identified as very small segments but are assumed to be groups of interest for two reasons. First, they are hypothesized to have significantly different behavioral patterns (e.g., the young, career oriented, childless households) than those defined solely on the basis of socio-economic attributes. Second, some of these currently small groups are growing at a fast pace and will, in the near future, constitute significant proportions of the population. Consequently, the identification of such groups and the understanding of their behavior will become necessary for policy decisions. Despite the limitations, obvious differences among life style groups were identified, and some tentative policy implications are explored.

The exploratory nature of this work is thus strong enough to suggest further development of life style measurement and applications which will probably gain in importance in a society which is characterized by a growing diversity of life styles.

Chapter 2: Motivation

Utilizing the concept of life style was motivated by at least three separate arguments. The intuitive notion that the concept of life style can capture the wholeness of the human being is the main source of motivation. This issue is elaborated on throughout the theoretical discussion as well as the empirical analysis of this study and therefore will not be discussed here.

The second motivating force nourishes from observations on current trends in the urban society of the United States. Changes in the demographic and social structure as well as the effects of the rising energy cost and changing views on the value of the environment will all intensify in the next decade. Developments in information and communication technology are bringing about the popularization of devices which may alter the demand for mobility for both work and entertainment purposes. Also, for the first time the large urban areas in the United States are experiencing migration of middle and high income groups toward the city center. While it is impossible to predict the synergistic outcome of these trends, it is possible to state that they involve changes in life styles practiced by urban dwellers. Each of these trends is briefly reviewed in Section 2.1. Although we chose to describe the United States scene, some of these trends are also visible in other countries and cultures and some changes in life styles are evident, in varying paces, almost everywhere.

The third motivating force, closely interrelated with the first, is the growing importance of taste variations for the understanding of decision making. This issue is discussed in Section 2.2.

2.1 Current Trends in the Urban United States

In the 1980's, according to numerous scholars of America's urban system, we will witness the intensification of a number of trends which, in conjunction with continuing processes, may alter the pattern of urban activities and urban form. Early identification of these trends and their possible outcomes may allow the development of public policies intended to increase social benefits and ameliorate some of the urban problems which were so evident in the last two decades.

This chapter cannot provide an in-depth analysis of the relevant trends, nor can it forecast their synergistic effect. It will, though, point out some of these trends and implications they are thought to have. The objective of the chapter is to demonstrate that in the future, more than presently, the concept of life style used as a social factor will be of increasing importance for explaining and predicting spatial behavior.

The concept of life style is defined and broadly discussed in Chapters 4 and 5. At this point we will adhere to the definition as given in Section 1.1. "Spatial behavior" is defined and elaborated on in Section 4.1.

The major trends which affect urban activities fall within different formal disciplines and therefore the fact that they all concur in a common space, namely, the city, is only rarely acknowledged.* They include the closely interrelated demographic and social changes, the rising costs of energy and its consequences on the economy and the environmental cause,

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* A collection of papers combined to provide a broader view was recently published (Solomon, et. al., The Prospective City, 1980, MIT Press).

and the developments in information and communication technology. Obviously there are other on-going trends relevant to this context (e.g., the changing roles of federal, state and local governments) which we chose not to deal with as their relevance to the concept of life style is not direct.

2.1.1 Demographic Change*

Demographic trends are, in fact, the outcome of social, economic and natural processes acting on a population. Hence, the trends discussed in this section should be viewed in conjunction with the social and economic processes discussed below. Natural changes (e.g., natural disasters) can be ignored in this context.

The recent demographic changes and their possible impact on urban structure were analyzed by Alonso (1977). He points at the decline of household size, from 3.61 persons in 1940 to 3.14 persons in 1970 and 2.89 persons in 1976. The recent steep change has exceeded the population decline rate in metropolitan areas and therefore there is an increase in number of households. As every household requires a housing unit there is an increase in demand for housing space despite the total decline in metropolitan population. The increasing social acceptance of singleheaded family households is one factor that induces the decreasing of average household size as birth rates per household decline. The pattern of household structure is also rapidly changing. In the period of 1970 to 1976, the total United States population grew by 5%. The growth of different household types in that period is shown in Table 2.1.

* This section relies heavily on Alonso (1977).

Table 2.1 - Growth of Household Types in the U.S. 1970 - 1976

Type	Percent Change
Total Population	+ 5
Total Households	+15
Primary Families (1)	+ 9
Husband/Wife Families	+ 6
Male Single Head of Family	+16
Female Single Head of Family	+33
Primary Individuals (2)	+41
Individuals Living Alone	+38

(1) A Primary family is a group of people living in a household who are related by blood, marriage or adoption (U.S. Bureau of Census, 1970).

(2) Unrelated persons sharing a household.

Source: Alonso (1977)

Although at this state the dramatic increases in the latter four categories are in absolute number relatively small, they are becoming increasingly visible and acceptable.

The decrease in fertility even in husband-wife family households is also remarkable. It is a result of changing social views and greater availability of birth control information and technology. Table 2.2 summarizes these changes in the period 1960-1976. Although the informa-

tion may indicate two phenomena: a decrease in fertility and possibly a postponement of first marriage or childbearing, the former is also supported by information on birth rate. The issue of postponed childbearing is discussed in the following section.

Table 2.2 Women aged 20-24 and 25-29 by marital status, and childlessness, 1960, 1970, and 1976.

	Aged 20 - 24			Aged 25 - 29		
	1976	1970	1960	1976	1970	1960
Single	42.6	35.8	28.4	14.8	10.5	10.5
Married, childless	23.9	23.0	17.3	18.5	14.1	11.3
Married having born children	33.5	41.2	54.3	66.7	75.4	78.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Alonso (1977)

Another trend often mentioned is the growing proportion of elderly in the population. This is a result of both the above mentioned trends and the increase in life expectancy. In an attempt to analyze the effect of these trends on the future urban society and urban activity patterns it is necessary first to assess the endurance of these trends in the future. Given that these trends are largely affecting the now young

adult post-war baby-boom generation, one could speculate that the current phenomena are specifically related to the size of that generation. Alonso suggests the trends are permanent indications of a new social reality. He notes that they are consistent with previous trends, and comparable trends are occurring in other Western countries. It is unlikely, according to Alonso, that temporary local peculiarities are in effect and lastly, he claims that the changes are "deeply anchored and mutually reinforcing" (Alonso, 1977, p. 17).

One clear consequenee of these trends, as noted above, is the rising demand for housing which may be of smaller units and in multi-unit structures. More smaller dwelling units demanded by urbanites will probably involve some densification of urban residences, although not necessarily in the central city. This effect is suggested both by Alonso (1977) and Schafer (1978).

Further implication of these trends upon urban activity patterns will be discussed in the following section which deals with social trends.

2.1.2 Social Trends

An attempt to review the myriad of social processes occurring in American society in a framework of a chapter is presumptuous. Hence, this section will limit its scope to a few observations on those trends which are relevant to the concept of life style and spatial behavior.

In a most general perspective the trend toward pluralism is observed. The integration of an immigrant society into an American way of

life is no longer the prevailing orientation. The subcultures of ethnic groups and minorities are increasingly accepted by social norms and by public policies. Advocates of family policy have recently referred to the pluralism of family life as legitimately including "child-free couples, unmarried couples, single parent families, single person families, homosexual pairings, communal arrangements and, to fill in the gaps, assorted minority life styles" (Carlson, 1980).

Second is the observation made by sociologists that the role of economic factors as a basis for social stratification is diminishing as more social factors are assuming that role. Also, there is a diminishing sharpness of class differences and boundaries (Reed, 1976). This is consistent with Friedmann's (1973) view on the emergence of affinity environments.*

Probably the most prominent current social change is the role of women in the American society. The diversity of family or household forms has put women as heads of household by choice and not only by default (divorce or widdowing). Even within the traditional family form household the role of women is rapidly changing and becoming visible enough to be dealt with by both the media (e.g., see Newsweek's cover story "The Superwoman Squeeze", May 19, 1980) and researchers in different disciplines. The most widely addressed change is the increasing engagement of women in the labor force and particularly in professional and career-oriented tracks. But other changes, coinciding with the

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* Affinity environments are defined by Friedmann as: "...a spatially bounded social environment that is based on voluntary residential choice and characterized by a shared preference for salient attributes such as ethnicity, life style, income, occupation, age, family status and religion" (Friedmann, 1973, p. 64).

working status are at least as important and noteworthy.

The employment statistics demonstrate a sharp increase in the participation of women in the labor force. In the period 1970 to 1976, the total number of working women increased by 17% relative to 6% for men. A particularly sharp increase occurred within the group of mothers of young children (under 6 years old). Their participation rate increased from 12% in 1950 to 34% in 1975 (Alonso, 1977).

The increased participation in the labor force has a multitude of impacts on travel behavior. Most obvious is the addition of a work trip. Traditionally it has been thought that a woman is a "secondary worker" if she joins the labor force and therefore her search for employment is carried out once the primary worker work location and the residential location have been chosen (Kain, 1964). Dual career households' residential location decision can be expected to differ from single worker or primary/secondary worker households. The addition of a work trip also implies competition for travel means within the household. Currently, women have been observed to rely more on public transportation than men (Guiliano, 1979).

Several factors interact in creating this situation. More women are employed in high density areas and therefore have better access to public transportation. The reverse claim can also be made: given the lack of an automobile women seek employment in locations served by public transportation. It may also be a result of male dominance in the household. While disadvantaged in the availability of convenient travel means it has been repeatedly observed that working women still carry

a larger share of the household responsibilities than their male counterparts (Palm and Pred, 1974; Chapin and Logan, 1969; Vanek, 1974; Damm, 1978 and Maxwell, Rosenfeld and Spilerman, 1979).

Thus, working women experience a tighter space-time schedule and their mobility requirements are greater than their spouses. Women may adapt to these constraints in a number of ways. Common adaptations could be the purchase of an automobile, relocation of employment or residence, reducing out of home work load or utilizing flexible work schedule if available. A different type of adaptation, which involves higher level decisions (see Section 4.2) could be the change in family status, withdrawal from the labor market (Andrews, 1977) or change the activity pattern within the household, i.e., reassign responsibilities between the household members. We suggest labelling this latter type of adaptation as "life choices", defined as the longest range decision a person can make. (Life decisions include among others the choice of family form, the decision to enter the labor force and an orientation toward leisure. Further elaboration of this concept appears in Section 4.2.) At this point though, we would like to demonstrate that, as a result of the social trends, the range, visibility and acceptability of such adaptations has significantly widened.

The change in living arrangements has been shown above. Moreover, it is becoming increasingly acceptable for women (or families) to stay childless by choice (Marciano, 1978; Teicholz, 1978, Newsweek, January 14, 1980), or for men to assume a share of the household maintenance responsibilities which traditionally were done by women. So, the modern fem-

inine life style is not merely the participation in the labor force (Reynolds, Crask and Wells, 1977), but also the realization of once unacceptable roles in society.

Another social trend in the American society starting probably in the early 1970's is the growing distrust in government, at all levels, and a resultant growing involvement in public activism.* Options for activism range not only from passive participation to civil disobedience. Some causes create personal commitments to practice particular routine behaviors, such as travelling by non-polluting or energy efficient means, or avoiding the use of certain products. Whatever manner of activism is assumed, it is a time-consuming activity and requires movements as well. Time allocated to these types of public activities, by men and women alike, may be of increasing importance in understanding people and their spatial behavior in the future. Activism is also facilitated and encouraged by the open processes required by law for some types of decision making.

Before concluding the section on social trends it is important to stress that, at present, most of those trends are in effect only in small sections of the American society. In 1976 90% of the households still consisted of primary families (Alonso, 1977). The more liberal or better educated fractions are probably exposed to change much earlier than others. The visibility of the trends seems to exceed their realizations. Only two years ago Coleman (1978) had shown that in his sample of mid-Western families, a wife's decision to join the labor

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* While not able to support this point by specific reference, I argue that it exists and is noteworthy.

force was only in order to obtain more power in the family's financial decision making, indicating that personal growth and other liberation arguments were not present.

The future of these trends can only be speculated upon at this point in time. Yet, the implication of the current trends needs to be identified so that appropriate policies can be devised.

2.1.3 Rising Energy Costs

The oil embargo of 1973 has triggered a major effort by both governments and the research community to study various aspects of the energy problem, with the objectives of devising conservation measures, identifying the interaction of the energy problems with the various facets of life and development of alternative energy sources. It seems that the only point with which almost all of the vast body of research done since 1973 does not dispute is that there is and will be an increase in the real cost of energy. Beyond that, uncertainty prevails and there is a wide range of ideas as to the intensity of this and related impacts and even about the direction of some related trends. This section will briefly review some of the studies which relate the energy problems to urban activities.

The consumption of energy in the urban area is, mainly, in three activities: transportation, space heating and cooling, and economic activities. The first two account for 25 and 20 percent of the national consumption, respectively (Harwood, 1977).

In dealing with the energy crisis it is necessary to distinguish

between two situations: a short term crisis and a long term one. The first may result from a war or a particular political or economic configuration (e.g., the Iranian crisis in 1979), and will, at least within the next few years, "capture" the American society as still primarily petroleum based for its energy needs. The long term problem is different as its long warning time allows, if the problem is acknowledged, the preparation of other energy sources (which may imply changes in usage characteristics) and the adoption of a series of market-initiated as well as public policy-initiated adaptations. The experience of the last seven years has shown the impacts of the short term crisis and has indicated some trends for the longer run adaptation, but the latter are still highly speculative.

The immediate response to a short term crisis can be identified in the transportation activity. It has been found both in 1973 (Stearns, 1976) and again in 1979 (Hartgen, Neveu, Brunso, Banas and Miller, 1979) that households adapt mainly by combining trips and cancelling only a very small number of trips. The impact of a short term crisis on space heating or cooling probably involves significant inconveniences as people can only adapt by reducing the use of temperature control. Other measures of adaptation can also be initiated but their effects will probably not be immediate (e.g., insulation, installment of solar energy systems, etc.). Economic activity will be affected by a short range crisis as well, although prediction of these effects is complex. It is intricately involved in the overall economic and political situation. Yet, we can speculate that the short range crises do

have an accumulating effect. Through them, people begin to perceive realistically the long term problem and gradually begin to adapt.

What are the possible effects of the long term energy crisis on urban activity patterns? No clear answers are accepted by all the various researchers who have dealt with the question. The range of uncertainty in almost all variables involved is such that hardly anything can be strongly argued. Current urban structure and activity patterns were definitely facilitated by energy abundance (Burton, 1979). Yet, in dealing with the question of urban form at this point in time, one cannot anticipate a reversal of trends to result from the lack of inexpensive energy. The pattern of urban dispersal is rooted in economic, social, political, and cultural processes which the rising cost of energy cannot simply overturn. (However, in the planning of new towns or communities one could expect new patterns of development to emerge as the result of the energy situation.)

In evaluating measures to conserve energy by changing urban activity patterns it is also necessary to weigh the energy capital required for construction, relative to the energy operating benefits. For example, the construction of a tunnel may require more capital energy than what it would benefit in energy required for operating vehicles without the tunnel for a reasonable planning horizon.*

As a general rule, some authors have pointed out that the American people will adapt to the energy shortage by exploiting all possible means, including paying higher prices, to avoid disruption of their life styles. Van Til (1979) claims that in most studies trying to assess

* This issue is exemplified in Lave's (1977) work of evaluating the BART (Bay Area Rapid Transit) system.

the tradeoff between mobility and costs, the first predominates. Kain (1979) argues that "there is little or no basis to expect the dramatic changes in life styles and urban development patterns...".

The difference between the short term and long term crises should be viewed under this general behavioral rule. The estimated price elasticity of gasoline demand is very small in the short run (-.07 according to Pindyck, 1979, and -.22 for the first year of a crisis according to Sweeney, 1979) and increasing steadily (up to -.73 according to Sweeney and -1.3 according to Pindyck, based on estimates in other countries). The reasoning is straightforward. In the short run people make only minor adjustments, as, without disruption of their mobility, they have no other options. In the long run one can adjust by a number of means while still satisfying the mobility "freedom". The travel options include a switch to smaller, more fuel efficient cars, improve the scheduling of activities, substitute some trips to other communications means (see next section), or relocate closer to their employment location. A number of options are also available with regard to space heating and cooling. Insulation improvements involve relatively high short-range costs for the single family detached home although it is ameliorated by tax deductions. Relocating to apartment houses will involve significant energy savings (Harwood, 1977; Keyes, 1980) so long as they are not in high-rises of over 10 stories, as these may require more energy.

The adaptation measures mentioned above are mainly initiated in the market place. In evaluating the role of market forces and public

policies in energy issues, it is important to note the differential incidence of impacts on income distribution. These impacts by themselves can prove to be important forces in shaping urban America. Public policies are also developed to encourage energy conservation or ameliorate crisis situations. The latter include contingency plans for short term crisis and support for long term research on alternative energy sources. The first group includes a variety of policies such as the development of public transit, pricing, regulation of the auto industry (fuel efficiency rates) and promotion of high occupancy modes (carpooling and vanpooling). In consistency with "rules of the game" of the United States political system, policies are developed and implemented in ways which will minimize direct financial costs or mobility constraints on the voter. Consequently, the policies actually adopted tend to be less cost-effective compared, for example, with pricing or other disincentive-oriented policies (Altshuler, 1979a).

A specific type of policy which is explicitly neglected is the land use policy. Such policies are the major levers which local governments have to achieve local objectives. These may often conflict with energy conservation objectives and, consistent with the non-interference approach of the American political system, federal politics do not directly impinge on local politics. Yet, the research community does try to assess the possible effectiveness of these presently non-feasible policies. Harwood (1977) suggests a series of land use policies aimed at energy conservation which she claims are more efficient than other measures taken today. Land use policies are also advocated for achieving

energy conservation by Owen-Carrol, Nathans, and Palmedo (1977).

What will in fact happen in the future urban areas depends mainly on the rate and direction of energy supply and demand trends, matters on which analysts fail to agree, and on other dependent or independent processes which shape urban America. The two basic directions of change are toward continued dispersion of urban activities or toward recentralization. The first view is held by those who believe that the dispersion forces are so strong that the relative increase of energy costs (which some see as modest -- cf. Kain, 1979) will not alter the general trend, although it may slow it. A variant of this trend, often cited as very plausible, is the development of a multinucleated urban area in which each nucleus will have a high density activity center (employment, shopping and some residences), and residential areas will be in the surroundings (Van Til, 1979; Romanos, 1978; Keyes, 1980). This pattern is consistent with the concept of the urban field suggested by Friedmann (1973) and Owen (1972). Proponents of recentralization take more of a normative approach and probably they foresee a more severe future energy crisis than their counterparts. Their suggestions range from super compact cities as conceived by architects like Danzig and Saati (1973) to local high density development, consistent with the nucleated scenario described above.

Whatever physical changes take place, one can anticipate that the long run impacts of the energy crisis will include changes in life style and hence travel behavior. Abt (1977) offers some possible changes in life style to result from the energy shortage like fewer and longer

workdays (three 13 hour days per week), a general slower pace of life and more. These or other changes in life styles can be at least partially predicted and the information on the total change in life style can then be used to predict changing travel needs, as will be shown below.

2.1.4 Environmental Concerns

During the 1970's the concern for the quality of the environment has ceased in general terms to be a major issue on the public agenda.* Following the NEPA (National Environmental Policy Act) legislation in 1969 a number of Acts** were passed by Congress with the single objective of improving the quality of the environment, at any cost, that is, as there was no knowledge of the cost involved (as well as the benefits) the political system preferred this approach which was very popular then.

By 1973 two independent factors have coincided to change this approach. The first was the oil embargo which demonstrated how dependent and vulnerable American economy and life patterns are to an energy shortage which is expected to occur regardless of the political event. The second was the realization that implementing measures which are geared only to improve environmental quality and incur significant costs (or inconveniences) on the voters are unacceptable to the politician (Altshuler, 1977 and 1979a). The National Wildlife Association

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* This statement requires qualification. There seems to be a difference between pollution perceived as immediate local danger (e.g., toxic water disposal) and dispersed indirect effects (e.g., regional air pollution, acid rain, etc.). The former is still treated as a major issue on the public agenda, when and where it is identified.

**The Clean Air Act, 1970; The Clean Water Act, 1972.

has labelled 1974 as "the year of the trade-off" (cited by Hummel et. al., 1978). Since that year there are increasing signs that the role of the environmental cause, relative to other public concerns, is on the decline. Some of the milestones of this trend are extensions repeatedly given to the auto industry on emission rate standards, the conversion of power plants to coal use and, most recently, President Carter's commitment to the auto industry to relax emission standards (New York Times, July 9, 1980).

This short review tempts one to speculate that the concern for the environment depends on affordability. People, or an economic system which can afford to take measures to improve the quality of the environment or at least to maintain it, are willing to do it even if it incurs some costs. In Altshuler's (1979a) terms, these need to be "diffused costs", i.e., very small direct costs borne by the individual as a result of a specific immediate measure (for example, excess tolls are non-diffused direct cost while the increased costs of automobiles due to emissions control devices, a cost which is spread over time and people, is a diffused cost). Yet, when it comes to a trade-off of losing a job or having some higher level of air pollution, the latter usually not perceived as an immediate problem, the choice for the economically threatened person is clear. The claim that environmental issues are the concern of the liberal leisure class has already been suggested by Tucker (1977) and England and Bluestone (1971).

Despite this gloomy outlook for the environmental cause in a period of economic recession and energy shortage, it should be noted that com-

pared with the pre-NEPA (1969) period, the situation even today is favorable. A number of reasons can be identified. First, environmental regulation today is embedded in legislation and with all its shortcomings (which are numerous according to Bardach and Pugiaresi, 1977), most major investments of private and public capital and policy implementations require at least an explicit assessment of environmental impacts. Moreover, the legislation allows active public participation which enables interest groups to raise their concerns. Second, the case of the environment has been presented to the public and decision makers in the general public today are no longer ignorant of the consequences to the environment and to themselves, although they may not perceive it correctly. One can probably state that the concern for the environment has become a value of the American society. Hence, a decision to prefer an economic, energy or even a political benefit over an environmental one reflects a choice of preference where the alternatives are known. Presumably, in this situation, decisions which involve significant health hazards will not be made. This though, is true under the assumption that the hazards are known. Compared to the situation ten years ago, much has been learned, but, still there is much uncertainty, and even the existing knowledge is disputed by people who hold different perspectives.

Given the greater knowledge and understanding of the environment, both popular and scientific, and given the legal requirement for explicit consideration as well as compliance with specific standards, many policies today attempt, to the extent possible, to accomplish all objectives.

Conceivably this is possible only when no controversial trade-off decision is required. For example, fuel economy of automobiles, within a certain range, is also beneficial for emission reduction. Hummel et. al. (1978) attempted to describe profiles of people who differ in their views on the trade-off between energy and the environment. Their study indicated that the people in their sample preferred mandatory policies which were aimed at the energy "guzzlers" rather than policies which incur costs on all. Hence, Hummel et. al. suggest that to avoid extra monetary costs the public will accept mandatory policies which incur environmental costs. As most simple options fall within the type of measures which require trade-offs it becomes necessary to develop such policies which may not be simple but will at least achieve marginal benefits for a number of social objectives. Section 2.1.6 deals with one such option: the move back to the city.

2.1.5 Changes in Information Technology

The second half of the twentieth century brought about major changes in information technology, both in its capabilities and in its popularization. Under the broad concept of information technology we include methods and hardware for information management, processing and communications.

Conceivably, a trade-off between available information technology and transportation can be anticipated. The brief review offered in this section is not intended to provide an in-depth evaluation of research done in this area. It will only point out some possible outcomes of the

trends and demonstrate that the conceptualization of a tradeoff should not be seen as trivial.

The major developments in technology achieved to date or anticipated in the foreseeable future include the development of a wide range of computers, varying in size, accessibility, price and an array of additional characteristics. Their uses are mainly for data management and improved control as well as for entertainment. The second major development is that of communication. The simple audio telephone invented over a century ago has continuously improved in its performance thus allowing audio information to flow further at less cost. Media communication has developed to a stage where the whole country as well as other parts of the world have simultaneous dissemination of information which, in a sense, creates a single system of all major urban areas (Berry, B.J.L., personal communication, 1980). First signs of interactive entertainment with the traditionally single direction media have recently been observed. The combination of computer and communication technologies facilitates text and digital data to be transmitted as well as visual images. Yet to be developed are the visual home telephones which, at this stage, still involve prohibitive costs for widespread use.

All these developments may in more than one way affect people's mobility needs.

The simple model of transportation-communication tradeoff, as suggested by Gray, Nilles and Lopez (1977) asserts that "telecommuting" will substitute commuting, namely that most of the information-related work could be done through communication rather than commuting. Case

studies in support of this view are brought in Nilles, Carlson, Gray, and Hanneman (1976) who seem to analyze mainly the firm's perspective. They fail to account for the individual's attitudes to and apprehension of the impersonal nature of work via telecommunication. Carried further, much of the shopping and services activities can be carried out via telecommunication networks (mail shopping, pay by phone, etc.). The availability of a wide variety of home entertainment gadgets such as audio and audio-visual systems, games, etc., will further decrease the need for travel.

A similar assumption about the substitution of "many of the urban ills associated with transportation" by the widespread use of two-way cable television is given by Buley (1977).

The assumption underlying these models seems to be too simplistic. Although technically the options are viable and may in fact be exploited, the tradeoff with travel is probably not direct. Pool (1979) reviews a number of factors which combine to make the prediction of impacts far more complex than suggested above. The first is that in many cases improvements in telecommunications can induce more transportation demand as the result of induced economic activity between two points. This is an activity shift, resulting from improved access (Manheim, 1979). Secondly, Pool argues that econometric studies into the tradeoff question fail to predict the elasticity of demand for communication for yet unavailable options. Thirdly, there is much evidence that direct face to face communication, both for work and for leisure is not substitutable by telecommunication because of its impersonal nature. Jean Gotteman (1977)

wrote that most telephone calls in urban areas still convey the same words used by Bell in his first call to Watson: "I want to see you."

The implications of the development of information technology on urban activity patterns are not clear. What can be inferred, though, is that trips can be made in a more efficient way, using the technological means for scheduling, and that the technology offers additional options for activity patterns. Such options may be exploited to tradeoff travel in the case of, for example, an energy crisis, but it is not conceivable that significant reductions in travel will be achieved because of the tradeoff availability.

2.1.6 The Movement Back to the City

In many central areas of the American metropolitan areas a new pattern of residential development has emerged in recent years: high quality apartments, usually in one of three forms: high rise complexes (e.g., the Waterfront and Charles River Park in Boston) renovated structures in older neighborhoods (e.g., Capitol Hill and Mount Pleasant in Washington, D.C.), and conversion of non-residential structures to residential use (New York City, Dept. of City Planning, 1977). Similar developments, though to a lesser extent, have also taken place in some suburban activity centers.

This phenomenon may be characterized by having a high density of dwelling units (in contrast to high population density) and by providing higher levels of accessibility to non-residential land uses, sometimes by "on site" facilities.

This dense form of residential development, often termed the "back to the city movement", stands in contrast to the overall trends of decentralization of population in the American urban scene and to the theory of residential location in the United States which "places" higher income groups in the fringe of the urban area. The term "back-to-the-city" is somewhat misleading, as it has been shown (Gale, 1979) that most resettlers do not come from the surrounding suburbs but from within the city.

Is this trend an indication of a possible reversal of the prominent trend of decentralization? Most urban analysts of different disciplines still agree today that urban sprawl will continue to dominate the development of urban America (Berry, 1977; Kain, 1979; Friedmann, 1973; Sternlieb and Hughs, 1979). If so, then the trend is of marginal importance and is a result of the increasing demand for housing units discussed in Section 2.1.1 above (the demographic trends) combined with the associated social trends (Section 2.1.2).

Conversely, it is suggested here that the trend, even if manifested only in a marginal magnitude involves some implications which are noteworthy.

Observers of urban crises have frequently advocated condensed urban development as being advantageous over sprawl.* Economic efficiency was one consideration in favor of condensation (Real Estate Research Corp., 1974). Environmental quality was another (Croke, 1973). Conservation of natural resources was yet another reason. Notably, the automobile which

* A review on the dispute is given in Coursey, 1977.

allowed the intensification of suburbanization was an underlying cause for the arguments brought in favor of centralization: it is the cause of some economic inefficiencies through congestion associated with its use, it is the source of substantial quantities of air pollution and noise, and it is a major consumer of energy.

Yet, arguments in favor of centralization never materialized in any form. Market forces were shaping the urban environment and suburbanization reflected consumers' preferences. If one can argue that the advocates of centralization based their case on the overall system's improvement as an objective, in contrast to consumers' individual welfare, it is clear that public policies have favored the direct benefit to the individual consumer, often at the cost to the system. By and large, most public policies since World War II have enhanced urban sprawl. Land use controls, to the extent used, have only been applied by local governments with the intent of achieving local objectives such as exclusion, commercial development or growth controls. Achieving regional or national goals such as reducing air pollution, conserving energy or racial integration through land use measures was virtually unacceptable by the political system.

The interest in the current back-to-the-city movement is multifold. It is a result of market forces and therefore may be indicative of new trends which are not artifacts of public policies. It may, if deemed appropriate, be encouraged by public policies to achieve a range of current public policy objectives. These include such objectives as central city revitalization, reduction of air pollution emission and

energy consumption and reduction in congestion. Some particular implications on spatial behavior should be noted: the relocation close to the city center often with on-site services allows greater reliance on walking, public transportation (including such options as Downtown People Movers (DPM)), possibly shorter trips to work, shopping and certain types of recreational facilities.

Recent research into the phenomenon of relocation of middle and upper income groups in city centers has pointed at some important issues. First, it is suggested by Alonso (1977) and Lipton (1977) that there is a potential for the continuation and intensification of the trend in the future, both because of social and demographic trends as well as the public concerns about urban decay.

Second, the current relocators can be characterized as a quite distinct group of population.* Gale (1979) compares the characteristics of urban resettlers based on studies at different locations in the U.S. He confirms the belief that most urban resettlers are young childless households, with above average education, above average income and a professional occupation. He also shows that most urban resettlers come from within the city and not from the suburbs, although many have had suburban experience and prefer the urban environment. Similar characteristics were found by Pattison (1977), Michelson (1977), and Parkman Center (1977). This group, according to Alonso (1977) is a rapidly growing one, hence the potential for some change in the dynamics of the urban structure. Gale's and Pattison's studies focus on the reno-

* Some forms of the central area "residents by choice" were already identified in some early studies of urban social structure, e.g., Hoyt (1939).

vated neighborhoods. Conceivably, the central city high rise complex, which in many cases offers a variety of on site facilities (recreation, churches, shopping, etc.) (Urban Land Institute, 1976), is also attractive to active retired people who return from the suburbs after their children have left the large family house. These complexes provide accessibility to a variety of central city amenities as well as the services and security desired by such people.

The possible implications of this movement on the city's revival, energy conservation, pollution reduction and the like are yet to be tested. Conceivably, public policies which encourage or discourage the movement should not be devised before such implications are identified. The importance of early identification of the impacts lies in the fact that this new trend points at a direction long desired by many planners and many positive impacts on the urban system lie at stake. Even with minor appropriate public support, a marginal trend can change the image of the central city and thus induce more change, which clearly will not bring about the abandonment of the suburbs but may balance the outward migration of people as well as economic activities.

2.2 The Increasing Improtance of Taste Variations

The understanding of the role of tastes in shaping behavior and the development of methods which properly account for taste variations are gaining importance in the current stage of development of travel behavior models. In recent years there has been a shift of emphasis from rather simple travel behavior choices like mode choice, to very complex choice

situations like the joint choice of residential location, automobile ownership, and mode to work (e.g., Lerman, 1975) or the choice of activity scheduling and trip chaining (e.g., Jacobson, 1979; Damm, 1979; Adler and Ben-Akiva, 1979).

The "complexity" of a choice situation is a function of the quantity of information that needs to be processed in making a choice. The quantity of information may depend on the number of alternatives, thus making the choice of destination for a shopping trip more complex than the choice of mode. It may also depend on the number of attributes considered in the decision making process. In this case, we may consider the choice of residential location as a more complex choice situation than the choice of destination for a shopping or recreational trip.

It is assumed here that the more complex a choice situation is the greater is the probability that it will be affected by the individual's tastes as more decision attributes interface with the individual's subjective perceptions and attitudes.

The concept of life style as conceived in this study is closely related to the preferences or tastes of the individuals. Consequently, the modeling of choices in which tastes are assumed to have a major role will benefit from a description which is assumed to be closely correlated with tastes.

In summary, the brief review of the various trends in the U.S. urban realm strongly suggests that in the 1980's changes in life styles may occur at a pace and diversity much greater than in the past. The

coincidence of certain social, demographic, and technological developments currently offers a wide range of life style choices for individuals to choose from and there is an increasing number of individuals choosing styles which in the near past were still considered deviant or strange. In fact, as will be noted in Chapter 4, some social scientists believe that in the future styles of life and not economic or social status will best serve as a differentiating dimension among individuals and groups. Perloff (1973) has called the attention of urban planners to his assessment that "...planning content in the future will be a pervading concern for providing a rich, full scope for varied life styles".

The growing diversity and pace of change of life styles in society will result in a growing relevance of tastes in the analysis of behavior. In order to better understand travel behavior, in light of the emerging life styles and the consequent implications on planning needs, we pursue an attempt to identify the effects of life styles on travel behavior.

2.3 Some Notes on Causality

Life style is assumed to have an explanatory power which stems from its theoretical conceptualization. Prior to presenting this theory a few observations on causality in social sciences and in travel demand analysis are noted. The evaluation of this study should be viewed, among other things, in light of these considerations.

One of the main objectives of science is the identification of the logic of phenomena. The identification process results in the formulation of models and theories which vary in the degree of abstraction of

the phenomena. Scientists constantly strive to identify higher order abstractions, which have the capacity of explaining phenomena in a wider range of contexts, or with less restrictions. But, with that aspiration there is also a desire not to lose the explanatory power at the lower end of the logic structure, i.e., not to lose the ability to explain particular events.

The social sciences share that quest. The phenomenon they deal with is human behavior and the basic building blocks are the observed characteristics of individuals or groups and the environment, in the broad sense, in which the individuals act. Using these building blocks: the socio-economic data, demographic data, and information on expenditure, mobility, etc., the social sciences attempt to abstract and construct models which interrelate these items with behavior.

The simple level of abstraction is that of correlations. Data items are found to correlate with behavior and some conclusions can be drawn about the relationship. Correlative abstraction does not require a theoretical basis; it simply builds upon the observed phenomena. Consequently, it lacks the power of explaining the phenomenon in situations which differ from the original. It may improve, at best, the odds of predicting an outcome if other events are present, but that improvement is limited by narrow bounds.

Much of the knowledge accumulated in the behavioral sciences belongs to this level of abstraction. Sociologists, it is suggested (Freese, 1980), have produced "a correlational science that is largely atheoretical."

A second level of abstraction is the construction of causal rela-

tionships. Causality does not necessarily exist if the condition "if A then B" is fulfilled. This is a necessary but not a sufficient condition. (Note that correlational relationships may in many cases fulfill this condition.) Causality exists if there is a theoretical basis for the observed relationship (Hicks, 1979; Freese, 1980). The necessary and sufficient condition may thus be rewritten as:

"if A then B given T"

where T is the theory.

Theories are and can be developed independently of observed phenomena and they are tested against observed data. A theory is the formulation of a causal relationship which explains the interdependence between two or more events which are separated by time. When tested against observed data a theory can be "accepted", either by accounting for all variations in the data or by accounting for some but complementing the remaining with rational reasoning, or it may temporarily or permanently be rejected.

In economics, in contrast to sociology, theories have been formulated (e.g., theory of consumer behavior, theory of choice) and models of behavior are developed within these theoretical frameworks. But while many econometric models reside within the framework of a theory, much of the relationships established by them are at the correlational level. In the case of econometric estimation of utility maximizing travel choice models, for example, the observed behavior is modeled as a function of an array of attributes which are believed to add or reduce individuals' utility (the operational meaning of the theoretical basis).

Notwithstanding the utility maximization decision rule there are some factors which cause the estimated parameters to be more of a correlative nature than a causal one. The first is that many of (or maybe all) the variables which are used are proxies for the real attributes of the decision. It is inconceivable that a person weighs his or her annual income in making a choice of mode. The annual income is used as a proxy for the person's wealth. But even that is not a causal attribute of choice. People do not choose to travel in an automobile because they are richer. They choose to do so because as rich people they have a different set of preferences or options than other people, and that is the cause of their choice. Thus, income is a cross-sectional correlate of taste or behavior but not a causal factor.

The second factor contributing to the correlational nature of the estimated parameters is the underlying assumption that consumers (travelers) have perfect information on the alternatives. The weakness of this assumption is intuitively obvious and has also been demonstrated by a large body of research dealing with environmental perception (c.f. reviews by Rapoport, 1977; Brög, 1980). If alternatives are differentially perceived by travellers, any relationship identified by models which ignore that fact are correlations between the "objective" or "engineering" data input and the behavior of the individuals.

A third related factor is the assumption that individuals' choice sets are determined by attributes such as distance, availability of a driver's license, etc. The actual choice set a person is facing, regardless of the information problem, may in fact be different than that

assumed by the analyst. (Some illustrative examples are mentioned in Brög, 1980.)

Consistent with the general quest for abstraction it is suggested in this study that drawing upon the basic building blocks (the data items), a second, higher level concept be developed which, in conjunction with the theories of behavior, may provide some insights on causal relationships. This higher level concept is life style. It is conceived in this study as a choice of a pattern of behavior which is stable for long periods (on the magnitude of years). As the concept is drawn from the basic "building blocks" and pertains to a longer period of time than the instantaneous cross-sectional nature of the data, it can be viewed as a different functional form of describing the decision maker than that offered by additive socio-economic and demographic attributes. The consistent pattern of behavior an individual chooses to pursue is more likely to explain his or her demand for activities and consequently the preference in the derived demand, that of travel and mobility.

Chapter 3: Previous Research

The theory developed in this study is built upon previous research on two subjects of interest. The first is the conceptualization of life style in the behavioral sciences and the second is the representation of the decision maker or the methods for accounting for taste variations in models of travel behavior. Section 3.1 is devoted to a review of the literature on life styles, its definitions, and past experience in its application to explaining behavior. Section 3.2 deals with the treatment of taste variations in existing travel demand models.

3.1 The Life Style Concept

Despite its frequent colloquial use, the concept of life style has not drawn the scientific attention it may deserve. The concept was and is used in different social sciences for seemingly different purposes. Prior to developing yet another use of the concept it is necessary to comprehend the various meanings and review the applications of it in previous research. A review of definitions of life styles is provided in Section 3.1.1, followed by a review of applications and measurement. In the concluding section, 3.1.3, an attempt is made to develop a typology of life style definitions.

3.1.1 Definitions of Life Style

The term life style is often used colloquially as well as in social science literature, but the lack of a universally accepted definition

beyond the colloquial notion is striking. References like the International Encyclopedia of the Social Sciences (Sills, 1968)* and A Dictionary of the Social Sciences (Gould, 1964) have avoided the subject. Yet, in a literature survey of various social sciences we find frequent reference to the concept which has been explicitly used by such prominent scientists as Max Weber and Alfred Adler.

In the social sciences, there appear to be three basic approaches to the definition of life style. The first is that which intentionally uses a loosely-defined qualitative dimension expressing the way of life of a population group, which in turn is also defined in very broad terms such as "urban" or "rural" or "western society" (Strauss, 1970). The well known advertisement of "hot dog, baseball, apple pie and Chevrolet", which relates to what a colloquial perception of the American life style is, is an obvious example of this type of definition.

The second approach has focused on the behavior of particular population groups or subgroups. This approach usually embodies an ad hoc definition of life style to differentiate between the research group and other groups. Zehner and Chapin (1974) have used this approach in distinguishing between a "stable living" group and a "hard living" one within a white, relatively homogeneous working class community.

The third approach is that which attempts to provide a generic definition of life style of a group or an individual describing or explaining a pattern of behavior. This approach is of most interest in the context of this study.

* The concept of "style of life" does appear as a sub-section under the "social class-measurement" section.

Shared by all the following definitions is the view that life style is a pattern of behavior; or in operational terms, it is the pattern of allocation of resources (namely time and money) by an individual or by a group of individuals.

The allocation of resources can be observed and measured, and reflects choices made by decision makers. As such it can serve as a basis for analysis of revealed preference which prevails in economics. On the basis of these observable dimensions, economists have developed the theory of time allocation and the "new home economics" approach which, in fact, as will be described below, deals with life styles.

Most writers, however, suggest that life style is a concept that describes attributes of a unit of association (e.g., a person or a group) which are beyond the observable resource allocation. One definition looks at a person's life style as "a construction system that he characteristically evolves for himself...Although persons allow us to notice their life styles, we never fully comprehend them...we are usually allowed to glimpse at best only a few aspects of his life style..." (Reynolds and Dorden, 1974).

Early in the twentieth century two social scientists independently developed the concept of life style.

Max Weber,* challenging Marx's theory that society is divided into classes based on an economic dimension, the "life chances", argued that in addition to the economic classes there are status groups to which all people belong and these do not necessarily coincide with the economic

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* The review of Weber's work relies mainly on Reed (1976).

class (Bendix, 1973). Social status is observed according to Weber by at least two characteristics. The first is the tendency of status group members to interact with other members of their own group and to minimize interaction with other status groups so that group delineations will be very clear. Second, and more interesting in the present context, is the characterization of each status group by a "style of life (which) can be expected from all those who wish to belong to the circle" (Gerth and Mills, 1958). In addition to life style, three more characteristics directly contribute to social prestige: occupation, formal education and family background. Weber also noted that occupation has a dual role: it affects directly the social status but it also affects the life style which in turn is one of the four attributes of status.

In discussing the difference between social status groups and economic class Weber points out that

> "with some oversimplifications one may think of the economic class as a stratification along the production and acquisition of goods, whereas status groups are stratified according to the principles of their consumption of goods as represented by special styles of life" (Gerth and Mills, 1958).

Weber's work, in summary, defined a concept of life style as an attribute of social stratification. It is, as such, a social phenomenon; a group's characteristic. Despite Weber's very clear proposition, the concept of life style was largely neglected by sociologists for about half a century.

A contrasting concept of life style pertaining to the individual, not to the group, was developed over the first quarter of the century

by Alfred Adler.* As one of the founders of individual psychology, Adler struggled for some time with a concept which finally evolved to "life style". Initially, in 1912, he termed it a "guiding image". In his own words:

> "Toward the end of infancy when the child has become capable of achieving independent, goal-directed actions which do not merely aim at drive satisfaction, when he occupies his place in the family and arranges himself in his environment, he has already acquired certain skills, psychological gestures and readinesses. Furthermore his action has become unified and one sees him on the way to conquer for himself a place in the world. Such unified action can be understood only if one assumes that the child has found a fixed point outside himself toward which he strives with his psychological growth energies. In other words the child must have formed a guiding line (Leitlinie), a guiding image (Leitbild) in the expectation thus best to be able to orient himself in his environment and to achieve satisfaction of his needs, the avoidance of displeasure, and the attainment of pleasure." (Adler, 1912, cited by Ansbacher, 1967).

This concept was interchangeably used with a similar one, the "guiding line" which according to Adler is a unifying line that guides a person's life.

Later, during the early 1920's, Adler's quest for a concept which captures the wholeness or the totality of the human being, emerged in the concept of a "life plan". But, still unsatisfied, Adler substituted "life plan" with "life style" (by 1929) and defined it as "the wholeness of the individual" (Adler, 1933).

Adler's long search for an appropriate concept which describes an individual is insightful. His view, all along, is consistent with the organismic approach.** All of the individuals' actions are subjectively

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* Review of Adler's contribution relies mainly on Ansbacher (1967).

**The organismic approach in psychology deals with the human being as an active totality. The fundamental causation under this approach is teleological in nature. By contrast, the mechanistic approach views the human being as reactive to exogenous stimuli, thus it allows the analysis of separable elements of behavior, searching for causation by explicit causes (Hultsch and Plemous, 1979). This may explain Adler's shift from "life plan", which may be viewed as mechanistic, to "life style".

determined within a self-consistent goal-directed unity. In Adler's words,

> "Not heredity and not the environment are determining factors. Both are giving only the frame and the influences which are answered by the individual in regard to his styled creative power" (cited by Ansbacher, 1967).

The life style concept as seen by Adler is much deeper in nature than the conventional meaning. It puts the pattern of resource allocation within a time framework of an individual's whole life span. The gradual development of the concept from a general term of "guiding image" to the term "life style" suggests, in my view, Adler's increasing belief that some organismic construct of the individual serves not only as a guiding image but also as a determinant of a style of life.

Weber and Adler conceptualized life style as being applied to two different entities. Weber saw it as a social concept of a group while Adler focused on the individual, although he did conceive of groups of individuals who share similar life styles, namely, being a psychologist he mentioned neurotics, criminals, etc. As wide apart as these approaches may seem, it is suggested (Ansbacher, 1967) that in fact both shared the organismic approach and both saw life style as a factor within a teleological framework.

Since these early contributions, the concept of life style was carried on by the Adlerian school of individual psychology in which methods for measurement and identification have been developed (Baruth and Eckstein, 1978). To a lesser extent it was also used by sociologists and more recently by two more disciplines: marketing and planning.

Some of the definitions used in these fields are reviewed below.

The concept of life style as defined by Adler has not been basically been changed by his followers, although some additional contributions have emerged. Allport (1961) sees life style as the highest level of organization of a personality. Coleman (1960) suggests that:

> "The individual's pattern of assumptions, values, and motives lead to consistent ways of perceiving, thinking and acting, which together constitute a characteristic modus operandi or life style".

Sociologists have offered a wider set of definitions, ranging among other things across different types of groups, from a family to a whole society. The following definitions by sociologists are of particular interest.

A number of definitions follow on Weber's contention that life style is a determinant of social status. Parson and Bales (1955), for example, write:

> "The status of the family in the community is determined probably more by the 'level' of job (the father) holds than by any other single factor, and the income he earns is usually the most important basis of the family's standard of living and hence style of life."

The nature of the family or the household structure has also been used as synonyms to life style. This is done both by psychologists and sociologists and it is probably rooted in both Adler's classical concept which viewed life style as evolving by the individual's self recognition in the family, being the predominant social environment at infancy, and in more modern conceptualizations. Households of varying structures include the variety of non-familiar communal groups, in itself a very diverse range of structures (Seal, 1975) often identified with subcultures.

Among the family based households there is also a growing variance in structure and consequently in behavioral patterns. Thus, even if one accepts the more quantitative definitions of life style which look at the allocation of resources, different household structures imply different life styles. Not surprisingly, a new quarterly journal devoted to "Changing Patterns in Marriage, Family, and Intimacy" is titled "Alternative Lifestyles".*

Life style is often used to describe subcultures. Feldman and Thielbar (1975) have titled their book "Life Styles: Diversity in American Society" and they define it as a group phenomenon which pervades many aspects of life and implies a central life interest (e.g., work, ethnic heritage, politics, children, etc.). Also they note that life styles vary with "sociologically relevant variables" meaning that, following Weber's contention, life styles do not necessarily conform with income. Last, Feldman and Thielbar suggest that life style is a reflection of culture, thus, linking their concept of life style to the common notion of life style as a synonym for subculture, which is in fact the theme of their book.

Some other sociological studies attempt to pursue a more analytical or quantitative approach.

Havighurst (1957) defines life style as allocation of resources between the roles one assumes. He writes:

> "a characteristic way of distributing one's time, one's interest and one's talent among the common social roles of adult life -- those of worker, parent, spouse, homemaker, citizen, friend, club or association member, church member, and user of leisure time...

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* Libby R. (ed.), A Sage Publication, first issue Feb. 1978.

> A life style can be described quantitatively as a pattern of performance in these common social roles" (Havighurst, 1957).

Rainwater (1976) in an attempt to develop models of life style (see Section 2.1.2) defines life style as:

> "Life style or subculture is conceived as a description of the way of living a group creates out of the resources available to it -- material, social, and intellectual -- in terms of the tastes and needs of members of the group. Life style is understood to be constrained by the resources of the group and yet to reflect the group's choices in constructing a way of life within those constraints."

Note that Rainwater, by assuming that a group of individuals share a life style explicitly says that life style is a subculture.

Wendell Bell (1958), in observing the emerging suburban way of life defines life style as an orientation (which leads one to a particular resource allocation). He defines three general types of life styles: orientation toward familism, orientation toward career and orientation toward consumerism. From these, individuals or households make their choice of preferred combinations. Still another approach looks at life style as a latent variable, as

> "...life style research is designed to account for unit of association (individual, family) differences in some kinds of behavior which cannot be accounted for by physiological, demographic and socio-economic characteristics." (Wind and Green, 1974).

A considerable body of research on life style in a planning-related context was carried out by Michelson (1976, 1977) and Reed (1976) who looked at life style as a social factor particularly in residential mobility and residential choice. Michelson (1976) suggests that life style is based on role emphasis. City dwellers play a variety of roles

in their daily life (e.g., worker, family member, traveler, client, etc.). The relative importance of each role varies across individuals and the emphasis each role assumes expresses a pattern of behavior which is life style. At least two elements constitute life style according to Michelson. The first is the set of behaviors which are performed in order to satisfy the roles. The second is the "sphere of life" emphasized by the individual. Spheres of life are such elements as political control, economic supply, propagation, socialization of the young and explanation of the supernatural (1976, p. 62-3).

Life style, as stressed by some writers, is a composite social variable of higher level of abstraction than the conventional socio-economic variables (Michelson, 1977; Porteous, 1977). Reed (1976) provides an excellent explanation of the nature of the concept as a synoptic and integrative variable. He writes:

> "There is clearly a great deal of evidence now which shows that in many instances behavior patterns (life styles) vary as much within income classes as between them. The same holds true for age (or stage in life cycle), education, occupation, regions or neighborhoods, and now even for some ethnic groups. These various social traits, in other words, are insufficient by themselves to account adequately for patterned behavioral variations. Alternatively, there is growing evidence in the literature, particularly that on suburban development and urban ghettos in the U.S., which shows the value of utilizing social characteristics in analytic-explanatory schemes in the same manner as they interact or cluster in the real social world: class and ethnicity (Gans, 1962), class and stage in the life cycle (Gans, 1967), age and local-cosmopolitan orientation (Rosow, 1967), are but three selected examples. For some purposes, then, it is conceivable that life style may have as much or more explanatory value than any of the single variables that help to shape it." (Reed, 1976, p. 52-3).

Further, Reed stresses the interaction among different social characteristics which are manifested as life styles:

> "While the literature is replete with studies using multivariate statistical methods to identify interactive effects of a set of social variables, it is suggested that life style may be an empirically (as well as an artifactually) synoptic manifestation of certain social characteristics and conditions operating in concert. If life style is viewed as a composite of role behaviors, distinctively chosen and differentially emphasized and performed, these behaviors must be selected from among the set of those potentially available to persons of specified social characteristics, and life style may be considered to be bounded by, but not otherwise determined by (i.e., essentially autonomous of) these social characteristics and conditions. Since any two persons may select very different life patterns from a pool of behavior possibilities, it makes more sense to work with the emergent pattern(s) than with the constituent items in the indeterminate pool. Insofar as life style patterns are not totally random, then, life style becomes a valuable descriptor in its own right." (Reed, 1976, p. 53-4).

In the context of travel behavior, the following three definitions are of interest. CRA (1978a) suggest that:

> "... life style may be thought of as the result of the differential allocation of resources and time among four role complexes of: work/career, household/family, interpersonal/social and leisure/recreation or as a withdrawal or disengagement from such investments."

Note that the allocation is not between the activities but between the role complexes of the behavioral unit.

Reichman (1977) suggests that:

> "life styles are assumed to be shaped by recurrent behavioral responses to socio-economic conditions as well as to deeper personal or social attitudes, roles or values."

He notes four aspects of life styles which are relevant to travel behavior: 1) level of economic resources available, 2) the social engagement/disengagement continuum, i.e., the extent to which individuals

are involved in social activities, 3) role differentiation within the household, and 4) control and awareness of time allocation.

A different approach is suggested in a recent study by Wachs (1979) in which he attempts to operationalize the concept of life style for transportation planning purposes. According to Wachs, "life-style is intended to measure simultaneously environmental constraints and personal choices given those constraints" (p. 22). The difference between this and all previous definitions is that here life style is defined as based on the environment and the actual choices which constitute the behavior, in contrast to the dependence on personality traits (e.g., values and attitudes) which are part of all other definitions. This issue will be elaborated upon below.

Burns (1968) suggests that in practical terms life style is a pattern of expenditures but, in a more abstract sense, it is the way in which individuals and families work out toward realization of their hopes and desires. A style of life, according to Burns, is evolved by people acting within and despite the constraints of resources and within an institutional relationship to which they are committed, but which they create or manipulate for ends which they hope are consonant with their own.

3.1.1.1 Summary of Definitions

In summary, we find that the definitions share the quest for a qualitive concept which relates to an individual's or a group's patterns of behavior. The major difference lies in whether that quest should be limited to the environmental context and the resultant behavior or alternatively, the role of psychological attributes is sig-

nificant as well. A second major difference is the level of detail or practicality to which the concept relates. It ranges from a theoretical notion which Bell (1958) termed an "orientation" to actual allocation of resources between role complexes as defined in the Havighurst (1957) and the CRA (1978a) definitions. These and other differences are discussed in the following suggested typology of the definitions (Section 3.1.3).

3.1.2 Review of Applications and Measurement of the Life Style Concept

As the concept of life style is shared by many disciplines, there have been a variety of attempts to measure and apply it. These efforts vary in the objective that each researcher or discipline had, and in the type of data deemed necessary.

Although only a few attempts to utilize the life style concept in the transportation and planning profession have been made, there is an increasing awareness that it has the potential of becoming a powerful explanatory concept. The National Cooperative Highway Research Program has challenged the research community to look at the concept as part of project 8-14A "New Approaches to Understanding Travel Behavior" (CRA, 1978). Kelly (1980) has recently suggested that transportation analysts pursue the approach taken by marketing, of segmenting the market by life styles rather than by social or demographic variables. Reichman (1977) also suggests the use of the concept as an underlying behavioral framework within which choices are made.

3.1.2.1 Applications in Marketing Research

Probably the most extensive efforts to apply and develop measures of life style were done, not surprisingly, by marketing researchers who also to date have the strongest application orientation in this field. The approach taken by marketing research could be characterized as pragmatic. It is used to define life styles of specific market segments in a product or class of products specific context. Both the potential demand and possible advertisement strategies can be inferred from studies of, say, the life style of young career-oriented professional women. For example, Roberts and Wortzel (1979) have compared the food preparation patterns of traditional and modern life styles of women and they were able to typify different food shopping patterns of these life style groups. Also, they have shown that the life style concept was a better predictor of food shopping behavior than demographic and socio-economic variables. This practical orientation has focused on developing tools for product-oriented analysis of life style and has thus lost some generality.

The conventional method applied by marketing research consists of 1) presenting the respondents with a large battery of "life style items" (statements about Activities, Interests and Opinions), typically of the form: "I usually do..."; "People do..."; "I Believe...", etc., 2) asking the respondents to rate the statements on a 5-7 point scale, 3) factor analyzing the results and cross-tabulating them with observable demographic and choice behavior data (Wind and Green, 1974). Although the statistical methods might vary, marketing has generally used the

"psychographics" approach, namely combining attitudinal and other psychological attributes with socio-economic, demographic and revealed choice data. The experience gained in this work has pointed to a number of basic issues that need to be addressed in any life style measurement, as will be discussed below.

3.1.2.2 Applications in Sociology

Sociologists have approached the measurement issue from at least two perspectives.*

The first is represented by attempts to measure life style per se. Probably the most notable example is Rainwater's (1976)** initial work in which he suggested that individuals may be stratified not only along the traditional class dimension, based on their socio-economic resources, but also in the dimension of life style. Note that this is an application of Weber's concept discussed in the previous section. To operationalize the concept of life style Rainwater identified four aspects which are represented by what he termed life style items: a) social activities, b) consumption patterns, c) subjective aspects, i.e., the social-psychological characteristics of the individual which include two types: c1) the individual's values, beliefs and knowledge and c2) the sense of satisfaction or well-being.

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* For an in-depth review of the life style concept in sociology see Reed (1976).

** This initial work was done in a framework of a proposal for research which finally was not performed.

Interested in stratifying individuals in the life style dimension and to identify the relationship between this dimension and the socio-economic or "class" dimension Rainwater identified two more dimensions which need to be controlled in the model. These are the family/life cycle dimension* and the locational dimension. The assumption was that these in themselves affect life style and therefore need to be controlled for. The suggested model was:

Life Style Item = f (socio-economic, family/life cycle, geographic location)

where: each individual life style item (e.g., average daily number of hours watching TV, still in first marriage, amount saved sewing own clothes, etc.) is regressed as a simple equation against an array of independent variables describing the three dimensions. Following the estimation of the regression coefficients, it was suggested to identify the relationship between various groups of life style items and the explanatory variables, based on the estimated coefficients. Unfortunately, the empirical phase was not carried out so the evaluation of the suggested approach can only be on theoretical grounds.

Although one may challenge Rainwater's choice of model structure and specification, the notion of stratifying individuals in a life style dimension in addition to the dimensions of class, family life cycle and geographic location is appealing. We will return to this point later.

A completely different approach is that of time budget analysis. This approach is oriented toward planning and hence is more relevant to

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* Family/life cycle are the family structure and age composition.

this study. Chapin (1974) has collected data on respondents' demographic and socio-economic characteristics, their attitudes toward specific issues and a time allocation report for a 48 hour period. The analysis of this extensive data revealed that activities can be categorized into the four role complexes suggested in the CRA (1978a) definition of life style. A time budget analysis with a similar orientation but which relies more heavily on observable data was done by Michelson and Reed (1975). This and later work by Michelson (1977) are of particular interest in the context of this study as they found time allocation patterns to be related to housing type and location.

Reed (1976) has used time budget data in conjunction with other socio-economic information to derive a definition of life style. His results show that life style, as defined, is a differentiating trait among people who vary in residential mobility or, alternatively, an explanatory factor of people's behavior in the choice of residential location. The measurement method he applied was a reduction (using factor analysis) of a detailed time budget data set (husbands and wives in 761 families) into a number of factors termed activity dimensions. Reed suggests that life style appears to operate more as a latent factor than as a direct explicit consideration in residential location, i.e., people do not explicitly perceive life style as a factor in their consideration, but life style can add to the explanation of their behavior beyond the explanation given by other factors which are explicit like income, age, etc.

3.1.2.3 Applications in Transportation

Probably the first suggestion to utilize the life style concept in a transportation context was done by Notess (1973) who argued that a simple discrimination between life styles (e.g., mainstreamers, activity seekers, etc.) can be used in addition to the socio-economic variables to refine the description of a market in analyzing mode choice.

A recent attempt to measure life style in the transportation profession was made by Wachs (1979). Using the factorial ecology approach (Murdie, 1969)*, Wachs collected data on 51 socio-economic and demographic variables to describe the elderly population of 1159 zones (approximately the size of census tracts) in the Los Angeles area. The variables were reduced, using factor analysis, to seven "life-style dimensions" which in turn were used to identify clusters of the zones which supposedly represent life styles of the research population in those zones. Wachs argues that for metropolitan planning purposes it is not practical to include information on perceptual measures in addition to the environmental, demographic and socio-economic attributes. The factorial ecology approach though, assumes that there is a geographical clustering of individuals who practice similar life styles. Obviously, zonal data will not allow the testing of this assumption. Herbert Gans (1962, cited in Freidman and Juhasz, 1974) opposes

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* Factorial ecology is a descriptive methodology based on factor analysis, which attempts to identify underlying ecological factors for describing social structures of areas.

the view of this approach that an ecological setting can determine styles of life. He says that "...the ecological processes and conditions which [settlement types] synthesize have no direct or invariant consequences on the ways of life" (p. 114). Similarly, Burns (1968) claims that a move to the suburbs does not constitute a change in life style. It is only a fulfillment of an aspiration "to own". A similar view on the ecological factor was expressed by Adler, cited above. We also feel that using tract level data, assuming some homogeneity within such units, fails to identify much of the variation in taste and behavior between the dwellers of each tract. Life style seen as a behavioral concept and not merely as a combination of socio-economic attributes may vary even within a household.*

3.1.2.4 Applications in Economics

Economists have contributed to the analysis of life style through the "new home economics" approach (Nerlove, 1974). This is, at least at present, a more theoretical microeconomic approach which attempts to understand the resource allocation within households, identifying, for example, the trade-offs between time resources and market purchasable commodities. This has implications on life style relevant issues such as a wife's decision to enter the non-home work market. The basically theoretical approach, combined with some of the basic assump-

* In contrast to Wach's approach which assumes life style to be correlated with environmental factors, this study suggests and tests an hypothesis that people who share similar life styles also share locational preferences.

tions made by economists on taste variations (Nerlove, 1974, f.n. 9, Domencich and McFadden, 1975, also discussed in Chapter 4 of this thesis) make the practical relevance of this approach somewhat limited, although it can provide some insights to the development of a theoretical framework. The contribution of this approach will be discussed in Chapter 4.

3.1.3 A Typology of Life Style Conceptualizations

The diversity of definitions and conceptualizations presented in the previous two sections calls for an initial attempt to develop a typology which would assist in understanding the multiple connotations of life style in colloquial as well as scientific use. Further, a typology can assist in examining the compatibility of various definitions which seemingly are so different.

The development of a comprehensive typology is definitely beyond the scope of this study. Hence, we will attempt to develop only the general lines for a typology. The various conceptualizations can be sorted by at least three dimensions: the first being the unit to which it relates, or "whose life style?"; the second the nature of the concept, or the "what is it?"; and the third the means by which one identifies life styles, or the "how?".

The unit of association ranges from the individual to large groups. The approach taken by Adler and his followers stresses that life style is evolving within the individual based mainly on his or her personality traits. They note, however, that different individuals may have

similar life styles, thus allowing for some stratification of the population along similar life styles.* Among the wide range of groups to which life style has been related, the small group of the family has drawn much attention. Not only sociologists who are interested in group behavior but also psychologists as well as economists see the family as the smallest basic unit in which decisions are made collectively or at least the decisions of all members are strongly interrelated. Thus, all conceptualizations which refer to patterns of resource allocation can converge on the family as the basic unit of analysis.**

Some definitions deal with the concept of life style as a characteristic of larger groups. Among the larger groups again we find at one extreme such groups as communes which are in fact modern variations of the traditional family household and at the other extreme large groups like subcultures. The employment of the life style concept to the former is a consistent extension of the employment to the family unit. The use of the life style concept to the latter larger groups is different in its nature.

In sum, the reference to a specific unit of association can be the first dimension for classifying the life style definitions. The dimension ranges from the individual to very large groups. Is this diversity

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* It must be mentioned, however, that this is definitely carrying Adler's concept beyond his intentions. His work as a psychologist was geared to identifying (and treating) neurotic situations, and his concept of life style related mainly to individuals in such situations.

** This choice of a unit of analysis will be elaborated on in Chapter 5.

compatible? We suggest it is, but we will argue that following the discussion of the next dimension: the content of the concept.

Psychologists again represent one extreme. For them life style is a deeply-rooted personality trait: it is the individual's orientation to life taken as a teleological conception. The actual pattern of behavior for them is the physical manifestation of life style. At the other extreme we find a very pragmatic approach that looks at the pattern of allocation of resources as life style, or, even further, the combination of some socio-economic and environmental attributes is seen as life style. Yet, we have not found a single definition which does not attribute life style to some psychological characteristics, be it attitudes, personality traits or others. Consequently, it may be suggested that the conceptual nature of life style is similar in all these diverse definitions and they vary on a continuum of emphasis from the purely psychological definition to the purely pragmatic definition. This diversity stems from the basic scope of the different disciplines from which these definitions were drawn. It also stems from the philosophical approaches that these disciplines are employing. For example, the "revealed preference" approach deals only with the actual overt behavior. This approach does not downplay the role of psychological attributes in determining behavior, but rather it assumes that the revealed choice is the test of behavior given the implicit psychological attributes and the choice situation which the decision maker was facing. By contrast, the psychological approach may shed light on the decision maker's satisfaction with the choice made and

infer the likelihood of change in behavior. Also, it allows the identification of the issues which the decision maker is cognitively concerned with. Both these points may be overlooked by the revealed preference approach when applied to cross-sectional data.

What is common to all definitions, and thus makes them variations of a common notion, is the quest to define a concept which describes a behavioral unit (an individual or a group) by a descriptor which relates to a consistent orientation of behavior. Identification of a consistent orientation of behavior is a higher order abstraction than the simple identification of the relationship between specific choice behaviors and arrays of "simple" socio-economic variables. Adler and Weber talked about teleological concept of behavior. In the context of this study it may be appropriate to refer to tastes. An orientation of behavior is reflecting a consistent set of tastes and by identifying life styles we hypothesize that we identify a system of tastes.

Reviewing all definitions from this perspective, we find a consistent pattern of attempting to identify not only similarities in behavior but an orientation or a consistent taste. This quest is shared by all definitions pertaining to the individual or to the large group. In the case of the large group, the definition of life style will be in broader, more generalized terms to pertain to the common properties of the group's members. Of course, in any group members still retain some of their individual styles, not shared by others. (The group's style is the aggregate over its members, but there may conceptually also be a case in which a group's style is evident only at the aggregate level and

is not identified at the individual member's style. This case, it can be argued, is in itself a life style component of the members of such groups.)

The orientation component of life style which is suggested to align all behavioral decisions into a consistent pattern is a strong argument in favor of using life style to improve the probability of predicting the outcome of choice situations.

The third dimension of the typology is that of the methodological approach taken to identify life styles. Typically, each discipline follows its own methodology. Generally speaking, psychologists draw upon the identification by "early recollection" method (Baruth and Eckstein, 1978), sociologists and market analysts draw upon their tools of attitudinal surveys and multivariate analyses and economists use (not explicitly for life style, but for life style-related issues) the revealed preference approach for building models.

In this research, as will be shown in the following section, life style is defined to be a concept which relates the behavioral dimensions which traditionally fall within different disciplines. Therefore, the most appropriate methodology to identify life style will require a combination of methods which ignores the traditional boundaries of social science disciplines and draws upon methods from all. Conceivably, after enough experience is gained with operationalizations of life style, simplified methods consistent with more elaborate ones could be developed. At present, we are at an exploratory stage, far from being able to fully operationalize the concept of life style.

3.2 Accounting for Taste Variations in Existing Travel Behavior Models

The disaggregate travel demand modeling approach embodies a theory that choices are made by decision makers (individuals or households) who face a set of feasible alternatives (a choice set).* The decision rule most commonly applied is that of utility maximization. A decision maker t, will choose alternative i over alternative j, if

$$U_{it} > U_{ij} \qquad (3.1)$$

where U represents the utility. The utility of alternative i depends on the characteristics of that alternative relative to the characteristics of alternative j, as perceived by individual t. Hence, choices made by decision makers who face an identical choice set will vary, among other reasons, because each decision maker may assign different weights to the attributes of the alternatives, or, in other words, individuals' tastes will affect their choice.

In developing choice models, it is thus necessary to account for systematic taste variations and, thereby reduce the error in predicting behavior. Systematic taste variation is defined as the variations in the weights that individuals assign to particular attributes, which can be controlled by identifying the individual's characteristics which vary systematically with the weight assigned by that individual. For example, individuals assign different weights to the cost of travel. The income of these individuals can account for some of that systematic taste variation, as it can be assumed that the weights assigned to cost are a function of income. Random taste variations are those for which

* Disaggregate travel demand models are further described in Chapter 7.

one cannot identify a systematic variation. Some approaches have been developed to deal with taste variations by assuming some systematic variation across individuals. This chapter will describe these methods of dealing with the systematic taste variation and the reduction of random taste variation in models developed to date.

It is hypothesized that the current approaches of accounting for taste variations, namely, the inclusion of or the segmentation by descriptive socio-economic variables can be improved by the utilization of the life style concept. The following sections of this chapter will deal with the theoretical background and then will assess the performance of the two widely used approaches of dealing with systematic taste variation: inclusion of descriptive variables in the utility function and market segmentation. The summary section includes some examples which will illustrate some shortcomings of these approaches as currently applied.

3.2.1 Theoretical Background

The study of demand modeling in economics tends to overlook the taste differences among consumers. Domencich and McFadden (1975) point out that, when dealing with a commodity for which the quantities vary continuously, this general approach is plausible. The conventional analysis of demand assumes that the randomness in observations stems mainly from errors in measurement, which may be of such a magnitude that other sources of randomness (e.g., variation in tastes) are negligible. However, the authors show that in the case of a discrete commodity

with a finite, usually small, set of alternatives, which is the case in most travel analyses, this approach is not acceptable because the sensitivity to errors in a discrete commodity is greater than in a continuous commodity. Hence, accounting for differences among individual decision makers in the analysis of travel demand becomes necessary.

In the analysis of discrete choice Manski (1973) suggests that there are four sources of randomness in the "observed" utility of an individual. The errors or randomness are caused by (a) the omission of variables which may actually play a role in the individual's decision making, (b) the use of instrumental variables to represent actual variables, (c) errors in measurement and (d) taste variations. Manski assumes that the disturbances are additive and therefore, the utility functions of alternative i for individual t may be of the form

$$U_{it} = V_{it} + \varepsilon_{it} \tag{3.2}$$

where: V_{it} is a mean utility attribute

and ε_{it} is an additive disturbance.

If we assume a linear in the parameter functional form we can define the systematic component of the utility function as

$$\begin{aligned} V_{it} &= X'_{it}\theta_t \\ &= \sum_{k=1}^{K} X_{itk}\theta_{tk} \end{aligned} \tag{3.3}$$

where X_{it} is a vector of attributes of alternative i for individual t and θ_t is a vector of parameter of individual's t tastes.

The vector of attributes X_{it} can be expressed as:

$$X_{it} = f\ (Z_{it}, S_t) \qquad (3.4)$$

where: Z_{it} are attributes of the alternative itself

and: S_t are attributes of the decision maker, usually referred to as socio-economic characteristics.

In discussing taste variations as a source of randomness Manski points at three types of taste variations. The first is the variation across individuals. The second is the variation of taste over time for a given individual and the third is the possible variation in the functional form of the utility across individuals and over time.

Restricting the discussion to the variation across individuals at a given point of time and with a given functional form, we can, following Manski, define

$$\theta = E(\theta_t) \qquad (3.5)$$

where the expectation is taken over the population. For any decision maker t,

$$\theta_t = \theta + \phi_t \qquad (3.6)$$

where: ϕ_t is a random variable with $E(\phi_t) = 0$.

For a linear in the parameters utility function

$$U_{it} = X'_{it}\theta_t + \varepsilon_{it} \qquad (3.7)$$

we get:

$$U_{it} = X'_{it}\theta + X'_{it}\phi_t + \varepsilon_{it} \qquad (3.8)$$

where: $X'_{it}\theta$ is the mean utility based on the mean taste parameters and on the observed characteristics of alternative i and individual t, termed the systematic taste variations; and $X'_{it}\phi_t$ is a random component of the utility that includes the random taste parameters and this random utility is dependent on X_{it}.

Recalling that the X_{it} vector includes both the attributes of the alternative Z_{it} and the socio-economic attributes of the decision maker, S_t, it is basically assumed for the logit form models that tastes vary across individuals in a pattern correlated with the socio-economic characteristics. This assumption is plausible when investigating the value of time for example as correlated with income. However, it will be shown below that the socio-economic characteristics are limited in their capacity to account for systematic taste variations.

The variables may appear in the utility function either directly or as interactions of attributes of alternatives with some socio-economic attributes, i.e., a term with both variables present. The most notable example of interaction is that of the costs with income. The interaction type variables convey more information on taste variations as will be discussed in the following section.

Unlike other sources of randomness which can be assumed to be independent and identically distributed (IID), equation (3.8) shows that random taste variations are dependent on the characteristics of the alternatives. If this is true and significant, then given that the IID

assumption is required in the multinomial logit model (Domencich and McFadden, 1975), one must conclude that the use of this model formulation is inconsistent with the existence of random taste variations. Less restrictive models which do not require the IID assumption (e.g., probit) can be specified to account for random taste variations, as demonstrated by Bouthelier (1978) and Fischer and Nagin (1979). The latter compare the performance of a linear in parameter independently and identically distributed disturbances model (LPIID) with that of a random coefficients covarying disturbances model (RCCD), both of a probit form. The utility function in the RCCD model is of the form of equation (3.8).

Assuming that ϕ_{it} and also ε_{it} are multivariate normal results in a probit model. This comparison demonstrates that random taste variation is captured by the RCCD model, but the costs of estimation are significantly higher than the LPIID model. Another question to be considered is to what extent the assumption of normal distribution of the taste deviations is valid.

In testing the specification errors of logit models, Horowitz (1979) shows that these models lack robustness with regard to random taste variations (as well as other errors).

The importance of capturing taste variation is not limited to the objective of increased accuracy of the logit model. It lies in the ability to predict the behavior of different market segments more accurately, thus providing a better tool for policy analysis.

Given the advantages LPIID models currently have in terms of estima-

tion procedures, it becomes attractive to attempt means of overcoming their major deficiency, i.e., it is desired to reduce the random taste variations as far as possible by accounting for systematic taste variations. Two basic approaches have been explored and applied. The first is the inclusion of additional variables in the utility function which describe the decision maker, separately or interactively with other variables. The second is the segmentation of the market into segments which are hopefully homogeneous in taste. Often the two approaches are applied together. Let us now turn to an examination of each.

3.2.2 Inclusion of Variables

In an effort to improve the performance of models attempts are made to include all the relevant factors. In fact, there is an underlying desire to replicate reality. This, of course, is done within the bounds of reason and feasibility. Clearly, the more information we have on the systematic variation of the relevant factors and the resultant behavior, the smaller is the effect of random errors. In other words, we attempt to increase the role of the systematic taste variation and thereby to decrease as much as possible of the random variation.

In practice, the values of the taste parameters, θ's, are estimated and the more parameters are estimable, in terms of available data and statistical significance, the better is our understanding of the tastes of decision makers.

There are three types of variables used in the specification of the utility functions. They are variables which describe the alternatives,

variables which describe the decision makers and variables which are interactions of the first two types. The parameters estimated for each type convey different levels of information about systematic taste variations. The coefficients of the attributes of the alternatives provide no information, as they are the average weights assigned to the attributes by the whole sample. The second type, the variables describing the decision maker, provide information on the variation of the utility between sub-groups of the sample with regard to specific alternatives. The third type, the interaction terms, provide information on tastes with regard to specific attributes (e.g., cost related to income).

Given that the coefficients estimated for the first type, the attributes of the alternatives are the values of the parameter across the whole sample, our interest here lies in the latter two types, which relate to the "means" of segments of the sample. Most variables used in models appear in a non-interactive form. The variables commonly used in travel and mobility models to describe the decision maker can be classified into three main groups, with some falling into more than one category.

The first category is the socio-economic variables, foremost among which is income (which may also appear as an interaction term with cost as noted above). Its role in economic choice needs no further justification here. Other variables in this category include occupation and employment status (e.g., Gillen, 1977; Howe and Cohen, 1976) which serve as proxies for income, social status and indicators of comprehension or

control of information. Education level has a similar connotation. Race provides information about social status and in some types of models (e.g., residential location) may serve as an indicator of deterence to the selection of a particular alternative.

The second category is the demographic variables. They include household size, life cycle, sex, head of household, etc. (e.g., Train, 1973; Johnson and Adiv, 1978). The relevant information that they produce is the total demand for travel in a household, competition for means within the household, levels of activity (as represented by age) and differences in needs and behavior among males and females.

The third category can be labelled as availability and constraints variables. Many of the variables described above can fall within this category (income as a budget constraint, occupation as a proxy for time flexibility, household composition as constraining mobility, etc.). Yet, some variables describe availability and constraints per se. Auto ownership is a prominent example. Kingham (1978) has shown that the availability of an automobile as an explanatory variable in a mode choice model outweighs the explanatory power of all other socio-economic variables. The availability of a driver's license is another example in this category. Further, even a variable like the "government worker" indicator (or dummy variable) (Ben Akiva and Atherton, 1977), which captures the incentives given to government worker to carpool, is in fact a variable which describes the availability of particular level of service attribute for some members of the population. The CBD workplace variables found in some models are of similar nature except that they represent a cost, not an incentive.

The choice of variables to be used in the analysis of behavior is guided by many considerations. First, it should have a theoretical justification; its behavioral relevance must be clear. Second, it must be obtainable through the available data collection methods. These two considerations are required. Additional considerations include sensitivity to policy issues, sensitivity to particular groups of population, cost of data collection, ability to forecast its future trends, and more.

It is obvious that introducing more variables into a model also involves increasing costs. Monetary costs of collecting and computing additional information are just one facet of the cost. Another is the statistical costs in terms of degrees of freedom. Consequently, the tradeoff between the cost and benefit of the inclusion of each variable needs to be weighted.

The emphasis given to different types of variables is also noteworthy. As most policies in the past were intended to provide service improvements it was obvious that the level of service variables needs to be included in the model specifications. As policies have shifted toward management solutions, and, as transportation planners are starting to study policies which involve travel disincentives, the role of the variables describing the decision making unit whether an individual or a household, are becoming increasingly important. Yet, there are some problems associated with the choice of these variables. First, the socio-economic and demographic variables are clearly correlates of travel behavior and not causal variables (Brög, 1980). As such, their utiliza-

tion puts some limitations on the validity of prediction. Second, for prediction purposes, an argument can be made that aggregating disaggregate socio-economic data probably involves more inaccuracy than the aggregation of level of service attributes, as many of the latter simply vary by distance.

The third problem is more of a conceptual one. The description of complex human decision making mechanisms cannot be properly "replicated" by an array of additive attributes. The real interactions that take place between the actual, in contrast to the proxy, attributes are not and cannot be represented in a model given the current state of understanding behavior. Hence, we attempt to identify the best correlates. But, this argument is presented to caution the query for additional variables and instead take a new direction of search for more appropriate descriptors of the decision makers.

Beyond the choice of variables, there is another fundamental problem. Disaggregate models take into account only the "objectively observed" characteristics of the decision maker, i.e., the demographic and socio-economic attributes. It involves an assumption that these variables, even if fully exploited, can account for much of the systematic taste variation between observations. Psychological attributes such as perceptions and attitudes and factors like intra-family dynamics are excluded from disaggregate models*, and their effect is assumed to be captured by the other variables as well as by the revealed preference.

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* The role of psychological attributes as a basis for market segmentation will be discussed below. Some disaggregate models have recently been developed to account for intra-household inter-dependence (Jacobson, 1979).

Models that deal with psychological attributes belong to the category of "reported preference", and their state of development lags after that of revealed preference models (Hartgen, 1979). Yet, they definitely convey significant information about individuals' decision making processes. These complementing approaches are currently separate and means of building up their compatibility need to be developed.

3.2.3 Market Segmentation

The second method widely used for accounting for systematic taste variations is the segmentation of the population into groups which are assumed to be homogenous with respect to the behavioral aspect under study. In other words, different population groups are assumed to have different parameters of taste. Market segmentation is actually similar in concept to the inclusion of variables discussed in the last section, with the difference being that some variables, those serving as a segmentation basis, appear as interaction terms with a binary form, (0,1).

In practice, the model coefficients are estimated separately for each homogenous group or market segment. Assuming homogeneity of tastes within a segment, prediction of the responses to policy and other changes is carried out for each segment separately, thus also allowing policies oriented to specific population groups to be analyzed.* The differences between population groups can also be captured without separate estimation by means of specification of the utility function,

* For a review of market segmentation techniques in transportation analysis see Dobson (1979).

but this is only useful when some attributes are constrained to be identical across the sample population.

The choice of variables to be used as a basis for segmentation depends mainly on their power in improving the performance of a well specified model in the specific context it is to be used. Most importantly, the behavioral relevance of the segmentation basis needs to be considered. Segmentation along an irrelevant dimension will result in inaccurate prediction results. Only variables for which there are sound theoretical grounds for their explanatory power of a particular choice situation can be used successfully. The variable used must also have a limited number of distinct values which are relevant to the behavior under study. For example, auto ownership levels are clearly relevant to travel behavior and may serve as a basis for segmentation. By contrast, household size per se which also has a small number of distinct values, may have different effects on travel behavior depending on age composition; or income, the effect of which is usually easily identified, does not have a few distinguishable behavioral relevant values.

The variety of experimentations with market segmentation carried out to date can be classified along three dimensions. The first is the nature of the variables used for segmentation. Most often, demographic and socio-economic variables as well as choice constraints are used as a basis for segmentation. The first type includes attributes like age, income, etc. (Nicholaidis, Wachs, Golob, 1977; Lovelock, 1975; Ben-Akiva and Lerman, 1976). The second type differentiates between

groups which face different constraints (or lack of them) like modal availability (Nicolaidis, Wachs, Golob, 1977; Golob and Burns, 1978). The third type of variable used is attitudinal or perceptual data (Dobson and Tischer, 1978).

The second dimension is the form in which the variables are used. The segmentation can be based on the values of the variables directly, either in a unidimensional or multidimensional form, or alternatively, the variables may be transformed into a composite variable which serves as the basis for segmentation. The first type is used most frequently. Ben Akiva and Lerman (1976) have used a two dimensional segmentation: life cycle by occupation. Golob and Burns (1978) have used a unidimensional segmentation of choice set constraints and many other examples are available. The second type makes use of one or more statistical techniques which reduce a data matrix to its principal components. Factor analysis is the most widely applied technique by which an array of variables is reduced to a smaller number of factors based on correlations between variables. This technique is particularly useful when a large array of variables is available and the significance of any single variable is limited, as is the case in many attitudinal surveys. Dobson and Tischer (1978) have applied factor analysis in their perceptual market segmentation technique. Golob and Burns (1978) have used factor analysis to create socio-demographic segments, in addition to the choice constraint segmentation cited above. Another technique in this category is cluster analysis which divides a population into groups based

on multivariate similarity.* Cluster analysis using the factors derived from factor analysis were applied by Golob and Burns (1978) and Tardiff (1979).

The third dimension is a conceptual one: it distinguishes between choice specific and generic segmentation. Most applications of market segmentation have justifiably chosen as a basis variables which are sensitive to the specific behavioral choice the model deals with (e.g., auto ownership for mode choice, life cycle and occupation for auto ownership choice, etc.). Yet, conceptually as well as practically, a generic segmentation, one which is applicable to the whole range of spatial choice models is very attractive. While a generic basis may lose its sensitivity to some specific choice situation, it can be practical for a wide range of applications.

The segmentation scheme developed by Ben-Akiva and Lerman (1976) is used in this study as a benchmark for comparison and assessment of the life style-based segmentation. Their segmentation scheme is based on life cycle and occupation, where life cycle constitutes four categories: young and old each with or without children, and occupation is either blue or white collar. A total of eight segments were formed. The underlying assumption in the choice of the life cycle and occupation as classifying dimensions was that these capture some loosely conceived life style. In other words, these dimensions were assumed to represent a wider set of characteristics which are correlated with them and typify certain population groups.

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* This technique is described in Section 5.5.

There is general agreement that market segmentation is a useful technique to capture taste differences between population groups. As to the segmentation basis, no single approach has been shown to be universally superior (Nicolaidis, Wachs and Golob, 1977). The choice of segmentation basis thus depends on the context and needs. The technique also provides a method for incorporating attitudinal data in disaggregate "revealed preference" models, which to date are not explicitly treated by disaggregate models.

The limitations of using market segmentation involve the decision on the number of desired segments. A small number of segments may not provide the desired discrimination among the segments, i.e., the variance in behavior within a segment may be close to the variance among segments, and the estimated coefficient may not be significantly different. On the other extreme, if each individual is treated as a segment, no significant estimates can be obtained (unless longitudinal data on repeated choices is available). The desired number of segments is that which has a theoretical basis and is still practically manageable in size.

3.3 Summary and Conclusions: What is Left Out?

Two methods, applied separately or jointly, can be utilized in order to capture systematic taste variation among decision makers, and thereby reduce the random components in choice models. Both methods, inclusion of descriptive variables and market segmentation, are capable of capturing taste variation which is assumed to vary with socio-economic, demographic and psychological attributes of the decision maker. In fact,

the two methods are very similar: the market segmentation is a restrictive form, assuming that the tastes vary across all attributes while the inclusion of variables is, in most cases, a less restrictive form. It allows some attributes to have identical weights over the sample while other attributes are assigned different weights.

Regardless of the choice of method, however, in their usual applications there is a key underlying assumption that taste variations are largely captured by socio-economic, demographic or psychological attributes each represented separately. This assumption is being examined in this study.

It is argued that travel behavior modeling has by and large tended to deal with "slices" of behavior, namely choice situations which are viewed as independent of their broader context. Trip making behavior (the choice of mode, destination, frequency, etc.) was and still is largely treated in separation from other trips done in preceding or following sojourns, independent of other household members' trip making and so on. Similarly, the human being whose behavior is the essence of the models is also represented by variables which at best describe but a few attributes of that complex entity.

In recent years more attention has been paid to the interdependence in trip making behavior, first by developing a choice hierarchy, later by the inclusion of variables which account for interdependencies and most recently by the explicit modeling of activity patterns and trip chaining. But, the parallel development in the comprehension of the taste variations has not occurred. The revealed preference approach still treats the decision makers as the bearers of a few socio-economic

additive attributes. Alternative approaches, which focus on the attributes of the individual as an entity with attitudes and values, have been developed but are still not compatible with the models of revealed preference. Some attempts at combining the revealed preference and psychological approaches into a single analysis have taken place (e.g., Koppelman and Hauser, 1978).

This thesis is offering one additional step in the direction of broader understanding of travel behavior by representing the decision-maker with a higher level construct than the simple array of socio-economic attributes. The concept of life style, it is suggested, is capable of representing preferences or tastes of individuals which are not choice specific and do not depend on a single or a very few socio-economic attributes.

Chapter 4: Life Style as a Concept of Behavior - A Theory

The work presented heretofore demonstrates the lack of a theory of life style within the behavioral sciences. Yet, evidently, the notion of life style exists both in colloquial use as well as in the social sciences. The question that this research is addressing may be phrased as the (re)examination of whether the concept is merely a loosely defined popular notion (and statistical artifact) or whether it is a factor in shaping or at least explaining behavior.

To comprehend the advantage of life style as a composite social variable which is advantageous in its explanatory power over its individual components, it is first necessary to review the major dimensions of behavior, specifically spatial behavior, and the means by which current behavioral modelling efforts account for them.

We stress the "spatial behavior" because as transportation planners, or in the planning profession in general we are interested in understanding peoples' use of space as a particular dimension of behavior.

Section 4.1 will describe the nature of each of the major four dimensions and note the manner by which they are captured or accounted for in available models. This description will, it is hoped, demonstrate the need for broadening the interaction between the behavioral dimensions. The concept of life style as conceived in this study serves to accomplish this objective. The theory of life style contributed by this study is described in Section 4.2. The major hypotheses of the study are then described in Section 4.3 and the chapter is concluded with a short description of the research approach.

4.1 Dimensions of Behavior

At least four distinct but interdependent dimensions need to be considered in the analysis of spatial behavior. Literally, spatial behavior relates to the spatial dimension and to the time dimension, as behavior is the action along the time dimension. The additional two dimensions are the inter-personal and the intra-personal dimensions.

The four dimensions define a space within which behavior occurs. Thus, any type or quality of behavior can be mapped into this conceptual space. This is illustrated in Section 4.1.5.

The following sections will treat each dimension separately, and they are not intended to present a comprehensive review of behavioral modeling approaches but rather to demonstrate the interdependence of the different dimensions of behavior and the limitations of the piece-meal modeling approaches which prevail today, which in most cases do not treat all four dimensions.

4.1.1 The Spatial Dimension

Treatment of the spatial dimension in modeling behavior is probably the simplest. We tend to use a two dimensional plane on which we can represent movements. *

The interdependence between space and behavior is usually treated by cost functions which represent the deterrence to movements in the space. In practice, the spatial dimension can thus be ignored and be

* In the context of a study on the "back to the city" movement one may think of treating space in all three dimensions, analyzing the trade-offs between vertical (high-rise complexes) and horizontal movement, as a means to reduce demand for horizontal movement.

represented only by the cost function. Yet, in some instances, particular attributes of space are desired and need to be treated explicitly as a separate dimension. Such are, for example, qualitative attributes of neighborhoods, topographic or morphological features, etc.

4.1.2 The Inter-personal Dimension

Second in order of complexity is probably the inter-personal dimension. Included are at least three distinct levels of inter-personal effects on behavior, ranging from within household interdependence, through an individual interaction with other people (including his or her economic activity) to the interdependence of an individual with society as a whole, which imposes values and norms of behavior.

4.1.2.1 Intra-household Level

Within a household, a person's behavior is dependent, to varying degrees, on the behavior of other members. There is competition for means in the household and there is some degree of joint decision making. Jacobson (1979) and Steinberg, Allaman and Dunbar (1979) have suggested that married people practice joint time allocation decisions. Childrens' spatial behavior clearly depends on decisions made by adult members of the household. Such attributes of inter-personal dependencies are accounted for, in some econometric models, by socio-economic and demographic variables which are assumed to capture some of these effects. The limitation of this approach is evident: the marital status or the presence of children in the household, in themselves, are at best only

proxies to the actual type and dynamics of the household's decision making processes, as these also depend on both cultural background and personal attitudes. An alternative approach recently developed is that of panel type data collection or interactive measurement in which the interpersonal dynamics within a family can be observed (e.g., Jones, 1976; Brög, 1979). This type of study provides information on the decision making process, but suffers from the drawback that the "decisions" are made under hypothetical situations and are therefore stated preferences and may not be the behavior when confronted with an actual choice.

4.1.2.2 Social and Economic Activities

The next level of the interpersonal dimension is the interaction of the individual with people from other households. Here we include all economic and leisure activities which involve other people. Shopping, work, social and some recreational activities are the most prominent. The need to maintain oneself (or a household) requires some engagement in economic activities. The residual time resources are spent either in social engagements or in solitary activities, according to the commitments one has toward the social environment and his or her own preference (intrapersonal dimension). These interpersonal interactions impose requirements for movement in space and in time. Given that these movements involve interaction among persons, there needs to be convergence points in time and space, known as peak and off-peak periods and congestion.

In modeling behavior, the treatment of these interactions is done mainly by using situation-specific models. Examples are models for specific trip purposes (assuming that each purpose has different elasticities), models which deal with specific groups (e.g., workers or non-workers), and models which deal with specific interactions such as ride sharing. A different approach, which can be used jointly with the first, is the specification of any number of variables which represent directly or indirectly the commitments one has to interact with others or the implications of such commitments. The cost function for peak-period travel is an example of representation of the interaction with other people at certain points of space and time.

4.1.2.3 The Social-Cultural System

The third level of interpersonal interactions is that of interacting with society as a whole. A person living in society is confronted with a set, or in a pluralistic society, many sets of values and norms which he or she may conform with or reject (depending again on intrapersonal attributes). Whichever is chosen, it implies a certain set of rules represented either by legislation or by informal norms. Obeying parking regulations means conforming to the formal rules, while discriminating women in the use of automobiles may be seen as conforming with informal rules in some cultures. Note that this demonstrates the interaction between the different levels of the interpersonal dimension.

These third level interactions usually do not receive explicit consideration in models of spatial behavior. Differences in norms and

values of subcultures have generally been ignored by most of the transportation planning methods and hence such peculiar travel behavior as driving up and down the low income neighborhood streets in a luxury automobile must have been considered as error in the data rather than the expected behavior in some subcultures. Moreover, in the evaluation of models, analysts assess the estimates of various coefficients by whether or not they intuitively "make sense". This is obviously sensible based on the a priori expectations of the analyst which need not be shared by the population analyzed, and consequently models may not reflect the "unexpected" behavior which is in fact expected in some population groups. While the literature on professional ethics has addressed this point (cf. Manheim, 1980), little has been done to effectively deal with it in the modeling arena. Changes in the planning process which require public inputs and the recent interest in the transportation needs of disadvantaged groups has already brought about the development of some models which deal with specific groups. Although these do not explicitly treat the different norms and values, they probably do capture some of the effects.

4.1.2.4 Summary

In summary, the approaches to dealing with the interpersonal dimension explicitly account for only some of the types of interactions, while others are overlooked. Also, the interactions accounted for are assumed to be uniform across individuals who share similar socio-economic and demographic characteristics. Differences in interpersonal

behavior which result from psychological attributes, all else being equal, are assumed to be part of the random component in models of revealed preference.

4.1.3 The Intrapersonal Dimension

The intrapersonal dimension refers to the personality subsystem in Parson's (1966) conceptualization of behavior.* Human reactions to stimuli are interpreted through preferences, opinions, and attitudes. While no one doubts the role that these factors play in shaping behaviors, there are conflicting opinions as to the role they should assume in practical planning models. Basically, the econometric revealed-preference type models assume that by identifying the context (the other subsystems in Parson's definition) and the actual choice made by an individual, it is possible to predict behavior, as the attitudes and opinions are implicitly captured in the revealed behavior. In addition, attitudes and opinions cannot be reliably or easily predicted and hence their practicality for forecasting is limited.

By contrast, dealing with the psychological attributes in a variety of modeling approaches is more powerful than the revealed preference approach in explaining choice making processes. The assumption that the decision maker has perfect information is not required. On the contrary, the analysis of the intrapersonal dimension can provide know-

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* Behavior according to Talcott Parson (1966) (as cited by Porteous, 1977) is the overt action performed by the individual in response to an environmental or self-generated stimulus, and mediated by five subsystems. These are (a) physiological subsystem, (b) cultural subsystem, (c) social subsystem, (d) personality subsystem, and (e) environmental subsystem.

ledge on what type of information is passively or actively accumulated by decision makers and through what type of subjective transformation the information is processed. A considerable body of research done by geographers and psychologists was devoted to the understanding of mental gaps, subjective distance and time perception, etc.* Developing methods to improve our understanding of subjective perception of time, distance and other level of service attributes can only be done by analysis of the intrapersonal dimension.

The analysis of the information processing at the individual's level can also throw light on the actual attributes which cognitively enter the decision process. As such, studies of attitudes can be useful for the development of both policies and marketing strategies.

The major shortcoming of using only psychological information for the understanding of travel behavior lies in the fact that the research methodology cannot be used as a reliable forecasting tool. First, because respondents express their views on hypothetical situations. Their actual behavior may be significantly different if in fact they face the choice situation which currently is described and perceived in biased form by both the interviewer (or the phrasing of the question in a written form) and the respondent. Second, psychological characteristics such as attitudes and personality traits cannot be predicted and therefore are of limited use for forecasting.

To date, the development of models which explicitly treat the

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* A comprehensive review of these is given in Rapoport (1976).

intrapersonal dimension has been independent of studies which deal with revealed choice (Hartgen, 1979) and the compatibility of the two types of information is limited. Some initial developments toward utilizing the knowledge gathered from the analysis of the intrapersonal dimension have emerged. Market segmentation based on attitudes (Tardiff, 1979) is one such example. Some others are presented in Chapter 3.

The intrapersonal dimension of behavior has another, deeper significance which requires attention. Most current models of travel behavior are based on the assumption that people are utility maximizers. This assumption is often criticized and occasionally alternative assumptions are suggested. The latest of the critiques is by Talvitie (1980) who goes back to Freud's dualistic "drive" concept to reject the assumption of utility maximization and most of the basics of today's planning concepts. Other authors suggested alternatives to the utility maximization approach. Tversky (1972) suggests that rather than maximizing a utility, people search through alternatives with the objective of eliminating those for which some aspects or attributes are perceived as undesirable. Other approaches for decision rules suggest that people choose by perceiving the dominance of one alternative over the others by selecting an alternative which satisfies a set of perceived needs or requirements.

Further development in behavioral research may shed more light on alternatives to the utility maximization approach or, alternatively, may strengthen its foundations.

4.1.4 The Temporal Dimension

Undoubtedly, the most complex dimension of behavior is time. The concept of time has over the years received only little attention in the behavioral sciences.* In recent years there is an increasing interest in time and numerous approaches are being explored to conceptualize it in philosophical and analytical meaningful ways. While finding time to be a crucial concept to the understanding of life style, we also find it to be too broad a subject to be reviewed here. Reviews of recent developments in the treatment of time in spatial behavior contexts can be found elsewhere.** Here, we will limit ourselves to a brief discussion of those notions relevant to the life style concept.

Among the myriad of connotations to the concept of time, two distinct meanings should be noted at the outset: first, time is a quantity or a measurable period. In this sense one can relate to units of time or duration spent at locations or activities and conceive time as a resource. The second meaning is that of time as a continuous sequence or an irreversible flow. The clear relationship between the two meanings is that the latter can be measured in units of time, elapsed or projected, relative to a defined origin. Hence, all decisions

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* Most research on time in behavioral sciences has been carried out by psychologists (cf. Orme, 1969; Cottle, 1976; Yaker, Osmond and Cheek, 1971) and with a totally different perspective by philosophers (cf. review of theories of time in Orme, 1969).

**Some valuable references include Carlstein Park and Thrift (1978), Vol. 1-3, Isard and Liossatos (1979), Lynch (1972), and Rapoport (1977).

of time allocations are inescapable of the calendar time which makes them, in essence, irreversible.

The interest of behavioral sciences in time stems from three factors. The first, which will be demonstrated throughout this section, is the complex interdependencies of activities along the time dimension. The second obvious reason is that in many cases the analyst is interested in making predictions of behavior and thus, whatever he or she may learn about past and present behavior must be projected into a point of time which lies ahead. The consequences of time therefore are an important consideration. Third, in recent years temporal policies such as flexible work time have drawn a growing attention of planners, both because they have the potential of ameliorating some of the effects of congestion and because they may improve the public welfare by allowing greater freedom of choice (OECD, 1976).

Time is the one dimension that interacts continuously with all other dimensions of behavior. Time can be viewed in an economic sense as a limited (and viewing it as a continuous sequence, an irreversible) resource. Hence, any behavior which inevitably is time consuming can be seen as a result of a resource allocation decision. As such, time is used as a scalar measure of a resource of which certain quantities are allocated to particular activities. In a most trivial manner, time is treated as part of the cost component in travel choice models (i.e., the time allocated to travel) as any movement in space requires time. This, it is suggested, is a very limited approach to the treatment of time and is of little value. It can teach us about the elasticity with

respect to time or the value of time for the choice in question. But even this information is probably valid only within a quite narrowly bounded range because it treats time in a simplistic scalar form.

Studies of time budget overcome this latter drawback. They collect and interpret information about time allocation to reflect the preferences and constraints within which people live. This is a higher level of the treatment of time, as it treats the total allocation within a time period (e.g., a workday, a week), some inference about the interdependence of activities can thereby be drawn, since the total time is a constant. It can also capture some of the rhythmic cycles of time such as the daily pattern of trip to work, work, return home, meals, sleeping, etc. But still, the main emphasis in time budget studies is on time as a resource and not as a sequence.

By illustration, these two approaches point at three important issues in the treatment of time in spatial behavior analysis. First, that time is a scarce resource and peoples' behavior manifests explicit, though not necessarily cognitive, decisions about its allocation. Second, because time is a continuous flow, activities are necessarily interdependent as participation in any activity can only be done if in the previous time period the necessary conditions for participation have been fulfilled. And, a decision to participate in one activity affects the possibility of participating in others. Third, as time flows we can observe some rhythmic cycles, the frequency of which varies considerably. Some cycles are natural (e.g., the needs to eat and rest, day and night, season, etc.), others are cultural (e.g., worktime,

weeks, holidays, election, etc.), and some are combinations thereof (e.g., life cycle). As these cycles all occur concurrently but have different cycle length, and needless to mention, some random components, behavioral decisions may have impacts on various cycles or alternatively stated, the impacts may take effect over a range of times. Figure 4.1 illustrates a simplified conceptualization of the nested structure of interdependence between some of the various cycles. In viewing this figure as with any other conceptualization of time, one should consider not only the interdependence along this single dimension (of time) but also the implication of events on the other dimensions of behavior discussed above. Consider, for example, interactions with the interpersonal dimension: an individual's cycles can be determined or interrupted by the cycles of other members of the household with which he or she must coordinate, or the constraints imposed by the economic activity (i.e., work, shopping) schedules one has to engage in determine the daily, weekly, and annual cycle. The interaction with the intrapersonal dimension need be noted as well. An individual's cycles may be determined or interrupted by his or her perception of time as well as the perceived ability to control the allocation of time.

Another issue that requires attention is the categorization of time to past, present, and future. Any experience gained in the past is subjectively interpreted into knowledge which at present affects one's decisions and expectations concerning the future. Consequently, in situations which seem similar, decisions may vary because of past experience. Also, past experience has inertia which may be powerful

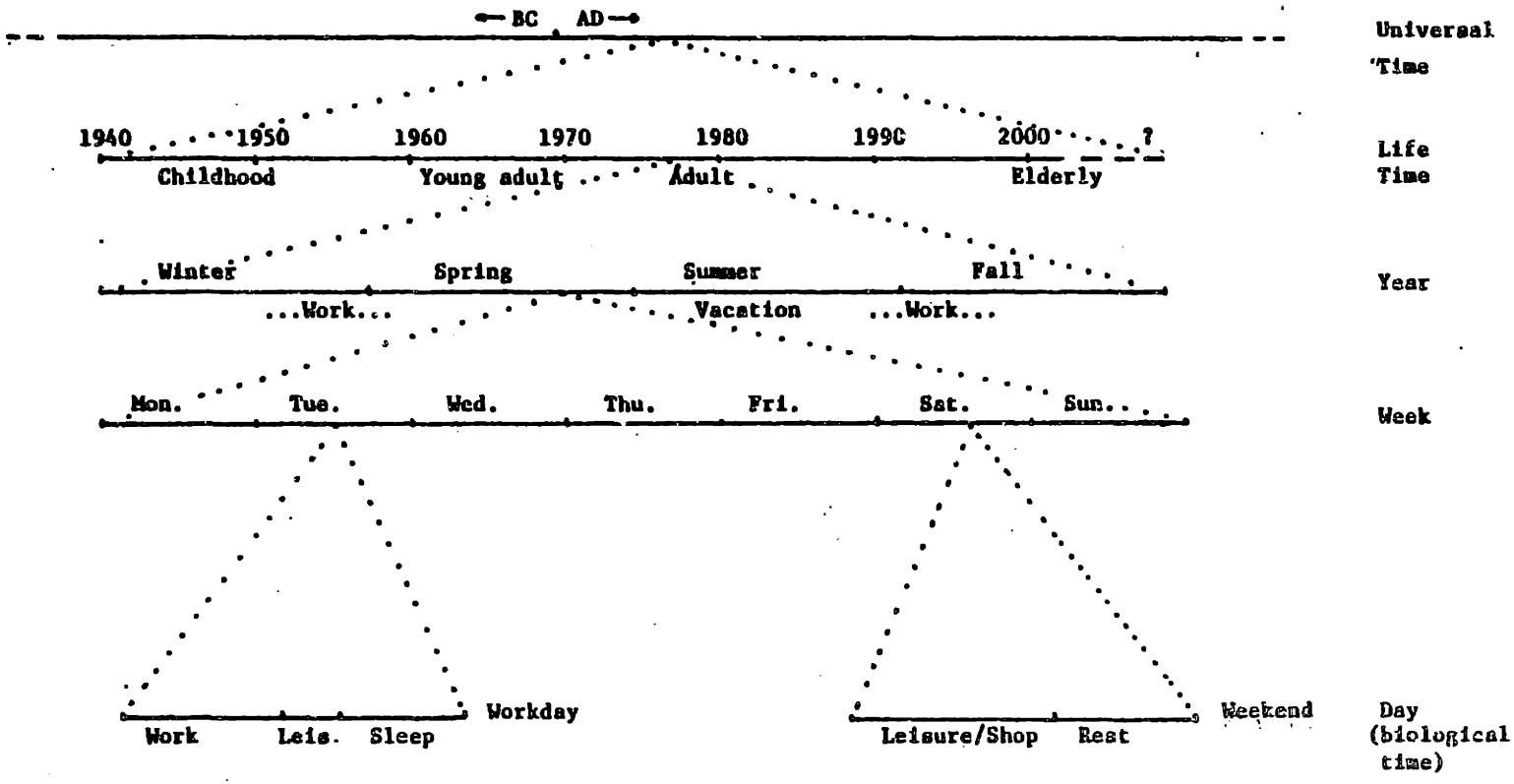

Figure 4.1 : Simple Illustration of Nested Time Cycles of an Individual

enough to eliminate what otherwise would be expected to be the "rational choice". Inertia may represent either of a number of situations or combinations of those. First, observed inertia may be a result of a lag of time in the flow of information, i.e., the information about the utility maximizing alternative either has not reached or was not yet perceived by the individual. Second, inertia may be the result of perceived or real transaction costs which within some perceived time horizon seem to override the savings which may be incurred by a new alternative. The existence of past and future have further implications which need to be accounted for in modeling behavior. For example, a person perceives as his or her economic resources not only the present assets and income but also the future income. A decision to allocate resources at a given point of time thus reflects not the current observed economic resources but the subjectively perceived resources available in the present and in the future. This is what Friedman termed "permanent income" (Friedman, 1976). Another example would be the case in which a person has made a decision to, say, relocate residence but that decision has not yet been implemented. Given that the decision was already made, that person may for the intermediate period, which can last as long as a year, manifest travel behavior which is based on his perception of the new situation and not on the current observed state.

The perception of past and future by decision makers puts a strong limitation on cross-sectional analyses. Inertia and time gaps between decisions and their materialization cannot be captured by cross-sectional

models and are often interpreted as noise. The concept of permanent income might be condensed into a current value but this requires in-depth information about the individual or a proxy may be developed based on age, education and, necessarily, some subjective information about plans.*

A useful concept for the following discussion is that of choice hierarchy suggested by Ben Akiva (1973)*. The choice hierarchy, depicted in Figure 4.2 consists of two blocks, that of mobility decisions at the top and that of travel choices in the bottom. Within each block, it is suggested that the structure is of joint choices. The choices in the lower block are partially dependent on those made in the mobility decisions. The content of each block should not be seen as strict. For some instances one or more choices may constitute separate blocks. What is essential though, is the hierarchical structure in which some choices are bounded by those made on a different level.

Time is integrated in the concept of choice hierarchy. First, one can label the two blocks as time related: the upper block is the long range decisions and the lower block is the short term decisions. The hierarchical structure implies that when one deals with a travel choice, certain variables are "predetermined" by the mobility choice made earlier. In other words, there is some (varying by case) degree

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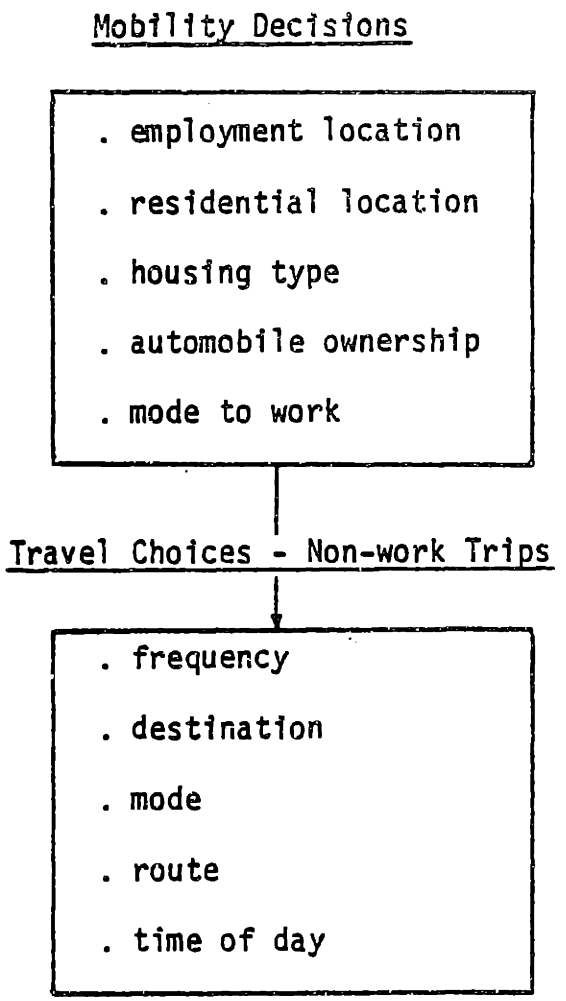
* Some experiments in estimating permanent income based on current income and other attributes have been carried out (cf. Carlton, 1975).

** The concept of a choice hierarchy is also important in the context of another time related concept, accessibility, which is presented in Ben Akiva and Lerman (1977) and will not be discussed here.

Figure 4.2

A Choice Hierarchy



Source: Ben Akiva and Lerman (1977).

of accounting for a broader perspective or other cycles on the choice situation. The choices involved in a non-work trip are not treated in isolation, they are seen in the context of broader, more stable deicsions made previously.

This is one method of integrating the dynamics of time into a behavioral model. Here, although each separated model is static, its location in the general hierarchy implies what choices have been made previously and affect the current choice. But, as the model system is conventionally employed only once, for a given point of time or scenario the dynamics are only ordinal, i.e., the order of effects is accounted for but not the actual effect of time. In this manner there is also no mechanism for feedback and change over time.

Another solution to the integration of time in models of behavior is done by "dynamic models", a wide family of models which explicitly treat time sequence by iterating over intermediate time units up to the target data. In this approach, which may be termed by analogy "interval" dynamics, some of the intermediate effects are explicitly reentered to the model calculation. For example, the effect of particular events which are known to take effect at particular points of "calendar" time can be integrated in the model. This has been done by Sherman and Manski (1979) who developed a model for predicting the effects of gasoline prices and vehicle design attributes (e.g., fuel efficiency) on consumer choice of vehicle type. The events which entered the model were the dates on which certain fuel efficiency standards must be met as required by the law.

Another approach to the treatment of time in models of spatial behavior which recently is drawing increasing interest is that of activity modeling. In this approach, the basic assumption often ignored in the analysis of travel behavior is made very explicit, namely, the demand for travel is a derived demand. The actual commodity is the activities or the combinations of time and space. The choice that needs to be understood and predicted is the choice to participate in activities, and conditional on that, the choice of schedule, i.e., the combination of activity durations and locations of which the travel choices are the outcome. Thus, Damm (1979) and Jacobson (1979) have suggested including in the travel choice block (Figure 4.2) two types of choices. The activity-related choices include the type, duration, frequency of participation and the time of day. The trip-related choices include the destination, route, and mode choices. Within this conceptual framework one can estimate models of activity participation and scheduling. Under the assumption that scheduling of activities (and trips) is done as a single choice, models of trip chaining can also be estimated, to capture the temporal (and possibly spatial) interdependence of trips (Adler and Ben-Akiva, 1979; Horowitz, 1979; Van der Hoorn, 1979).

In summary, time, both as a resource and as a sequence, is intricately interrelated to the spatial, the inter-personal, and the intrapersonal dimensions of behavior. Behavioral sciences have mostly dealt with time as a resource and ignored its cyclic characteristic, its flow along a calendar sequence and the conceptualization of perceived past and future

in cross-sectional analysis. In recent years with the realization of these shortcomings and the growing interest in temporal policy options, a number of directions have been pursued to integrate at least some of the complexities of the temporal dimension of behavior in modeling efforts. The following section will demonstrate how it is suggested the life style concept is yet another contribution to this effort.

4.1.5 Qualitative Aspects of Behavior

As noted earlier, the four dimensions of spatial behavior define a space within which any type of behavior can be mapped. Some examples will illustrate the meaning of this space concept. Consider the work activity of a production worker. It occurs over a certain span of the temporal dimension and has its rhythmic nature over a day, a week, a year and a life span. It takes place at a specific point of the spatial dimension. It involves a certain specific combination of interpersonal interdependence with other workers, with non-workers, with the household members, and with society at large. These are obviously also interrelated with the intrapersonal attributes.

Of more interest here is an example of travel behavior. Consider the movement of an individual from home to work. The spatial and temporal dimensions are obvious. The interpersonal dimension, in the broad definition given above, relates to the interrelationship with other members of the household who may be competing for the same means of travel or may join the trip or may even serve as drivers for the trip. Interdependence on other people, closely interrelated with the spatial

and temporal dimensions are, for example, the congestion effects, safety of the trip, costs, and possible social interaction during the trip. The choice of mode for the trip is thus a unique combination of space (road vs. rail), time (speed), interpersonal (interaction, competition, economic effects), and intrapersonal (desire for comfort, privacy) dimensions.

To conclude, the four dimensions are defining a space in which any type or quality of behavior can be mapped as a unique combination. It might be desirable to conceptualize the broadly defined interpersonal dimension as having its sub-dimensions of household, social interaction, economic activity and cultural context to further explain the behavioral space.

4.2 Broadening the Interaction of Behavioral Dimensions

The preceding sections have demonstrated the intricate structure of behavior as being the manifestation of interactions of four dimensions, each of which is complex and only partially understood in itself. They have also indicated some of the limitations of modeling efforts in dealing with this complex structure. This thesis suggests that the utilization of the concept of life style as a method for accounting for some of the interactions between the dimensions reviewed above, will improve our understanding of spatial behavior. To explain life style as conceived in this study, this section will first refer to a related concept, that of life decisions, and then pursue the life style concept.

4.2.1 The Concept of Life Decisions

The focus of most modeling efforts which treat time explicitly was the relatively short period of a day, a week or possibly even a year. Decisions of time allocations over these periods are, of course, of interest for studies of conventional temporal policies such as flexible work time, leisure related policies, and the like. While for many uses this time range suffices, there are decisions to which we will refer as life decisions or life choices which are taken in reference to a time frame which is significantly longer. They may extend in the magnitude of a few years or more, yet they have very clear implications on the daily life patterns.

Life decisions are the decisions made by an individual about his or her own life. They relate to the longest cycle of time over which an individual has control. Shapcott and Steadman (1978) define life decisions as those which commit the individual to a long term, for example, marriage, taking particular jobs, residential location, etc.

The long term choices which people make have been identified by some behavioral sciences, although the label of "life decisions" was not explicitly used. Ghez and Becker (1975) suggest a theory of allocation of time and goods over the life cycle. They argue that the decisions on family formation (or dissolution), engagement in the labor force and investment in human capital (e.g., education) can be explained by economic reasoning and manifest a pattern which correlates with life cycle. A normative perspective on the lifelong allocation of time is offered by Chalendar (OECD, 1976), who argues for greater flexibility

in the use of time in a manner which will allow people in different life cycles to engage in activities of their choice rather than in the firmly prescribed course of compulsory education at a young age, followed by work and compulsory retirement. Psychologists also address the long term or life span behavior (Baltes and Brim, 1979), although their focal interest is in the impact on the individual's psyche rather than the effect on the social aggregate.

The concept of life decisions is important and interesting in its relation to the daily behavior. Cullen and Phelps (1975) and Cullen (1978) suggest that behavioral choices should be classified by their motivation rather than their physical or observed features. This would correlate with the level of deliberate premeditation involved in making the choice. Actions which involved much premeditation are separated from the decisions by longer time than actions which involved little or no premeditation. For example, an action of relocating residence or changing employment type or location is usually based on longer premeditation than a shopping trip to the street corner grocery store. The time that elapses between the decision making and the execution of the action is longer in the first type and approaches null in impulsive actions.

Cullen (1978) suggests that the highly routinized daily pattern of behavior ("life style" in Cullen's terminology) is the manifestation of life choices which are the most highly premeditated decision, as "Repetitive deliberation and choice are impossible luxuries when it comes to day to day living in the post-industrial city". Cullen and Phelps have

shown in their empirical work that about 80% of daily activities engaged by their sample population were part of the routinized pattern. The remaining 20% were not routinized and were either "planned" or impulsive activities such as shopping trips and participation in organized leisure.

4.2.2 An Extended Choice Hierarchy

Building upon this view it is suggested to extend the choice hierarchy concept to include an additional block which includes the life decision. Figure 4.3 illustrates the suggested extension. The life decision block should at this stage be seen as a conceptual notion, representing the longest range decisions taken by individuals. It includes at least three separate cardinal choices: the choice of family formation, the choice of participation in the labor force, and a choice on the orientation toward leisure. These three choices are, it is suggested, done jointly. Economists (Nerlove, 1974) have also suggested that the decision on educational investment is simultaneously made with the first two, but it can be argued that it is part of or a variant of the decision on participation in the labor force.

The life decisions are made within a social and cultural context, shown in the dotted circle in Figure 4.3. This context bounds the range of alternatives for each of the decisions. For example, the choice of remaining childless and having an abortion is not permissible in some subcultures and rejecting the context may in many cases require abandoning the subculture, as is often the case with non-conformists. Also, in some cases the bounds may be such as to include just a single

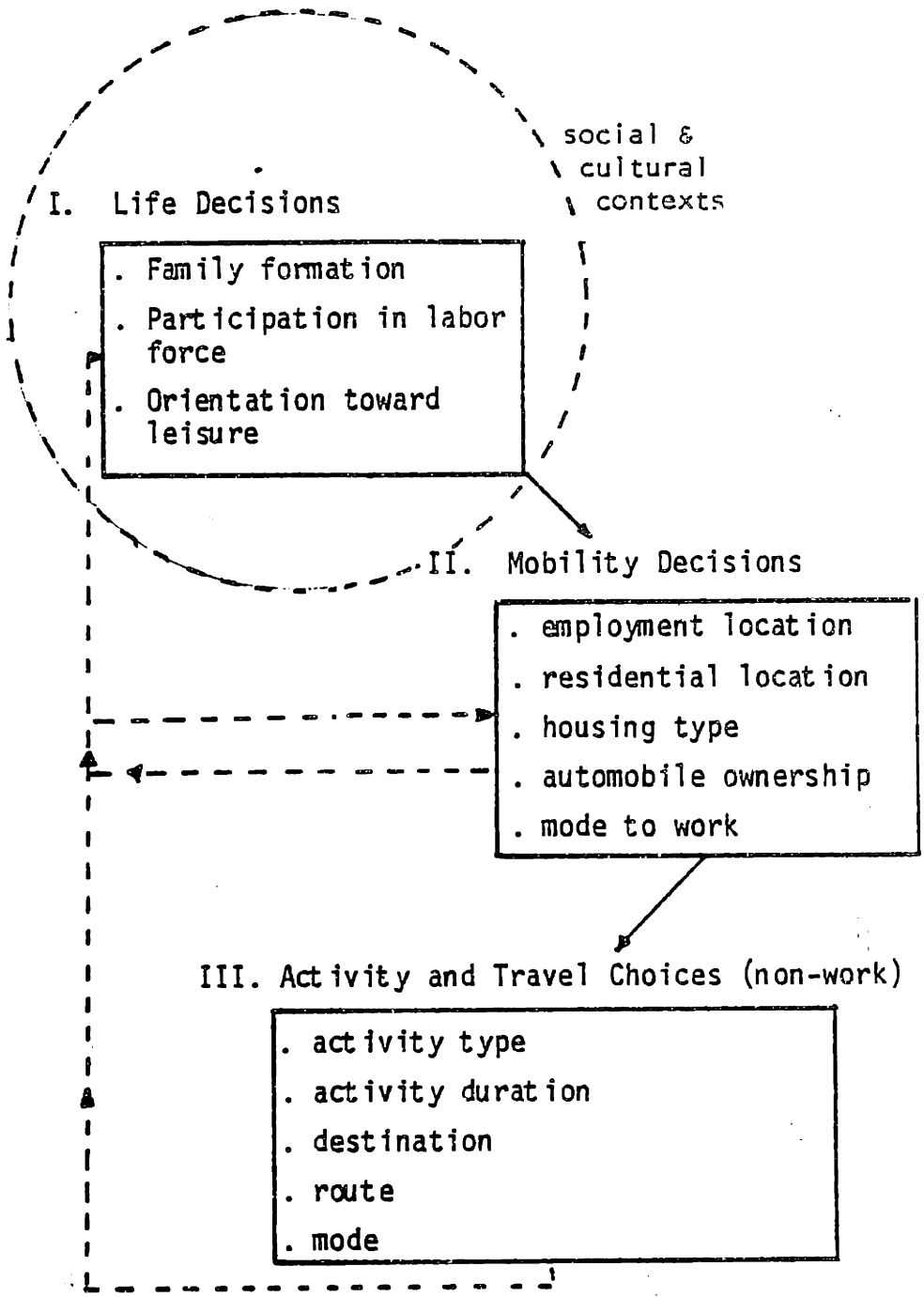


Figure 4.3 Extended Choice Hierarchy

choice, i.e., captivity to a particular option. The most obvious example is the widespread necessity to participate in the labor force.

4.2.2.1 Life Decisions on Family Formation

The decision to form a family (or any other type of household) implies a commitment in the interpersonal dimension. It requires varying degrees of necessity to engage in economic activities and in interpersonal relations and dependence. Researchers of "modern household economics" treat this (and also the decision to participate in the work force) in pure economic terms (Nerlove, 1974; Grunau, 1977). The current time and money allocation are taken as manifestations of an economic decision trading-off long term investments with current satisfactions. While the decision on family formation is usually taken as a commitment for a long period of time, it is evident that some people avoid that long term commitment not only by forming a single person household, but by joining other new forms of communal living patterns in which, at least formally, the commitment for length of participation is not as strict as in forming a family. Thus, the growing number of alternatives to the traditional family provide options on a continuum of commitment levels for an individual to choose from. The commitment range includes both temporal and interpersonal dependence of the individual on other members of the group.

The decision on the living arrangement reflects an orientation. Such orientations may be motivated by religious or social values (in the interpersonal dimension) or by personal attitudes (in the intraper-

sonal dimension). Whatever the case may be, the decision involves a commitment and a set of benefits. The relative weights of the commitments and the benefits are dependent on the interpersonal and intrapersonal dimensions and consequently, the temporal stability of this life decision is interrelated with these.

4.2.2.2 Life Decisions on Participation in the Labor Force

The decision to participate in the labor force is for most households in the American society, as well as in most others, a necessity and not an option. Yet there are still some variations within this "captive" situation. First, the necessity in many cases applies to at least one member of the household. To the others, the option of non-participation is viable. Second, given the general necessity there are still some options which permit maneuvering, such as obtaining education and deferring the entrance to the market or working on a temporary basis without a long term committed schedule. Third, the decision to participate in the labor force will be relevant to a growing portion of the population for which in the future the option of non-compulsory retirement will apply. The decision need not be a binary choice. It involves a decision on the capacity (occupation and level of responsibility) to be assumed in the labor force and the desired/required reward. One can, at one extreme, assume a simple low level position with very little commitment or one can, at the other extreme, engage in a career oriented or personal growth oriented position which may require more time and other commitments than the previous ones.

4.2.2.3 Life Decision on Orientation toward Leisure

The third decision, the orientation toward leisure, is related to the intrapersonal dimension. This decision is defined as an orientation because, in contrast to the previous two, it is noncommittal. It pertains to the residual time (after the first two decisions have been allocated their share of time) and involves a much greater flexibility than the other two. Being an orientation, it may not take the form of a cognitive or explicit choice, but it is suggested that at least implicitly it is made by every individual. People seem to have very clear preference on how to use their leisure time from the wide and ever-growing range of alternatives. Under this category are included all activities one assumes at his or her discretionary time. It may include rest at home or cultural, social, and recreational activities.

Leisure activities vary not only in the location in which one can engage in them, but also in the threshold time blocks required. Reading or listening to music may require very short threshold time blocks (and may be done simultaneously with some other activity), while mountain climbing, in most cases, will require at least a day, and camping or a Carribean cruise will require a few days. Obviously people engage in more than one type of leisure, but assuming that they have distinct preferences, they will attempt to plan their schedules in a manner which will allow them to engage in the preferred activity. For some it may mean "going out" every night to bars, discos or restaurants and for others it may mean exploiting flexi-time in work so as to allow them to spend a 3 day weekend in outdoor recreation. This is not to say that

the latter will not go to discos. What it implies is that observing behavior over a short period of time like a simple 24 hour period will lead to an underrepresentation of some types of activities, especially leisure related ones. If the orientation is assumed based on "revealed choice", it will lead to an underestimation of the presence of some orientations. This point was specifically addressed by Robinson (1976) and by Kornblum and Williams (1978) and we will return to it in Section 5.3.2 (the use of time budget data).

4.2.2.4 Summary

The hierarchy suggested in Figure 4.3 can be interpreted in similar terms to the simpler version shown in Figure 4.2, namely, that within each block choices are made jointly, the choices made in each block are conditional upon those made in the upper blocks, and the frequency of changing the choices increases from the upper block to the lower one.

The three life decisions described above are defined in broad terms. It is suggested that these are the major decisions which determine a person's pattern of behavior in the long run. It may be suggested to add to these three the choice of a political ideology as being in itself a determinant of behavior. But, given that the life decision block is explicitly bounded by a social-cultural context implies that this fourth element is not necessary, as its behavioral implications are captured by the other three elements.* Assuming that the three broadly

* If the political ideology conforms with the social-cultural context, then the range of choices of the three elements applies. If the ideology does not conform and the individual chooses to abandon the context, then his or her choice set is outside the range of interest or, if popular enough, will become part of the social-cultural context.

defined elements do cover all major aspects of life and that they are made jointly, it can now be suggested to label this block of the three life decisions combined: a life style decision.

4.2.3 The Concept of Life Style: A Synthesis

Life style is the composite outcome of the life decisions an individual makes. In this section the relationship between the life choices and life style will be discussed. Following that it will be suggested that life style in itself is a choice made by individuals.

4.2.3.1 Life Style and Life Decisions

Viewed separately, the three life choices depicted in Figure 4.3 are the pragmatic decisions an individual makes in order to fulfill his or her feasible aspirations within the three aspects of life: patterns of interpersonal relations, economic activity, and patterns of leisure. Jointly, they can be interpreted as the choices which reflect one's aspirations for a life pattern. This joint choice determines the bounds of the choices made at the bottom blocks those of mobility and travel choices.

The "joint" structure does not necessarily mean that the three choices are always made simultaneously. It is intended to indicate that they are highly interdependent and are made in the same time frame. So, even if an individual does not make an explicit or cognitive choice of changing the leisure orientation when making a decision to form a family, that change is implied and recognized by the individual. As these three decisions comprise the main types of roles as well as activity

types to which time is allocated, any change in one must have an effect on at least one other as total time is constant.

The outcome of the life decisions block is a scheme of time allocation which the individual aspires to fulfill. This may be viewed as a general "policy" of time allocation the individual will attempt to practice. For example, an individual may decide to increase his or her devotion to work or career by allocating more time to it. This life decision will affect the time available to either the home/family activities or to leisure or both. An individual who also has a strong orientation to these activities may adjust, for example, by residential relocation so that the additional work time will be traded off by reduced commute time, thereby reducing the total disruption caused by the decision to work more.

The individual's actual daily time allocation pattern may depart from the desired pattern for a number of reasons. Some unexpected events and constraints are a trivial example. An inherent problem though is that the time allocation "policy" is based on the individual's combined perception of short and long term allocations while the actual daily pattern is not a simple reflection of the long term allocation. Some long term allocation decisions are not manifested in the routinized daily pattern. An example is the occasional recreational activity which fulfills one's orientation to leisure yet is not evident in the daily pattern of behavior.

Building upon the extended choice hierarchy and the relationship

between the life decisions and the pattern of behavior, life style can be defined as a synthesis of these building blocks.

Life style, in this study, is defined as the pattern of behavior which conforms to the orientation an individual has to the roles of family member,* worker and consumer of leisure and to the constrained resources available.**

Pattern of behavior is a recurrent course of actions taken as a result of explicit decisions. A non-routinized pattern of activities which may typify some individuals is, if persistent, in itself a recurrent course. The overt behavior this definition pertains to is the allocation of time and other economic resources and as such, includes consumption patterns as well.

The conformity with the orientation of the individual required in the definition ensures that the behavioral pattern is comprised only of those activities which are part of the pattern and excludes all sporadic behavior. How frequently an activity must be practiced to cease being sporadic is a matter of judgment in each context.

The definition pertains to orientations because, in this manner the perceived preference for the future of each individual can be collapsed to its current meaning. If, for example, the orientation of an individual to extended family life or to career development is (or can

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* Under family in this definition, I include any alternative form of living which provides intimate relationships.

** This definition is conceptual. Its operationalization will be discussed in Chapter 5.

be) identified, it is assumed that most of his behavior in the present will reflect this preference. In other words, this is a means for accounting for the future, long-range decisions or aspirations in a present model.

Without entering the controversy of what roles are (cf. CRA, 1979), roles are seen here as both expectations and behavior. Every individual assumes at least the three roles (of family member, worker and consumer of leisure) or refrains from assuming such a role which is also an option. The three options are defined in broad terms and as such are engulfing most aspects of life. To illustrate, an orientation to political activism would fall into the category of leisure activity as it may be the way a person prefers to spend his time (unless, of course, it is done as work).

The constrained resources and their perception by the individual are a necessary component of the definition as they set the physical bounds to the choice options one has within each life decision.

This definition has emphasized the behavior of the individual in the context of life style. This should not eliminate the use of the household as the practical unit of analysis, as will be discussed in Chapter 5. It also should not eliminate the reference to a group's life style, being the common denominator shared by the individual members of the group.

In formal terms, still at a conceptual level, life style can be defined as behavior, determined by two exogenous factors: the social context and the personality attributes. The behavior is the manifestation

of the choice an individual makes. That choice is determined both by his or her aspirations as well as by the constraints which the social environment, in its broadest sense, imposes. This issue of choice of life style is elaborated upon in the following section.

4.2.3.2 Life Style as a Choice

Although the life decisions are made as cognitive choices at particular points of time (with reservation about the leisure orientation) it is maintained that each such decision implies a wider range of effects on the other components which are known to the decision maker and are most probably considered in the process. Consequently, the concept of life decision pertaining to any one of the three can be substituted by life style choice which is a broader concept.

In making life style decisions people may have different decision rules. At this exploratory stage of conceptualization of life style, it is not possible to suggest a utility maximizing formulation. Possibly the decision rule is that of satisfying a set of perceived goals and not "optimizing" the behavior to conform with the utility maximizing approach. As life choices can, in many cases, involve significant transaction costs, it is plausible that inertia effects and satisfying oneself with "second best" alternatives is a common course of action.*

To constitute a choice, there must be a set of alternatives from which an individual can select. If behavior is determined by social

* One may think of the advertisements of the Dale Carnegie Institute as oriented to this type of situation: making people aware of the fact that they are living in a second best choice and that they may realize their "real" objectives.

structure as one school of thought suggests, then there is seemingly no choice of life style. But, even in strictly structured homogeneous and coercive societies there are cases of individuals who are making a choice of a style that does not conform with the social context. These may not be of much interest due to their small number but their existence demonstrates that at the very least, a binary choice of conform/non-conform is available. The longstanding controversy of "free will" vs. determinism (Cazenave, 1979) is not occupied with which of the two applies singularly, it is a controversy about the balance between the two forces. Action, according to MacIver (1942, cited by Cazenave, 1979), is simultaneously both free will and determined, and he qualifies "what is free, however, is the choice between alternatives, not the choice of what the alternatives shall be". This is to mean that the choice set is created and bounded by the social context, that depicted as a circle in Figure 4.3. Within that choice set, individuals can select their preferred options.

In a pluralistic society the range of choices is very wide and the individual can make a choice which does not comply with that of his or her immediate context without being, in many cases, penalized by exclusion. The openness or acceptance of change is becoming a norm for itself in many of the subcultures in a pluralistic society. In fact, this is what perpetuates pluralism.

Despite the overall availability of a wide set of alternatives in a pluralistic society like that of the United States, the actual choice set that each individual is facing is significantly smaller.

The set of social contexts is almost exhaustive. Therefore, even if a course of total non-conformism and rejection of one context is taken, the individual by default falls into another context, which may be less binding than the first, but has its own norms and values. The social context does dictate much of what is expected, what is required and what is unacceptable in behavior. It determines, in most cases, captivity to some options. For example, in order to lead a "normal" life, in most subcultures, a person is expected to work and the option not to work is generally not viable. For many women the participation in the labor force cannot be seen as a choice, satisfying liberation or other idealogical convictions. It is simply a need and no other option is available (Kreps, 1972). But, beyond the requirement to work, the social context does not dictate the choice of the type or capacity of work and other life choices.

Another type of constraint on the choice set is derived from ideological and value systems. Ideological as well as normative discrimination or lack of discrimination can either eliminate or add options to certain groups which may be subject to it. For example, the discrimination against women in one subculture or against elderly in another eliminates a whole set of options from these groups and vice versa, the lack of discrimination may open access to such options which traditionally were not accessible. Notably, the ideologically based choices, usually carried out by relatively autonomous individuals with strong convictions (Cazenave, 1979) are those which initially create new options which later are integrated in the general choice set.

A third type of constraint is set by natural elimination of options. For example, the sexual imbalance in the elderly population makes the choice of marriage at old age improbable for a large part of elderly women (Cazenave, 1979).

These types of constraints would make any attempt to develop models of choice of life styles, across subculture groups, very complicated. Added to this complexity is the need to assess personality traits in order to identify whether or not the choice of rejection of the context is viable, as this is only viable to certain personality types.

Choices of life style are assumed to be made in a frequency of one to a few (probably less than ten) in the course of a lifetime. While some people may adhere to one style for all their life, from young adulthood when the first choice is made,* most people probably change their style at least twice (entering and retiring from the labor force).

The change in life decisions and life style is a result of dissatisfaction with the current life style. Such dissatisfaction can result from an accumulation of negative feedback from the current pattern of behavior (represented by the dashed arrows in Figure 4.3). When the accumulation exceeds the transaction costs, a change can be expected. Alternatively, a change can result from a change in the social context. Essentially, the process is similar: the current

* Note that changing one's employment location, but not type, does not constitute a change in life style unless it involves significant changes in availability of leisure time.

pattern of behavior does not conform to the new social context, thereby creating discontention which in turn brings about a change in life decisions.

The question of stability of life styles over a person's life span, or alternatively, whether life styles of the future can be predicted, is important both to the understanding of the concept as well as to its practicality in the planning field. Only little is known on this question as it requires longitudinal studies which are usually difficult to administer. Maas and Kuypen (1974) have performed an unusual study of life styles over a span of 40 years. Their results show conflicting trends. Some of the sample members demonstrated little or no change while others demonstrated significant changes of life style. The theory of developmental psychology (Maas and Kuypen, 1974) suggests that changes in life style are expected over a life span. Wachs (1979) in his recent study of transportation planning for the elderly, presents the thesis that today's planning for the elderly is inadequate because the elderly of the future will basically continue to practice the life styles they practice today as adults. Not withstanding the thesis, I tend to disagree with his assumption of continuity of life styles although, in fact, life styles of the future elderly may differ from those of today's elderly.

It should also be noted that some changes of life style are by default rather than choice, e.g., becoming a widow. The more frequent choice making, i.e., greater than five times,is probably characteristic of only a minority, although given the growing pluralism of society,

that group may increase in size and importance.

At this stage we deem it impossible to model the choice of life style. Yet it is hypothesized that people do make those choices and that their behavior in all aspects of life in the period between the making of two subsequent life decisions conforms to their choice of life style.

4.3 Hypotheses

Two levels of hypotheses are suggested in this study. At the higher level are the hypotheses which deal with the concept of life style as a factor in behavior. At the lower level are hypotheses about the actual effects of life styles on specific aspects of trip making decisions.

The underlying assumption is that life style as defined in Section 4.2.3 is an existent entity. This is a necessary departure point, as testing it as an hypothesis within the scope and limits of this study is not feasible. Such a test requires completely different data and methodology than those available in this study.

Individuals, following this definition, practice a certain style of behavior which generally conforms with the preference or tastes they have developed as a result of making certain life decisions. Stated differently, in making some life decisions an individual is setting an "objective function" he or she desires to fulfill. The course of behavior in the interim between the making of life decisions is life style, which is so designed as to minimize friction toward the attainment

of the "goals".

Carried to an extreme, this definition implies that every single act* of the individual must obey the preference set forth by his or her orientation. If this is true it obviously applies to travel behavior as to any other type of behavior.

Based on these assumptions, the first hypothesis is that individuals who practice a similar life style constitute a market segment which is relatively homogeneous in tastes and therefore can be assumed to have similar reactions to given choice situations.

To test this hypothesis it is first necessary to identify life styles. An assumption is made that groups of relatively homogeneous life styles can be identified by specific combinations of socio-economic and demographic variables.

By identifying the multivariate combinations over the sample population, groups of similar combinations are formed. These are assumed to be groups based on life style similarity. Returning to the hypothesis stated above, the working hypothesis of this thesis is that life style, as defined, is an improved descriptor of behavioral units over those descriptions commonly used. The improvement is evaluated by an increase in the explanatory power of the models which utilize life style as compared with commonly used socio-economic segmentation.

An argument can be made that the identification of life style developed here is not really capturing life style but rather an unlabelled com-

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* This statement must be qualified, as a number of factors may interfere with this ideal concept. This is further elaborated on in Chapter 5.

posite measure of socio-economic, demographic, and, in some cases, behavioral attributes. If this composite construct is not totally random and is valuable in improving the explanatory power of behavioral models, the labelling of it becomes a secondary issue. However, in view of the theoretical construct developed in this chapter it is contended that the operational definition is an acceptable operationalization of life style.

At the lower level, specific hypotheses about the differences between life style groups as related to the aspects of travel behavior are formulated. For example, different life style groups may assign different weights to the size of a shopping center in their choice of shopping destination, or they may assign different weights to the use of walk as a mode of travel. The lower level hypotheses are described in Chapter 8 following the description of life style groups and the travel model used for the hypothesis testing.

4.4 Research Approach

Testing the hypothesis that life style is an improved descriptor of decision makers requires first the development of an operational definition of life style. Yet this task could not be initiated without a prior conceptualization of the subject matter on a theoretical level.

A search through the relevant studies carried out in sociology, psychology, economics, marketing, and planning yielded information on a variety of conceptualizations of life style. Most of these were found to be either too general or too specific, pertaining to certain types

of behavior. Only a few dealt with the concept of life style in a broader framework of behavior. Consequently, the first task of this study was to identify the role of life style in a behavioral framework, with emphasis on spatial behavior as was done in this chapter.

Having developed a conceptual definition, we proceed to the operationalization of the concept. Using a home interview survey sample designed for disaggregate travel demand analysis, which provides a substantial quantity of socio-economic and demographic data as well as detailed information about trip making, an attempt was made to identify groups of individuals who share similar combinations of those attributes which, according to the operational definition, are discriminatory dimensions between life styles. As the data set used was not collected for this purpose, a series of assumptions were required to account for discrepancies between the desired attributes and the available ones.

The identification of groups was done by using a cluster analysis procedure which provides a mechanism for grouping data items based on some measure of their multivariate similarity. Alternative methods for multivariate grouping like factor analysis were rejected because of the assumptions they require. Cluster analysis lacks a theoretical basis for grouping, and hence it should be used as a purely mechanical tool for exploratory reconaissance and not for testing hypotheses on grouping. The identified groups should therefore be taken as merely clusters of similar cases and not necessarily as distinct life style groups. A

judgemental evaluation of the obtained groups is a necessary step for further utilization of that information.

Being such an exploratory tool, a series of experimentations was carried out, varying in two dimensions. First, the specification of the clustering (i.e., the variables included in the procedures) was changed. Second, the number of groups identified was parametrically changed, until the obtained groups could withstand both an intuitive evaluation* and some statistical measures of separability.

The subsequent task, following the identification of the groups, was the empirical testing of the hypothesis that life styles are improved descriptors of decision makers, in the context of spatial behavior choices, than those commonly used. Due to constraints of data availability and other resources, this study is limited to the demonstration of one test of the hypothesis: the case of the choice of mode and destination for shopping trips. This specific test is also a demonstration of prototypical application of the concept. It is contended that the concept developed here applies as well to other mobility and travel choice situations. The test of the hypothesis is done by using the information on the life style groups in the estimation of disaggregate choice models. The models with and without the use of the life style information are compared by their statistical performance.

As the concern of this study is with understanding mobility and travel behavior as dependent variables, the information used to define life styles in the clustering procedure did not include any spatial or

* The "intuitive evaluation" or judgment is discussed in Chapter 6.

travel related information. Cross tabulations of the group membership against some trip characteristics are provided to demonstrate that life styles can be identified distinctly without use of environmental factors.

Chapter 5: Development of an Operational Concept

The development of an operational definition and a classification measure of life style are necessary steps toward testing the hypotheses suggested in this research. A distinction is maintained between the operational definition and the operational classification measure. The first is the operationalization of the conceptual definition developed in Chapter 4. The second is the classifying tool suggested for use in practical applications. This distinction is further elaborated upon below. It should be noted at this point that employing the life style measure for classification only is less demanding than the development of a measure which fully maps the relationships between various life styles. In formal terms, it is sufficient at this exploratory stage to identify life style on a nominal scale rather than a higher order scale.

As in any empirical study, a discrepancy may exist between the ideal definition one desires and the realistically available information one is compelled to use. In this study there are two levels of such discrepancies. A priori we restrict the operational definition to the utilization of the types of data readily available in surveys commonly administered for travel demand analysis. But within this general framework, as one attempts to define a new qualitative composite concept as life style, the lack of sensitivity of these data sources to some issues which seem crucial to the definition becomes apparent. Using an existing data set makes it necessary to utilize proxy variables which, as we will suggest, could in future data collection efforts be replaced

by more sensitive variables (proxy or other) without increasing the costs. For example, information on the frequency of participation in certain activities could be collected. The second discrepancy is that between what can be obtained from the improved future data sets suggested at the end of this study and what has been used in the present study.

This chapter addresses the practical and conceptual questions involved in developing an operational concept based on the definition given in Section 4.2 above. The following section describes the general approach and practical considerations employed in this study. Section 5.2 describes the data set used, followed by a discussion of some conceptual issues in Section 5.3. Section 5.4 provides the operational definition. The statistical methodology employed is described in the concluding section.

5.1 Approach and Practical Considerations

The objective of this study extends somewhat beyond the testing of the hypothesis set above. It is also intended to provide, under the assumption that the hypothesis will be accepted, a practical tool to be used in future travel behavior analyses. This obviously adds some restrictions on the information and the methodology used, but if it were not undertaken, the contribution of a theoretical concept would have been only of limited value.

Two important implications stem from this objective, the first being that the data necessary for the operationalization will be of the

type which is usually readily available for transportation planners. The second is that the operational measure will be independent of the actual behavior so that it can be used to explain and predict behavior. Stated differently, there is a distinction between an operational measure of life style which would "measure" individuals' life style based on their socio-economic, demographic and behavioral patterns and a measure which is used to classify individuals into groups assumed to be homogeneous in life styles, without the utilization of behavioral data. Only the latter can be employed as an explanatory argument in models of behavior.

To classify this distinction let us deal with each type separately and elaborate on the relationship between them.

5.1.1 The Measurement of Life Style

Consistent with most definitions reviewed in Section 3.1 and the definition given in Section 4.2, life style is defined here as a pattern of behavior of a decision maker exercised in a given context and dependent on the decision makers' values, attitudes, and perceptions. The "pattern" is meant to stress that sporadic activities are excluded.

This definition combines all four dimensions of behavior discussed in Section 4.1. The behavior is carried out along the spatial and temporal dimensions. The context is the interpersonal dimension which imposes a set of constraints on the decision makers' available options. These include basically two types. The first can be termed the within household factors, e.g., family structure and the consequent constraints,

income, etc., or what is commonly termed the socio-economic and demographic characteristics. The second set is the supply side constraints. A given context imposes a set of costs (distances, time and financial), which in combination with the income and temporal constraints bound the range of available options. The fourth element in the definition is that of the personality traits. These include the values, perceptions, and attitudes which affect the decision makers' orientations and hence the choices made. In formal terms:

$$\text{Life style} = \text{behavior pattern} \qquad (5.1)$$
$$= f\ (\text{personality traits, context})$$

Assuming that this is the true relationship, then life styles are probably unique to any possible combination of personality structure and context. (Context is taken here in its broad sense as noted above.) To identify such unique life styles it is necessary to obtain perfect information on both components. For practical purposes some simplifications are required as the arguments in equation 5.1 are unattainable in realistic situations. As a first simplification equation 5.1 is restated with the following substitutions:

$$\text{Life style} = \text{behavior pattern} \qquad (5.2)$$
$$= f\ (\text{orientations, constraints})$$

where orientations and constraints are narrow representations of the previous arguments. This is the pragmatic approach applied by marketing research which attempts to define life styles by obtaining some information on attitudes and opinions to determine what is here labelled orientations (cf. Sartarelli, 1979; Reynolds, Crask, and Wells,

1977; Roberts and Wortzel, 1979). The inevitable requirement for some degree of generalization may result in a lack of uniqueness: two or more distinct life styles may converge on the same combination of measured attributes whereas their true distinction lies in the unobserved attributes.

By a careful design of the data collection tools to provide sensitivity to those personality traits and context attributes which are relevant to the specific research problem, the pragmatic approach can ensure, or at least improve, the identification of unique life styles. But this is also its shortcoming. The life styles identified by this approach pertain to discrimination with regard to specific types of behavior. In its application in marketing research one can find studies on life style and the use of credit cards (Plummer, 1971), food shopping (Roberts and Wortzel, 1979), etc. At a somewhat higher level of abstraction there are studies which identify "modern vs. traditional" behavior (Douglas and Urban, 1977; Reynolds, Crask, and Wells, 1977), but still the implications of such studies are limited in most cases to very specific behavioral aspects related to consumption patterns.

Another approach which draws on the "revealed preference" concept applied in economic research is proposed for the current study. It is argued that given the observed behavior and the observed context the intrapersonal dimension is not required. If the argument on the left side of equation 5.2 is observed and the context attributes are observed then there is no need to observe the psychological attributes or the orientations if one is not specifically interested in them. The assump-

tion made in the revealed preference approach is that in making a choice an individual has integrated his or her preference in the overt choice. The prediction of life styles based on the right hand side arguments (equation 5.1) seems to be a very complex problem which may not have a solution. Even the projection of currently identified life styles into the future raises, at this stage, questions about the stability of life styles over time (see Section 4.2).

Two major reasons are suggested for undertaking this approach. First, the pragmatic reasoning: to become a practical tool in travel demand analysis the concept of life style should be based on available data. Most surveys which are the basis for disaggregate travel models do include the information required for this approach but do not include information on attitudes, values, etc. Hence, if this dimension is deemed necessary a major change in common data collection methods would be required. The second and more substantive reason is that the value of personality traits in a prediction tool is very limited, as there are no ways to predict changes in values and attitudes of individuals. Reported preference models which rely heavily on psychological attributes, both in transportation and in marketing, can be used mainly for short term prediction regarding very specific changes in attributes of a product or an alternative.

The attitudinal data was also excluded from Wachs' (1979) definition of life style because he found it impractical to deal with such subjective data in a metropolitan level. Michelson and Reed (1975) support the view that an individual's behavior as seen through time budget

data provides the basis for inferring attitudes, values, and value hierarchies.

The exclusion of the psychological attributes does incur some costs. Some lack of uniqueness in the definition of life style may occur. This can be illustrated by the example of the "toaster fixing activity". Two individuals who, under this assumption, practice identical life styles may spend time fixing their home toaster, but one does it as a hobby while the other has a strong resentment against professional services and therefore is compelled to do it himself. Presumably, a psychographic approach should capture such variations. In the tradeoff between level of detail of understanding behavior and the practicality of the concept for planning purposes it is suggested that the latter is at this stage preferable. Yet it is suggested that further study into the points of conflict, i.e., issues which may be misconceptualized as the result of the exclusion of psychological data, be carried out. Also, identification of variables which are simple to collect and are good correlates of psychological attributes should be undertaken.

In summary, depending upon the research context and the availability of data life styles can be measured or identified using the relationship given in equations 5.1 or 5.2. The orientation can be identified either by psychological attributes or in the context of available travel behavior data by assuming that the time allocation pattern of an individual reveals his or her orientation. Measuring or identifying life styles in this manner will, subject to the quality of the data, reveal

fine differentiation among individuals who are similar in all socio-economic and demographic attributes but differ in their time allocation pattern, and hence are assumed to lead different life styles.

Despite its conceptual consistency with the theoretical construct of life style, this approach cannot serve as a practical tool for planning purposes because it employs information on the behavior which the concept is supposed to explain. Time allocation patterns are either the topic of travel demand analysis in and of themselves (e.g., activity modeling) or related to particular travel patterns (e.g., shopping, recreation) and therefore cannot be used in both sides of an equation.

5.1.2 Identification of Life Style Groups

Given the limitation of the measure of life style it became obvious that for the purpose of accounting for taste variations among individuals who are assumed to practice different life styles, it is not necessary to "measure" the particular life styles. What is needed is a classification scheme which can classify individuals into life style groups which are assumed to have similar tastes. To maintain its applicability for planning purposes, such a scheme should not employ any "dependent" attributes (e.g., time allocation). It is, of course, necessary for it to be conceptually consistent with the life style measure defined above. In other words, this approach is attempting to identify the orientations in a manner which is more restrictive than the previous and which also incurs loss of relevant information, as the identified groups will not be as refined

as those which are based on all available data. Yet this approach is valid for use as an explanatory variable of behavior.

- The question of whether life style can serve as a basis for segmenting a population is addressed in Section 5.3.3 below. At this point the discussion is limited to the general approach.

The major problem in the identification of life style groups is the identification of the best set of available data items which are consistent and efficient in discriminating between life styles.

Consistency, here, is the quality of an attribute that makes it discriminating between life styles in all conceivable situations. Let A_{kij} be the difference in the observed value of attribute k between individual i and j. Consistency of attribute k is defined in a probabilistic sense so that the probability that individuals i and j belong to the same life style group increases as the difference A_k decreases. For example, the permanent income of individuals is probably a consistent attribute because it is inconceivable that individuals who differ significantly (say $8,000 vs. $50,000 permanent annual income) could share the same life style. By contrast, level of education may be regarded as an inconsistent attribute because it is conceivable that a highly educated person will share the same life style as one who lacks formal education but who is a capable, self-educated person.

Efficiency of a data item relates to the quality of the information conveyed by it, relative to the true attribute. In other words, it relates to the quality of proxy variables in representing the real attribute. Some examples will illustrate the point. If life styles are dis-

tinguished by the amount of time a person works, then the time observed as work time is an efficient variable. But if life styles are differentiated by the amount of time spent with the family then the variable "time spent at home" is a relatively inefficient one, as a number of non-family oriented activities will be included and some family related activities practiced elsewhere will be excluded. Similarly, "permanent annual income" can be assumed to be an efficient variable relative to the available variable of "current income".

Thus, in the search for identifying life style groups a set of socio-economic and demographic variables which are consistent and efficient in discriminating between assumed life styles is sought, specifically, the variables should indicate the orientations to the three life decisions which constitute the choice of life style and the set of constraints.

The orientation toward family formation is assumed to be captured, as will be detailed below, by the demographic attributes. The orientation toward work is captured by variables describing employment and occupation status (rather than time allocated to work which is subject to a sampling error on any given day) and the orientation toward leisure is accounted for by education level and income, which are not efficient and not necessarily consistent for that purpose.

One method of testing the extent to which this approach to identifying life style groups is consistent with the actual definition of life style is to compare the time allocation patterns of the identified groups, testing the hypothesis that the patterns are, in fact, different

across the groups. This test, though, requires controlling for the environmental context, because time allocation patterns may differ due to differences in accessibility.

If the time allocation patterns are significantly different between the identified groups then one can conclude that the groups are, in fact, representative of different life styles.

The distinction between a measure of life style and a classification of life style groups as presented here can be seen as a distinction between a deterministic and a probabilistic approach. Measuring life style by utilizing all the variables that define it, including behavioral patterns, is a deterministic approach. Identifying groups based on socio-economic and demographic attributes and assuming that they represent life style groups is closer in nature to a probabilistic approach, as there is an underlying assumption that different life styles have different values along the socio-economic/demographic dimensions. Although in general this assumption can be accepted as valid, it is only in a probabilistic sense true for any individual in the group.

The following sections will discuss various issues related with use of the conventional readily available data. The discussion will take a normative approach, namely, what ideally should be done in the development of an operational measure of life style. Limitations of data have hindered us from carrying the actual application as far as the following discussions suggest. The necessary compromises will also be discussed.

Frequent reference is made to the use of time allocation data because it is assumed to be an efficient and consistent indicator of life

style. Yet, its role should be viewed within the limitations described in this and the following sections.

5.2 The Data

Before addressing the problems involved in deriving an operational definition of life style, it is necessary to present the data set used so that the constraints discussed in the following sections will be understood.

The data set used for this study is the Baltimore Travel Demand Data Set (BTDDS)* collected under the sponsorship of the Federal Highway Administration (FHWA) of the U.S. Department of Transportation. It is a disaggregate data set, collected in home interviews which were performed throughout the Baltimore metropolitan area between May 2 and June 18 of 1977. The data set is supplemented with level of service information obtained from network data of the Baltimore area transportation agencies.

In at least two ways this data set is atypical of disaggregate data sets available elsewhere. First, it is, compared with many other data sets, a small one in terms of number of observations (967 households compared with five digit sample sizes in other sets). This is so because it was designed primarily for research purposes and not planning. Second, it is relatively speaking an in-depth survey, providing a rich amount of data on each household, its members, and their trips. The third feature which makes this data set unique in the United States is the inclusion of walk trips (longer than one block). Walk trips were by and large ignored in other urban transportation data sets (e.g., the Washington, D.C. Data Set (1968) included only walk to work trips but no others). In the context of the study of life styles and travel behavior ignoring walk trips may involve an underrepresentation of a significant amount of spatial activities, as will be discussed in Section 5.3.2.

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* A detailed description of the data set is given in U.S. DOT, FHWA (1980).

The disaggregate data set is organized in five topical files, as illustrated in Figure 5.1. The data set also includes two files of data collected from transportation agencies in the Baltimore area.

The household file includes basic information on the household as a unit. It includes some socio-economic and demographic information as well as information on residential location and auto ownership. Also included in this file is information on one selected trip made by a member of the household. (This will be described below.)

The vehicle file contains detailed information on vehicles owned or otherwise available to the household. It includes 1193 data records.

The third file is the person file in which each individual in the households is described by one record. There are 3173 records in this file. The information includes detailed socio-economic and demographic data.

Fourth is the trip file which includes one record for each trip made by each individual in a 24 hour period, totalling 7570 reported trips. This file includes information on trip purpose, time of day, mode, accompanying persons, origin and destination and more. Given the detailed time information on each trip, time allocations can be calculated for individuals or households. Also included in this file are the level of service attributes derived from separate network information.

The fifth file is the detailed link data file. In each household one person was selected and for that person one trip was selected for detailed description. The selection process was designed to ensure the sampling of different types of trips. The selected trip is described

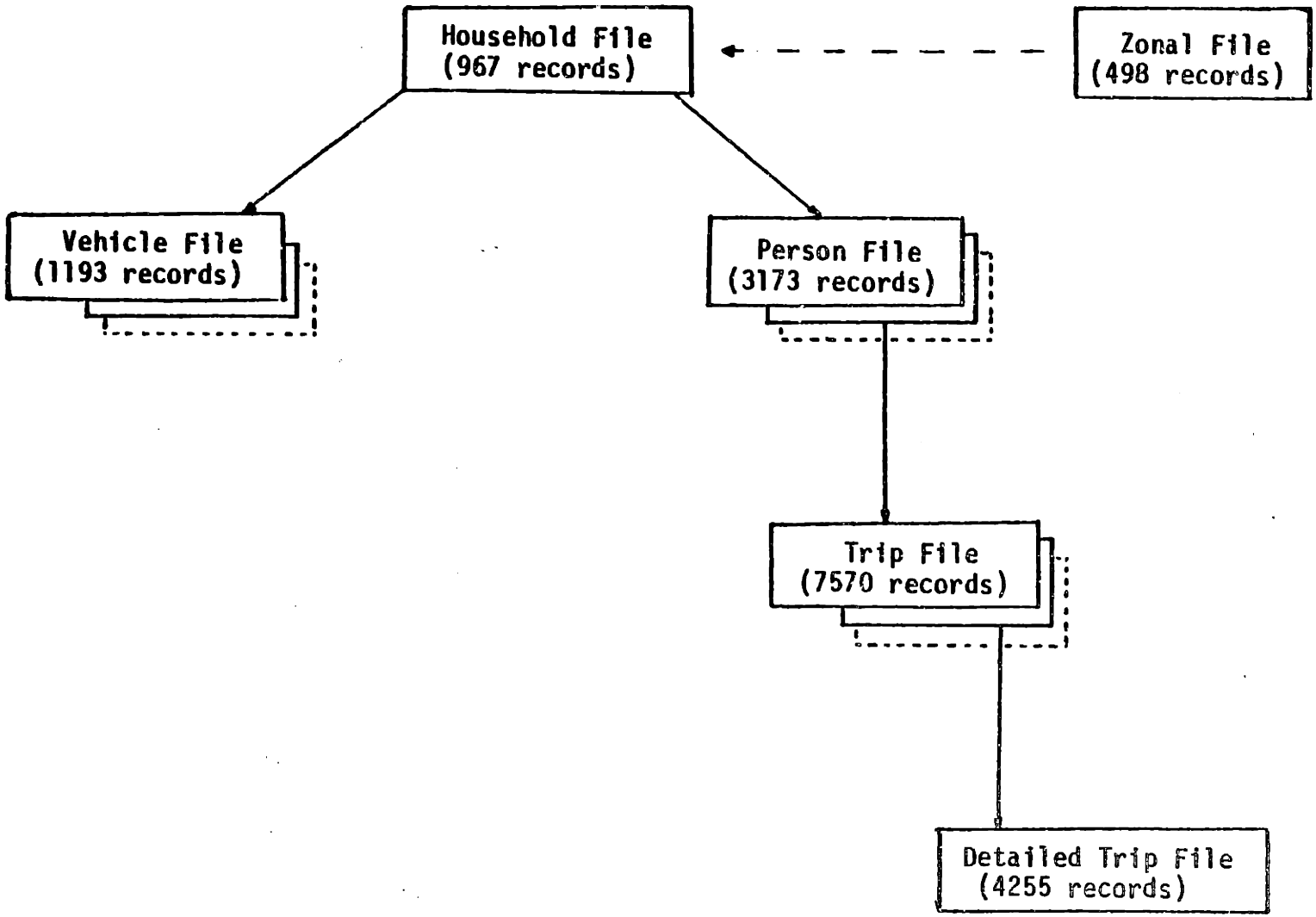

Figure 5.1 Organization of the Baltimore Travel Demand Data Set (BTDDS)

in detail including the route and the alternatives to the mode, destination and sequence of destinations chosen. Some of the information about the selected trip is also given in the household file described above.

The two additional files are skim tree data and zonal data. The first includes level of service data for all origin-destination pairs in the Baltimore area based on the local agencies' data. Travel times and distances for automobiles and transit fare are included. For highway travel on- and off-peak information is available.

The zonal data file includes 498 records, one for each traffic zone with information on land use, employment, residential population characteristics and some level of service variables such as parking cost and an average out-of-vehicle time.

Two subsets of data were created from the original BTDDS for the purposes of this study. The first is the detailed description of households which is used to define and group households by life styles. The second is a trip data file which is to be used for estimation of a travel demand model and is described in Chapter 7.

The data for the development of the life style concept was derived from the original household, person, and trip files of the BTDDS. The basic unit in the new constructed data set is the household and separate files were created for the various household types described in Section 5.3.1. The variables included in these files were chosen on the basis of theoretical relevance to life style as conceptualized in this study. Generally, the approach was to include many variables which may be

relevant, out of which only a smaller set of variables will be identified as most useful.

The Baltimore Travel Demand Data Set was not collected for the development of a life style concept and its use for that purpose involved some basic conceptual problems as well as compromises with the appropriateness of some of the variables. The major reason for using this data set despite its shortcomings was the desire to rely on data available to transportation planning agencies, and its information on walk trips. Aware of this latter peculiarity of the BTDDS, it is argued that for the specific use of this study it is appropriate to utilize an atypical data set, provided that the consequences of this fact are explicitly addressed (see Section 5.3.3). The alternative was to seek a data set that may better serve for the development of the life style concept but that would fail the requirement for practicality in the transportation planning field.

The basic conceptual problem in using a data set of this type for the development of an operational definition of life style is the fact that life style relates to recurrent patterns of behavior over time while this and other similar data sets usually cover a period of only 24 hours. At best, a 24 hour diary provides information on a single participation in most activities. Moreover, in the BTDDS, there is a specific shortcoming in the design of the questionnaire which caused the lack of relevant information on this point. Respondants were asked how frequently they engage in an activity (trip) they reported. This provides information on the subjective frequency of activities or recurrent

participation. What is missing though, is information about the frequency of participation in activities not sampled. This could have been avoided by asking about frequency of participation in some categorical activities. The use of such data is discussed in Chapter 9. In diary type data sets this type of sampling error is reduced as the probability of sampling any type of recurrent activity increases with the length of time sampled.

5.3 Some Conceptual Considerations

The objective of this section is to translate the conceptual definition given in Section 4.2 above and the actual operationalization. To do so it is necessary to address some specific issues to which the following subsections are devoted. First, a discussion of the appropriate unit of analysis is presented. Section 5.3.2 addresses the problems associated with the use of time budget data. Following that, the classification of households based on life styles is discussed.

5.3.1 Unit of Analysis

Although movement in the urban space is usually done by individuals or small groups of individuals, analysis of travel behavior has focused on the household as the decision making unit. The rationale, similar to that taken in other consumer behavior studies, is that the household is an economic unit in which decisions on consumption and production are made "collectively". The degree of "collectivity" varies across households and across decision types. Major mobility choices, such as residential location, work place and mode to work are decided by the household

as a unit or by individuals within it, subject to within households constraints and interactions. Trips to non-work destinations, such as shopping, social, and recreation can be the choices of individual members with some level of independence. Some business-related trips during work time can be totally independent from household attributes (Ben Akiva, 1973).

The information on the household used by disaggregate models was in most cases limited to observable socio-economic and demographic attributes such as income, household size, the presence of members in certain age groups, etc. What these information items failed to reveal or account for is the existing differences in household decision making processes.

Households, by the common definition, include families, individuals living alone and groups of unrelated individuals living together. The family category itself may consist of different structures, including two parents, single parent, sibling and extended families. At the outset it is obvious that the decision making process among these types varies significantly. In particular, the households consisting of unrelated individuals include the widest range of situations varying on a continuum from "family type" relations to incidental sharing of living quarters by individuals who do not share any economic decisions. There is a sharp increase in the number of households composed of unrelated individuals relative to family type households, 67% and 9% respectively, over the period 1970-76 (Alonso, 1977), and it indicates a growing diversity of the household as a behavioral unit in the future.

Within the family type households (which in 1976 still accounted

for 90% of the U.S. population, U.S. Bureau of Census, 1977), there is also a wide variation of decision making processes. Family dynamics with regard to decision making processes have drawn only limited attention of researchers to date (CRA, 1978b). Transportation-related decision making issues were addressed by Hartgen and Tanner (1970) as reported in CRA (1978b). They argue that norms, values, and attitudes of family members as well as their roles in the family affect the household's mode choice decisions. Jones (1976), in realizing the importance of the family's internal dynamics, has developed a methodology for observing it and inferring impacts of transportation and related policies through the family's decision perspective.

Studies of the family and household economic behavior do address the interaction effects resulting from decisions made by family members with regard to their consumption and production (Nerlove, 1975; Grunau, 1977). But, consistent with the revealed preference approach, these studies disregard the intra-household decision making process.

An interesting study of life style, family dynamics, and income was done by Coleman (1978) based on a longitudinal analysis of household income and expenditures, socio-economic attributes, attitudes and preferences. In an in-depth analysis of 186 households (in Michigan) over an eight year period, he reached the following conclusions of relevance here. First, household expenditure patterns are determined by the husband-wife interactional dynamics and by the man's self image. Second, "when women work, it ordinarily reflects a desire to have some say in how the household money is spent". Although the decisional power cannot

be determined from the ratio of earnings, Coleman does suggest that womens' decisional power extends beyond their relative earnings.

Recent studies on time allocation patterns have indicated that the joint husband-wife time allocation patterns have significant impact on the household's total activity patterns (Steinberg, Allaman and Dunbar, 1979).

Marketing research faces similar problems to those of the transportation research. Due to difficulties of data collection, a single respondent is usually assumed to represent the household and the information obtained is biased through the respondent's interpretation and preferences. Methods for obtaining household information based on more than one respondent are searched for in the marketing research (Wind and Green, 1974).

Arguments brought by some writers criticize the current prevailing practice of treating the household as a single entity. Hillman, Henderson, and Whalley (1976) suggest that the variance in roles, preferences, and mobility within the household vary widely so that household measurements are misleading. Burnett (1978) argues that the prevailing reliance on household data and the assumption that an identical (or randomly assigned) choice set exists for the whole population results in misrepresentation of the particular constraints which individuals or groups experience, e.g., women.

The awakening of womens' issues in recent years has shed more light on this problem. Mobility needs of women, for example, as derived from their family responsibilities, put them in a more constrained time-

geographic schedule relative to their male spouses (see Section 2.1). This is largely ignored by the current treatment of the household as a single unit.

The notion of the wife being a "secondary worker" described by Kain (1964) as seeking employment close to the residence after the choice of its location has been made, or as defined by Ruiter and Ben Akiva (1978) as having a lesser effect on auto ownership, is becoming obsolete for a growing number of households. With the increase in womens' participation in the labor force and in other out-of-home activities the range of their input to the household decision making process increases too. It is clear, by any definition of life style, that a woman's entry into the labor force involves a change in the life style of that household, as both time budgets and income change.

The conclusions to be drawn from this discussion are that for the classification of a population by life style, the household is the appropriate unit of analysis <u>if</u> some corrective measures are taken. The following list of measures is suggested.

1) Households of different types need to be treated separately, as they a priori practice different life styles. The major types of households are: single-person household,family and households of unrelated individuals. The family type should be further disaggregated into: two-parent units, single-parent unit (by sex of head) and siblings living together. For specific research purposes it is conceivable that this grouping may be further refined. A special problem exists with the households consisting of unrelated individuals. Into this

category fall a wide range of living arrangements varying from a quasi-marriage type through various communal groups to student dormitories and houses for the elderly. If not treated explicitly, this variance may introduce errors which can result in drawing conclusions which are not applicable to any of these different variants of the unrelated individuals' households.

2) There must be a clear distinction between various rates of labor force participation and occupation type of the adult members of the household.

3) Information on constraints imposed on the household activities, such as the presence of young children or elderly disabled persons and flexibility in work time must be accounted for. (The sharing of such constraints and responsibilities between husbands and wives may in itself be a discriminatory variable among life styles, as will be discussed below.)

While these points may not be new, it is suggested that a measure of life style of the household which accounts for inter- as well as intra-household variations, may serve as a useful proxy for the psychological attributes (roles, attitudes) which are not readily available but are known to affect travel behavior.

At least one problem may arise in using the household as an analysis unit. It assumes that all members share a similar life style which may or may not be true. As the composite life style variable is assumed to be a continuum with some degree of clustering, one may hypothesize that members of a household practice similar if not identical life styles,

and further hypothesize that distinctly different life styles within a household are not compatible, but clearly these are beyond the scope of this research.*

5.3.2 Use of Time Budget Data

In the context of this research there are two roles for time budget data. In the definition of life style given in equation 5.1, time budget is the major component of the dependent variable (the others being expenditure patterns and constraints). Conceivably, life styles could be identified and classified on the basis of time budget complemented by a few socio-economic variables. In the second role, time budget data are used as instrumental variables to account for the orientation of individuals. In this study time budget has been employed in some of the analyses but has been excluded from others for reasons discussed in Section 5.1. But even for the latter analyses evaluation of the life styles identified is partially done by comparing their time allocations. Consequently, we deem it necessary to discuss the characteristics of time budget data in this section.

Transportation analysts are paying a growing attention in recent years to the analysis of time budget and activity patterns. Other social sciences have made major contributions in this field. The development of time allocation theory in the work of economists like Becker (1965), Nerlove (1974), and Grunau (1977) provides one perspective. The

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* A further search of sociological analyses of families may be necessary to better understand the implications of this assumption.

analysis of activity patterns through empirical studies in the work of sociologists and geographers like Chapin (1974), Michelson (1975), Szalai (1972), and Hagerstrand (1970) provides another perspective.*

The information obtained from these studies has raised the interest of transportation analysts in activity patterns and time allocation due in part to the recognition that travel demand is a derived demand, i.e., people travel to perform certain activities at the destination and hence, understanding the choices people make with regard to duration and location of the activities is of prime importance. A second contributing factor is the fact that travel behavior analysis is over a period of a few years changing focus from explaining simple work trips to explaining non-work trips and complex trips in which the role of activity related choices is of greater significance. A possible additional factor is the recent diversion of transportation policies toward systems management, in contrast to construction solutions. Transportation Systems Management (TSM) type solutions include such options as changes in activity patterns by introducing temporal policies such as flexible work hours, etc.

Recent work in transportation research includes attempts to estimate models of activity patterns and time allocation and their interrelationships with transportation. Bain (1976) estimated models for choice of activity duration for weekdays and weekends. Jacobson (1979) estimated models of non-work activity duration and the sensitivity to transportation

* A review of these and other studies is provided in Damm (1979) and Jacobson (1979) and Burns (1979).

level of service attributes. Three types of activities were treated: shopping, social/recreational and other trips. Damm (1979) studied the question of activity scheduling behavior and estimated models of participation and duration of non-work activities in five different phases of the day, three of which are part of the work trip. Steinberg, Allaman and Dunbar (1979) studied time allocation using the Baltimore Travel Demand Data Sets (BTDDS). These look at the time allocation of individuals and households by twelve activities and estimate twelve linear equations in which the independent variables are various socio-economic and demographic terms. Using these estimates the authors forecase the impact of the changing demographics on time allocations of households for 1990 (Allaman, Dunbar and Steinberg, 1979). A third report in this series (CRA, 1979c) deals with forecasting short-run changes in household time allocations to activities using a time derivative matrix which allows a prediction of the effects of a marginal change in one activity on all others.

Any use of time budget data involves a number of interesting problems, as will be briefly described here. In addition, there is a problem of classification of the activities in a manner consistent with the current research objectives.

Time budget data are usually collected for a 24 hour period on a weekday and/or weekend. Inference from a single 24 hour period involves the risk of a number of biases in the data. The first is the temporal bias resulting from special events occurring on the survey date or seasonal effects.

A second type, more relevant to the issue of life style and more complicated to cope with, is what may be termed as a "time budget planning period" or what Cullen (1978) termed "premeditation time". The interest in time allocation should conceivably relate to the time frame for which people make the allocation choices. Carrying this approach too far may mean dealing with time allocation over a multi-year period, i.e., the life decisions. At the other end, dealing only with interdependence of activities over a single day as was done in the recent studies cited above is misleading, because people often make a two-day to a week-long plan for such activities as shopping and entertainment and thus any single day involves a sampling error. As one can assume that the length of the planning period varies over the population as a function of attributes such as control over time, dependence on other individuals, etc., this sampling error is complicated to deal with.

In the case of leisure activities, for example, Kornblum and Williams (1978) argue that "Americans tend to choose blocks of leisure rather than addition to their daily discretionary hours". This preference for vacation days instead of reduced daily work hours has significant implications on the spatial patterns of movement within and around the city. Further, it implies that any short-time diary information is biased and leisure activities are underrepresented.

Similarly, Robinson (1977b) compared daily participation rates in 18 non-work activities reported in a 24 hour diary with the respondents' estimate of the rate of annual daily participation in those activities. He found the annual estimates for most activities to be significantly

lower than the diary information. This again demonstrates that if a leisure activity is recorded in the diary, inferring that there is a constant allocation to that activity over a longer than 24 hour period is misleading.*

So, while for the estimation of a travel model a single day's sample is sufficient, for the purpose of defining life styles, an attempt was made to estimate the frequency of participation in the non-sample activities, based on the socio-economic characteristics and the reported participation in activities. Linear regressions were estimated for the expected participation time in activities per day, but, for various reasons discussed in Section 5.4.1, they were not found to be useful.

A third type of bias stems from the respondent's attitudes towards the activities and toward the interviewer. Certain types of activities may be over-reported or under-reported due to this type of bias (Michelson, 1976; Brög, 1979). This bias remains untreated in this study.

A second major issue in the utilization of time budget data is the categorization of activities. Categorization is required in order to classify the available data into groups which are relevant to the research objectives. In this research of life styles, as defined in Chapter 2, it is necessary to define sets of activities which pertain to the three orientations that together constitute the life style choice: the orientations toward family, work, and leisure. The categorization involves two steps. In the first, it is necessary to identify the types of activities

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* This latter evidence should be taken with caution because annual estimates are probably, as Robinson indicates, subject to some biases.

which pertain to the three orientations and assess their potential discriminatory power among life style groups. The second stage is the reduction of the available data into the activities identified in step one.

In the process of collecting time budget data an initial classification is already being done, whether by the design of the questionnaire which requires the respondent to classify his or her own activities into a prescribed set or, in unstructured questions, that burden is put on the analyst. The level of detail may vary considerably. At the lowest end is the trichonomy of home-work-leisure often used by analysts of the "new household economics" cited above. At the higher end, there is no limit but for practical purposes, a standardized set of 99 activities, divided into ten categories, has been developed (Szalai, 1972).

Any categorization leaves ample room for ambiguity and misclassification. Activities which are practiced simultaneously are one example. The functional definitions of home and leisure may be a source of more ambiguities: is home taken as a location or as a function relating to the family?

In attempting to infer orientations from time budget data, such ambiguities, combined with the various biases reported above, may seriously affect the results and therefore it is necessary to consider such possible errors in the process of further categorization.

The choice of categories should reflect the objective of this analysis. The categories of activities need to be indicative of life styles, i.e., the difference in time allocated to these categories should be a

discriminative dimension among people/households who practice different life styles. A second factor to be considered is that the categories should reflect the spatial dimension of the activities. This issue will be illustrated in the discussion of the classification schemes below. Another question is the number of categories to be chosen. A small number of categories is economically advantageous but it incurs loss of information and accuracy due to a growing ambiguity as to the proper classification of some activities. The constraint is obviously the available data. The Baltimore Travel Demand Data Set (BTDDS) provides information on the duration of 21 activities. It is noteworthy to recall that the activities in this data set are derived from the trip purposes and therefore are strongly oriented to the spatial dimension.

The second step is the assignment of the available classification into the desired one. This obviously depends on the choice of the categories. While it can easily be argued that all activities carried out in a given time period are indicative of life style as they reflect the preferences over the complete choice set of activities (under the limitation of the time frame of a 24 hour period), it can also be claimed that a number of activities are either not indicative of specific life styles or their definition is too ambiguous and their inclusion may be misleading. The first type includes, for example, a visit to a medical treatment. If there is no further information on the nature or frequency of this activity, it is only of very marginal significance to the definition of the life style. In the second type consider, for example, the activity of eating in a restaurant. It can be very significant to the

identification of some life styles, yet it is too ambiguous as it can be a business meal which may be weakly indicative of orientation to work, a lunch break or a family gathering which may be indicative of a family orientation. If no additional information is available, this activity should be excluded from the analysis.

Three classification schemes were considered. The first is based on the definition of life style suggested by CRA (1978a). Four role-complexes are identified and the differential allocation of resources among them defines life styles. The role-complexes are:

- work/career (WC)
- household/family (HF)
- interpersonal/social (IS)
- leisure/recreation (LR)

Also considered in this definition is the disengagement from such role-complexes. This structure is oriented to the conventional definition of life style and lacks sensitivity to the spatial dimensions of activities.

A second categorization scheme, suggested by Rein (1979)*, includes the following categories:

- work (W)
- home (H)
- leisure (L)
- civic (C)
- social reproduction (SR)

* Rein, Martin, MIT, Dept. of Urban Studies and Planning, personal communications, November, 1979.

This scheme also suggests a distinction between activities one undertakes for oneself and activities one does for the household. Social reproduction refers to all activities which are related to the child and family, geared to maintaining the continuity of the family's well being. This categorization is sensitive to some newly emerging forms of life style such as the growing participation of women in the career oriented labor force and the variety of sharing rates of household related responsibilities by members of the household. It can capture the dichotomic division of "traditional" vs. "modern" female roles within the family life styles suggested by Reynold, Crask, and Wells (1977) and also mentioned by Rainwater (1976). Despite its appeal for the identification of emerging life styles, this scheme is not sensitive to the spatial dimension. That is, it ignores the locational aspects of where the activities are practiced.

Under both schemes shopping activities, for example, would fall under household related activities, but it is clear that shopping is a behavior component which has implications on life styles, not only by the quantity and type of shopping but also by its spatial attributes.

The initial scheme selected for use in this study includes the following categories:

- work (W)
- home/family (HF)
- shopping (SH)
- personal services (PS)
- social interaction (SO)

- recreation (R)
- services to family (SF)

The seven categories included in this scheme capture the activities provided in the data set in a manner which is both sensitive to the spatial dimension as well as to the life-style forms which are of interest in this study.

Table 5.1 summarizes the classification of the 21 activities provided by the BTDDS to the three classification schemes. It is argued that while the suggested scheme is not collectively exhaustive, it does provide a framework for eliminating some of the ambiguities and satisfying the dimensions of life style as well as spatial patterns.

The suggested categorization scheme of 7 activities was applied by calculating the percentage of a 24 hour period allocated to each activity separately for the male and female heads of the household. Due to the fact that at any given single day a person participates only in a few routine and even fewer non-routine activities, many of the categories were found to have zero participation rate for a large proportion of the sample. Two measures were taken to overcome this problem. First, as noted above, linear regressions were run to estimate values of activities not performed on the particular day for which the data was collected. Second, activities were aggregated into a smaller set, thereby eliminating many of the empty categories but also incurring some loss of information. The aggregated categories used in further analyses shown in the fourth column of Table 5.1 included: home activities (unchanged), work (unchanged), leisure (including entertainment, social

TABLE 5.1

COMPARISON OF CLASSIFICATION SCHEMES OF ACTIVITES

Activities in ATDDS		CRA	Rein	Initial Categorization	Final Categorization
01	home	HF	H	HF	HF
02	work	WC	W	W	W
03	work related business	WC	W	W	W
04	school	(WC?)	(SR?) W (?)	-	-
05	shopping: food	HF	H	SH	SR
06	shopping: convenience purchase	HF	H	SH	SR
07	shopping: other purchase	HF	H	SH	SR
08	personal business	(HF?)	SR (?)	PS	-
09	doctor, dentist, other medical	(HF?)	SR (?)	PS	-
10	eat meal (1)	(all?)	all (?)	HF	HF
11	automobile related	(?)	(?)	-	-
12	entertainment, religious, civic, cultural	LR, IS	C, L	SO	L
13	visit friends or relatives	IS	SR	SO	L
14	outdoor recreation	LR	L	R	L
15	pleasure walk ride or drive	LR	L	R	L
16	serve passengers - children < 16	HF	SR	SF	SR
17	service passenger - adult	HF	SR	SF	SR
18	rider-accompany driver (1)	HF, IS	SR (?)	-	-
19	travel to terminal in/out of area	-	-	-	-
20	accompany child not in auto	HF	SR	SF	SR
21	accompany adult not in auto	HF, IS	SR	SF	SR

Note: (1) Eating outside of house was included only if accompanied by at least one household member.

visits, outdoor recreation and pleasure walks and rides, corresponding to activities 12, 13, 14, and 15 in Table 5.1) and services (including shopping, personal business, and driving other family members,. corresponding to activities 5 through 7, 16, 17, 20, and 21 in Table 5.1).

The utilization of time budget data in the form described in the last paragraph is far from what is ideally desired. The discrepancy between the ideal and the available has implications on the concept of life style as defined in this work. This issue is further elaborated on in Section 5.5.

5.3.3 Life Style as a Basis for Segmentation

Assuming that life style is a descriptor of people which is powerful in explaining their behavior, it is necessary to examine whether it can be used to classify population groups so that aggregate generalizations on behavior can be made. If each individual has a unique life style then the usefulness of the concept is nil. If, on the other hand, with some degree of simplification and generalization people's life styles are similar, then there is a basis for such segmentation. In other words, if the number of distinct life styles is smaller than the number of people, then it withstands the necessary condition of serving as a segmentation basis. But this is not sufficient. To become practical, the number of distinct life styles needs to be small enough to be manageable.

Two separable problems draw attention. First, on the conceptual level, is the question of whether life styles can be grouped. How similar

is similar? Second, on a pragmatic level, what are the efficient means of identifying life style groups?

It is contended that life style in a pluralistic society varies on practically a continuum, in contrast to the case of a homogeneous society.* The components of life style are of two types. Some are discrete and some are continuous. For example, household type which an individual chooses to form/join is a discrete component. In current society it can include a nuclear family, a single headed family (which can be broken down to sex of head), single person household (by sex), and household of unrelated individuals. These major groups can a priori be assumed to be practicing different life styles. This classification can be further refined at the cost of adding more groups to the analysis. While it may be necessary in some cases it can also be ignored for others.

Within each such life style group, life styles probably vary on a continuum of orientations to work and leisure. If the time allocated to these activities can be used as proxies for the level of orientation (the non-qualitative component of it) then there is probably a continuous distribution of people in the space defined by each activity. Figure 5.2 illustrates a space in which each of the heights of the triangle represents the total available time (e.g., 24 hours) so that any point in the plane represents an allocation of time between the three "heights": work, home and leisure. The dots plotted on the plane repre-

* Classification by life style may be employed more successfully in societies which have a single cultural history or a strong theocratic structure.

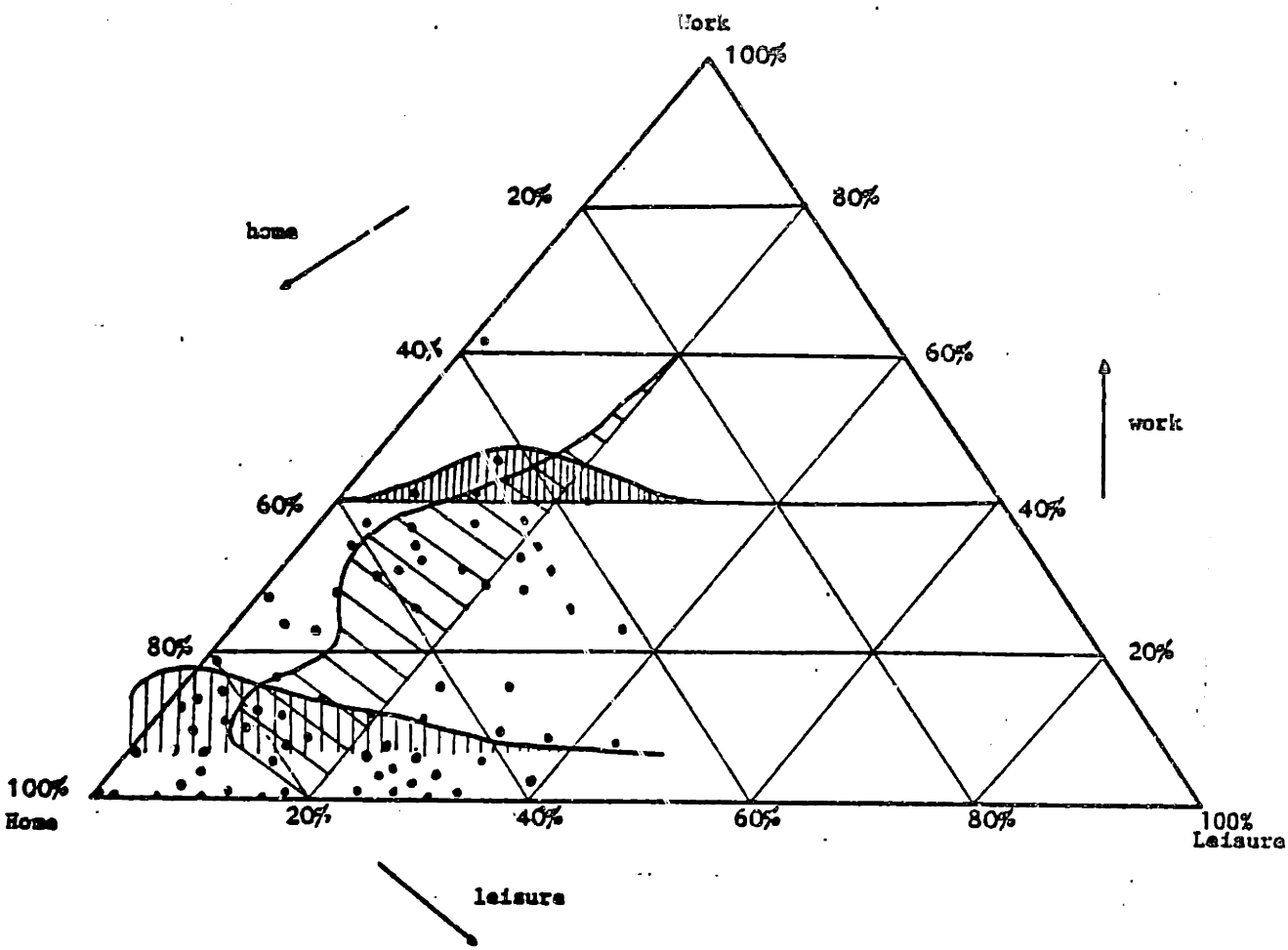

Figure 5.2 Conceptual Dispersion Diagram of Time Allocation between Home (H), Work (W), and Leisure (L).
(Each point represents a unique (H, W, L) combination.)

sent what we assume is one reasonable distribution of individuals. A number of points should be noted. The dispersion of cases in the work-home dimension is probably a bimodal one, truncated at the "home" end. The dispersion along the home-leisure and work-leisure dimensions is probably closer to a form of gamma distribution and varying from a more condensed dispersion closer to the higher working proportion and more dispersed for the least or non-working cases. In such a distribution of a real sample it may be possible to identify clusters of cases by their location on the plane. Superimposing on these clusters the other discrete dimensions (e.g., household type, occupation, etc.) will result in grouping of multidimensional combinations of cases. If the discrimination or variance among the groups is greater than the variance within the groups then they represent distinct life style groups to which a population may be classified.

In general terms, similarity between objects characterized by K variables can be defined as the proximity of these objects in a K dimensional space. The proximity can be measured by a metric distance like the Euclidean distance, defined as:

$$D_{ij} = \left[\sum_{k=1}^{K} (x_{ik} - x_{jk})^2 \right]^{1/2} \qquad (5.3)$$

where: x_{ik}, x_{jk} are the values of objects i and j on the kth dimension.

If all observations were uniformly distributed in the K dimensional space so that

$$D_{ij} = D_{il} \quad \text{for any } i, j, l$$

then no grouping except for a totally arbitrary one is possible. If observations are unevenly distributed in the space, then some level of non-arbitrary* grouping is possible.** It is important to note, though, that the presence of groups in a population, defined solely by the uneven distribution, does not imply that there is a meaningful interpretation to these groups.

A population can thus be divided into groups which are mutually exclusive and jointly exhaustive. A variety of specific methods are available for identifying groups in a population. Some of these will be reviewed in the following chapter. At this point we continue the discussion of the conceptual problem of grouping.

5.3.3.1 The Number of Groups

An attempt to define groups which are mutually exclusive and jointly exhaustive may result in either or both of the following situations: one possible case is that a very large number of groups will be required. For example, categorizing time allocations of three activities to, say, three levels and superimposing on these three more dimensions, each of which has only a binary form, accumulates to 216 (!) cells of possible

* The choice of the level of grouping can still be arbitrary, but the criteria will not be. For example, if in a two dimensional space the incidence of observations monotonously increases with x, then the criterion for grouping necessarily lies on an (x = a) line, but the "level" of "a" can still be set arbitrarily.

** It is also possible to transform the variables (X_k's) to achieve uneven distributions.

combinations, a number which is beyond the practical range for the number of segments. Most probably a significant number of cells will remain empty or have only a very small number of cases for any given population, either because some combinations are inconceivable in a given context or because their incidence is low and they were not sampled. But even reducing this matrix by half, the small number of variables results in a matrix which is beyond the manageable magnitude. We presume the manageable magnitude to be under 20 groups.

The second possible case is that which results from limiting the number of groups to a manageable size, either a priori or a posteriori. This is, in fact, a constrained version of the previous case. Obviously, to remain jointly exhaustive this structure will result in some groups which will have a very large variance to include all outliers. It is important to note that an a priori choice of the number of groups should have a sound theoretical reasoning.

The first case, that of variant number of groups, may seem more appealing as it can allow the identification of "natural groups" in the population. But this is also its deficiency, for if sampling errors are present, as always can be assumed for any sample, then the number of groups will vary from the true population groups. Consider, for example, a case in which the true population is divided into two groups, unknown to the analyst. If in the sample used in the clustering procedure some gaps in the variable values exist due to sampling errors, the two groups will not be identified. Thus this approach is seen more appropriate when a complete population enumeration is available.

The alternative approach is also subject to numerous errors, the most prominent of which is that a structure (number of clusters) is being imposed on a population which may, in fact, include a different number of groups. Yet this problem can be partially treated by a proper search procedure described in Section 5.5.

For a number of reasons discussed in Section 5.5 we preferred the latter approach. This then raises the second question noted above: given that life style can serve as a basis for classifying people, what is the range in which the appropriate number of groups should be searched? Ideally, such a question should not exist. For any sample one should use an open-ended approach which will identify the existing groups, whatever their number is, and then with the analyst's discretion groups can be combined on the basis of their similarity. Conversely, it can be argued that the choice of the number of groups can or should be based on practical considerations, i.e., what is the marginal benefit in explanatory power and policy sensitivity of an additional group compared with the cost of obtaining that group and estimating models for it.

As this study is not concerned with the hypothesis that there are distinct life style groups, but rather with the effects that life styles of individuals have on their travel behavior, the whole issue of grouping the individuals becomes a pragmatic problem and the choice of the number of groups should be determined by convenience and logistical criteria. But notice must be taken that the identified groups, in whatever number, should have a theoretically based distinction as well as

a distinction along a (travel) behavioral relevant dimension. For example, if a relatively homogeneous sample is clustered into two groups which differ only in educational level, they would not be conceived as different life style groups and will not be valid groups for testing the hypotheses of this study. In other words, it is suggested that the most important evaluation of the obtained groups is by their intuitive meaning. If a plausible description of distinct groups can be drawn then the groups can be valid candidates for testing the hypotheses. Of course, beyond the intuitive meaning the grouping need also withstand some statistical test of significance. But we emphasize, the latter in themselves are not sufficient.

The imposition of a group structure on a sample probably involves a number of misclassifications. The issues of errors in the classification is further elaborated on in Chapter 5.5.

In summary, the number of groups to be formed should be determined by evaluating the marginal gain in explanatory power vs. the cost of estimating additional models. The cost of estimation is both monetary and statistical. In any case, we stress that the identified groups need to withstand a "test" of theoretical significance.

5.4 An Operational Definition of Life Style

An operational definition is one which utilizes tangible elements to represent an abstract concept. As such, it requires bridging between some conceptual notions and available information by means of making assumptions on the representation of the former by the latter. Ideally,

in seeking an operational definition one should obtain data specifically designed to represent, within the accuracy of available measurement methods, the conceptual elements. In attempting to develop an operational definition of life style under the constraint of using available data, it becomes necessary to make a series of assumptions many of which can easily be challenged. Yet, the objective of this thesis is the demonstration that a composite measure, which we choose to label "life style", is capable of providing information on decision makers which improves the understanding of their behavior. The assumptions made should be viewed in light of this objective.

The definition of life style given in Chapter 4 states that life style is "the pattern of behavior which conforms to the orientation an individual has to the roles of family member, worker, and consumer of leisure and to the constrained resources available." This definition is far from being tangible. Concepts, like patterns, orientation and roles, lack precise quantitative definitions and therefore make the whole definition intangible.

The attempt made in this study to define an operational measure of life style is confined to a sub-group of the population, the household headed by married couples. This was done because there is an underlying assumption that household type is by itself a discriminatory dimension between life styles. Different household types involve completely different patterns of commitment toward other individuals as well as different sets of constraints on the individuals' own behavior. Despite the fact that the diversity of life styles in the near future will

nourish mainly on the non-nuclear family households, we chose to focus on the family type because it is still the most popular one, yet it is also subject to recent changes in the internal structure of role allocations, the implications of which may be of interest to planners.

A valid question at this point is: if household type is by itself a discriminatory dimension between life styles, why not use it as a sole basis for market segmentation? Although we have not tested it, we assume that household type may in fact provide a reasonable basis for segmentation. But further, it is suggested that the life style concept can refine that segmentation to capture differences within each household type group. Obviously, a refinement within the largest group, that of the nuclear family, is warranted. This study, being an exploration into a new concept, is concerned with demonstrating that the concept is viable. With that purpose in mind, the application to one group only is justified, although clearly in the future the concept can be employed to different groups depending on the research or planning needs.

5.4.1 Orientations

The first assumption is that in practicing a certain course of behavior individuals reveal their preference. Individuals engage in activities of two basic types: voluntary and compulsory. The manner in which they choose to deal with the obligatory and voluntary activities represents their preference. Further, it is assumed that if the revealed preference with regard to particular activities is persistent over time, it represents an orientation, or a lasting direction.

These first two assumptions do not always hold true. For example, assuming that a person is family-oriented merely by the fact that he or she is presently living in one is misleading. Changing the choice of family formation is a process which involves long deliberations and high transaction costs and consequently it is plausible that although people presently live in a family (or outside one) this situation does not necessarily indicate their current orientation and preference.

In other words, this is a situation of disequilibrium between the demand (orientation) and the supply (the current status). It will probably not be captured by cross-sectional data used under the revealed preference approach, but could be identified by the use of psychological data.

A second problem to which we have made reference earlier is that a single day's time allocation data cannot satisfactorily serve as representing a pattern of behavior. A number of approaches were experimented with in order to obtain some information on a longitudinal pattern of time allocation.

The first experiment was the utilization of another data item available in the trip file of the BTDDS, namely, the subjective frequency of activities. An expected value of time allocated to each activity could be calculated (by multiplication of the actual duration of the activity by the inverse of the frequency). But, for a number of reasons, this approach was rejected. First, the frequency information was available only for activities reported in the trip file. There was no information about the frequency of activities not practiced on the given

survey day. Second, an examination of the phrasing of the frequency question in the questionnaire revealed that it referred to the frequency of making a trip between the exact origin-destination pair. This is too narrow a definition of frequency as it excludes trips for the same purpose taken in other origin-destination pairs and it may include trips made between the same origin-destination pair but for a different purpose.

A second approach was the estimation of the "missing data" (i.e., the values for activities not undertaken on the survey date) by regressing against socio-economic and time allocation for other activities. What this approach provides is a "smoothing out" of the real data to provide participation rates with less fluctuations. But it also causes multicollinearity between variables which later are treated (in the cluster analysis) as independent variables. Also, the estimation requires cautious model building (of a limited dependent variable). Consequently, it is not an "ideal" solution and it may be applied only if a very cautious model building is undertaken, a task which is beyond the scope of this research.

The third approach, also mentioned earlier, is the aggregation of activities from seven to four or three, thereby avoiding some of the empty cells. While statistically valid, this approach incurs loss of information which may be important to refining life styles categorization.

In summary, orientations to roles are assumed to be manifested by the revealed preference for household type and activity patterns. It is realized that the approach applied here is weak as it is based on diary data of a very short period. Moreover, assuming orientations to

family based on time spent at home may be misleading, as a variety of non-family related activities can be practiced at home.* Also, the orientation toward leisure conceptually involves a qualitative dimension distinguishing, for example, between entertainment and public activism. This qualitative dimension is lost in the aggregation scheme available.

One specific time budget item, that of services, is designed to capture variations in the allocation of responsibilities between the heads of the household. These may prove to be significant in the emerging new dual career households.

5.4.2 The Representation of Roles and Constraints

The definition of life style provided in Chapter 4 includes three broadly defined roles which are viewed as cardinal components of life style. As noted earlier, the differential allocation of resources to these three roles is assumed to manifest differential tastes or preferences to a complete pattern of behavior, as these roles cover the main realms of human life.

For this assumption to hold true, the three roles need to be represented by observed variables which fully capture the range of variations in each role. The search of variables to be used in grouping the sample population was guided by this objective but obviously fell short of its fulfillment, as will be described below.

The definition of life style also bounds the pattern of behavior

* The most typical examples being work at home or individual leisure (reading, listening to music, etc.).

by the available resources an individual has at his or her disposal. These binding constraints need also to be represented by available data, often by the very same variables which describe the roles.

Basically we identify two types of constraints: economic and social. The first limits the individual's ability to practice certain life styles. For example, abstaining from the labor force, obtaining education, and certain types of leisure are not viable options for all those constrained by limited economic resources. While the implications of the economic constraints are obvious, it is not quite clear how it should be measured. The common practice is the use of current income as a surrogate for wealth, which is probably the true attribute.

Social constraints can be observed at two different levels. At the higher level are the constraints imposed on the individual by the values and norms of the society he or she lives in. In this study these have been ignored, assuming that in a pluralistic society such as that of the United States' urban areas, the constraints are binding only in extreme deviant behavior. Short of that they are not significant. Yet, a reservation is warranted. Subcultures in the American society do have norms which their members share, largely as a voluntary act, but also to some degree as coerced acts. The differentiation of the effects of these two requires an inquiry into the intra-personal dimension which for reasons mentioned above we chose to avoid.

The lower level constraints are those which bind an individual's behavior as a result of his or her commitments to the household members and to other individuals. This level corresponds to the lowest level

of the interpersonal dimension of behavior discussed in Section 2.2.2.

5.4.2.1 Major Variables

Three types of variables are used to define the life styles groups: demographic variables, economic and social variables, and time budget variables. In the following paragraphs the assumed effect of each variable within each of the groups is described. The list of variables is given in Table 5.2 (a complete list with definitions is given in Table 6.1.)

The demographic variables are intended to represent the orientation toward family life as well as the constraints imposed by a family on an individual and the effect of life cycle. Included in this category are the total household size and the number of adults (over 18 years old) in the household. The first is mainly an indicator of the level of resource consumption of the family and also it may reveal the preference for family size, although this at any given point of time may not capture the actual preference. The number of adults in the household represents a different type of input to the household's decision making than that of the two-adult household. Although the input of various members probably varies across cultural groups as well as across individual households, depending on the personalities involved, it is assumed that a larger number of adults does have an effect on the behavioral decisions and the allocation of resources within the household.

The presence of children in the household is represented by two variables. The first is a dummy variable indicating the presence of

Table 5.2 Variables Used in Life Style Definition

Demographic

1. Age
2. Presence of children under 6 years old
3. Presence of children between 6 and 18 years old
4. Household size
5. Number of adults in household

Socio-Economic

6. Income
7. Proportion of household income earned by male head
8. " " " " " " female head
9. Level of formal education
10. Occupation status, male head of household
11. Employment status, male head of household
12. " " , female head of household

Time Allocation (limited use)

13. Time spent at home, male head of household
14. " " " " , female head of household
15. " " " work, male head of household
16. " " " " , female head of household
17. " " " leisure, male head of household
18. " " " " , female head of household
19. " " " services for the household, male head of household
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18. " " " " , female head of household
19. " " " services for the household, male head of household
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children under 6 years old in the household and the second is a dummy indicating the presence of children between the ages of 6 and 18 years old. Combined, these variables represent an orientation to family life, although again with a qualification: the effect of the temporal dimension may mask the actual preference. Separately, these variables represent different levels of constraints imposed on activities of the adult members of the household. Younger children require a different type of care than older ones and consequently they impose a more binding constraint.

The last component of the demographic variables is the life cycle. Life cycle is assumed to affect the rate and type of activities in which people engage. The very young and the elderly, in general terms, have more leisure and less compulsory activities than the age groups in between. In terms of travel behavior, we can assume that motorized trip rates have a peak at adulthood and decline to both ends while the inverse is true for walk trips. In view of the life style and life decisions it is plausible to assume that with the increase in age the life decisions made are perceived as being more long-lasting. An elderly person who retires probably does not expect to make additional life decisions while, in contrast, young adults in many cases may make such decisions knowing that there is enough time to re-evaluate and change their life decisions.

Life cycle was represented in the data by five (or less) dummy variables pertaining to the age group of the older of the two heads of household.

The variables which relate to economic and social attributes provide information on the available economic resources, some information on the allocation of responsibilities between the household heads, and information on "social status".

The economic resources are represented by the total annual household income. The limitations of using this variable are numerous. First, as noted earlier, life styles are probably more sensitive to permanent income or wealth than to current income. Second, the response to income information in questionnaires is subject to both upward and downward bias as well as a decline to response at all. In the latter case an estimated income was provided in the BTDDS by the interviewer based on his or her impressions. Given these shortcomings, future analysis of life style may have to put more emphasis on the data collection technique for this as well as other variables. Under the limitations of the approach adopted in this study, we used the annual income despite its shortcomings.

Another income related variable is designed to account for the degree of sharing of responsibilities among husbands and wives and for the involvement in the labor force. It presents the proportion of each head's contribution to the household's total income. (Although presumably these two variables should be perfectly negatively correlated, they are not because income can be contributed by other members, some of the household income may not be earned income, and the categorization chosen for the two variables is not perfectly complementary).

Other economic related variables which serve as surrogates of

time budget are the employment status for both male and female heads of the household. As the time budget data derived from the BTDDS is subject to a severe sampling error we chose to represent the participation in the labor force by dummy variables which are not subject to severe errors.

Two variables which conventionally are indicators of social status were also applied here although they were not intended to capture this dimension. The first is educational which is categorized to four levels: elementary education or less, some or complete high school education, some or complete college education, and some or complete graduate level education. The role of this variable is multifold. Most importantly, it relates to occupational status which relates to a capability to control time and make long range plans. It is also correlated with income thus serving as a complementary attribute. It may also indicate the type of leisure activity people prefer, assuming for example that highly educated people will engage more in creative or participatory cultural and leisure activities than people with lower levels of education. The household was characterized by the highest level obtained by any of its members, assuming that this is the dominant effect on the household's decision making.

The distinction between college and graduate level education was deemed necessary as we assume that the latter have a different, wider set of options for work opportunities including higher ranking positions and more options for flexible schedules. Further, the increase in the number of college graduates in the population warrants the need

to refine this group to separate levels.

The last socio-economic variable also usually used as a social status indicator is the occupation. We used only a distinction between white collar occupations and others, with the assumption that white collar workers are less constrained by strict work schedules.

The third type of variable is the time budget data. For reasons detailed earlier only limited use of this type was undertaken. Where used, the ideal categories were collapsed into a smaller set of four categories: time spent at home, at work, at leisure, and at services for the household. The variables are percentages of 24 hours spent at each activity by each of the heads of the household. The quality of these variables is the lowest of all but still we felt that some instrumental value can be inferred from them. Recall that the main shortcoming of this data is that it is a sample of activities of a single day. The second shortcoming is that the broadly defined categories are more sensitive to the location of the activity than to its content. We do not know what type of activities an individual is practicing at home. Leisure activities and household services are accounted for only when practiced out-of-home and no information is available on the type or level of sharing of these when practiced at home. Due to their low quality we chose to substitute the time spent at work by a set of dummy variables for employment status. As for the remaining, their fragility requires caution in use and in the evaluation of the results, as will be discussed in Chapter 6.

5.4.3 Summary

The operational definition used to identify life style groups based on the available data suffers from some shortcomings compared to the conceptual definition. A household's life style is defined as the pattern of behavior and orientations of the male and female heads of it, as manifested by their preference for family structure (revealed by demographic variables), participation in work force and participation in out-of-home leisure activities, and constrained by income and assumed temporal commitments to the family and work.

The weakest component in this definition, as expected, is the leisure orientation, first, because no consistent and efficient variables account for it (except the time allocation data). Secondly, leisure, more than other activities, is sensitive to the temporal component of the sampling. Sampling of only a single work day's activities is prone to underrepresent some types of this activity. Even where reported, no information is available on the type of leisure, which in itself is assumed to be important to the definition of life styles.

The general operational definition given here will be applied in a clustering procedure to identify households which share similar life styles. The clustering procedure, as will be detailed in the following two chapters, allows experimentation with alternative combinations of these basic components of the definition by assigning different weight to the variables.

5.5 Statistical Methodology

In the analysis of behavior scientists are often confronted with the necessity of reducing an available data matrix, in which usually the observations constitute the rows and their attributes constitute the columns, into a manageable data set which pertains to the specific research agenda. A wide variety of statistical strategies are available for this task and in the context of this research multivariate analysis methods which can be used for grouping of elements of the data matrix are of interest.

One approach which includes a number of methods like factor analysis and principal components,* is oriented to the reduction in the number of variables (columns of the matrix) by identifying factors which correlate with a number of variables. Another approach is that geared to reducing the number of observations into groups. The prominent method of this approach is cluster analysis, which in itself is a family of procedures varying in the underlying assumptions and in the algorithms. It should be noted that cluster analysis can also be applied to the clustering of variables thus becoming similar to factor analysis and also to a combined clustering of cases and variables (block clustering).

Most of these methods are currently available in computer packages like the SPSS (Statistical Programs for Social Sciences), BMDP (Bio-Medical Programs), SAS (Statistical Analysis System), and TROLL.

In this research an attempt is made at identifying groups of indi-

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* For reviews of these and other multivariate methods see Kendall (1975).

viduals who share similar life styles and consequently, are hypothesized to demonstrate some similarities in travel behavior. Two questions need to be addressed in this process. The first is what is the appropriate approach for grouping the population into clusters? The second is how can the clusters, once identified, be characterized?

Before dealing with these it is necessary to briefly review the alternative methods.

To obtain groups which are similar across a large number of dimensions the choice of methods is limited to either factor analysis (or a variant of it) or cluster analysis. These methods differ significantly in their underlying assumption as well as mathematical form. Grouping based on factor analysis involves a two-step procedure where first the array of descriptive variables is reduced into a smaller array of "factors", each of which is a linear combination of some of the original variables. The second "mechanical" step is the assignment of "factor loadings" to each observation based on its values across all variables and the relative weight each variable was assigned in the factors. The underlying logic is that correlations between variables which are almost inevitable in rich data sets are eliminated by the creation of the factors which are uncorrelated among themselves. An intermediate step is required between the two mechanical steps described. It is the need to attach a meaning to the obtained factors.

We found cluster analysis to be more appropriate for the purpose of this research, but before supporting this decision a short review of cluster analysis is provided.

5.5.1 Cluster Analysis

Cluster analyses are procedures which in a deterministic fashion classify objects or elements of a data matrix into groups. The clustering is done on the basis of similarity or proximity between observations in a multidimensional space. A large number of computer-based algorithms are presently available.* They vary in type, in the required assumptions, and in efficiency. In this study, our interest lies only in clustering of observations and only such algorithms will be discussed below.

Cluster analysis is an exploratory tool. It allows the analyst to search for different structures which may exist in the data. There is no need to have an a priori knowledge of the groups that constitute the data set, but there is an assumption that the data is heterogenous so that some groups do exist.

There are at least two uses for such an exploratory tool. The first is the obvious need for grouping which allows the reduction of a data set into a small number of groups on which generalizations can be made. The second is to uncover relationships which are latent and unexpected in a data set.

Anderberg (1973) points at some important "philosophical" observations on cluster analysis which are noteworthy in this context. He notes that:

1) Any data set may admit to a number of meaningful classifications,

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* Some algorithms are described in Anderberg (1973), Hartigan (1975), and in various manuals of statistical computer packages like BMDP, SAS, and others.

and there is not necessarily one "right" classification. Different classifications obtained through cluster analysis may reveal new, previously unexpected relationships.

2) Cluster analysis is a device for suggesting hypotheses. The groupings revealed by cluster analysis do not in and of themselves have an inherent validity.

3) "Cluster analysis methods involve a mixture of imposing a structure on the data and revealing that structure which actually exists in the data." While ideally one would be interested in identifying the "natural groups" in the data, "to a considerable extent a set of clusters reflects the degree to which the data set conforms to the structural forms embedded in the clustering algorithm."

4) Rarely do cluster analyses result in a satisfactory structure for a total data set, i.e., in most cases some cases will be forming independent small clusters which are for practical purposes incompatible with the clustered data.

5) Prior information on the population needs to be used with caution. As an example consider a population which a priori is thought to consist of five groups but for some random or systematic cause only four groups were sampled. Imposing the prior knowledge on the structure will lead to insignificant results.

Bearing in mind that in view of these comments cluster analysis cannot be seen as anything but an exploratory tool, the following decisions need to be made in applying the method:

1) The type of similarity or distance measure

2) The basic approach of forming groups

3) (Related to 2) The number of desired groups

4) What types of inference can be drawn from the output, given the decisions made in 1) through 3)

The following sections will briefly review each decision in turn.

5.5.1.1 Distance Measure

The most common similarity or proximity criterion used is a metric distance function which measures the distance between data points in a space. The Euclidean distance between two points, i, j, in an k dimensional space given in equation (5.3) is often used.

$$D_{ij} = \left[\sum_{k=1}^{K} (X_{ik} - X_{jk})^2 \right]^{1/2} \qquad \text{(5.3 repeated)}$$

where: X_{ik} and X_{jk} are the values of attribute X for individuals i and j in the kth dimension

Variants of the Euclidean distance as well as other distance or similarity measures like matching measures (proportion of matched items compared with non-matched items) are also available. Note that the Euclidean distance requires an assumption that the variables (the k dimensions) are orthogonal, an assumption often violated (Green and Tull, 1978). Clearly, the type of distance function selected depends, among other things, on the type of data used.

The fact that all variables enter the distance function makes it necessary to transform the variables to a uniform scale. Otherwise, a

variable like age will have a greater effect on the distance than a variable like household size and both of these will have a greater effect than a nominal variable like marital status. There are two elements to the transformation as illustrated here. First, variables of the same type (e.g., interval scale data) need to be standardized to eliminate the effect of scale differences. This can be done through simple linear transformations which are available as part of the computer-packaged algorithms (e.g., BMDP-2M and BMDP-KM). The common standardization is by the standard deviation but other like standardizations by the covariance matrix are also available. The second element is the treatment of variables of different types. Clearly the distance between values given to a nominal variable (e.g., marital status, race, presence of young children) is meaningless in comparison with interval scale variables. Ideally, variables used in cluster analysis should be of one type to avoid possible distortions. Yet in most applications one needs to deal with data sets which include different types.

There are a variety of approaches for dealing with this shortcoming Some may be labelled mechanical and they range from ignoring variables which do not match the majority type to separate clustering of each variable type and subsequently attempting to match up the groups. Other methods involve scale conversion (a review of scale conversion methods is provided by Anderberg, 1973). Scale conversions require making assumptions and judgments by the analyst and, in many cases, they involv some loss of information as, for example, in the case of ordinal data transformed into nominal data. An additional lever at the analyst's

disposal is the assignment of weights to variables. This is clearly a judgmental procedure which can be done if one has sound reasoning to justify it. Weights can be assigned to variables of the same type or to "scale" variables of different types to a common scale.

5.5.1.2 The Clustering Approach

The second issue is that of clustering approach which is closely interrelated with the third issue, the number of desired clusters. Basically two contrasting approaches are available. One, labelled hierarchical clustering, contains different algorithms which search for the closest proximity among all pairs of observations. Initially, each observation constitutes a cluster and in an iterative procedure pairs of single observations or previously-clustered observations are clustered together if they demonstrate the shortest distance at any given iteration. The result is a tree-like denogram in which finally, all observations constitute one cluster. The analyst may then exert his or her judgment in the choice of the number of desired clusters, which vary from (n-1), where n is the number of observations, to one.

In the alternative approach, the non-hierarchical clustering, the number of clusters is predetermined for each run. Two options are available: to strictly determine the number of clusters or to set a convergence criterion, a procedure which will create additional clusters until the condition is met. The algorithms of this approach set a number of points at intervals in the space, which will serve as centers of the specified number of clusters (hence the name "K-means clustering").

All observations are assigned to the closest center point and then in an iterative process the "centers" are moved in the space until they become the actual centers of the respective clusters, i.e., the total distance between all members of the cluster and the center point is minimized. Observations can be reassigned if in the process of moving the means they become closer to another cluster center.

5.5.1.3 The Number of Clusters

The basic problem in the latter approach is the choice of the number of clusters. As Ever-Hadani (1980) put it, "the question is whether we impose a structure on the data, or (hopefully) find it." To some extent, the choice of approach and the choice of number of clusters can be viewed as a pragmatic one; selecting the number of clusters which is logistically manageable for whatever subsequent use is intended.* On the other hand, a predetermined number of clusters is definitely closer to imposing a structure than to finding one. To overcome this one can, in consistency with the general exploratory manner in which cluster analysis should be used, experiment with varying numbers of clusters for a given data set and evaluate the results by the difference in the intra-cluster and the inter-cluster distances, and more importantly, the meanings of the clusters. This as a style of analysis will draw further discussion below.

One necessary step is an iterative (and costly) search through the

* It should be noted that the K-means procedures provide a variety of summary statistics on the clusters which are not available in hierarchical methods as the choice of clusters is judgmental.

data in order to identify outlying groups or cases. Assume, for example, that a data set is composed of two large groups and three separate outliers. Any clustering which produces between 2 and 4 clusters will identify one large cluster which includes both large groups and between 1 and 3 single case clusters for the outliers. Only if five clusters are produced will the real structure of the data be observed. An example of such a search, varying the number of clusters from five to twelve on the actual data set, is given in Appendix A. This leads the discussion to the fourth issue, the question of what inferences can be drawn from the identified clusters.

5.5.1.4 The Interpretation of Clusters

The identified clusters can be described by a variety of summary statistics (available directly, as machine output for the K-means procedure, or calculated for the hierarchical procedures). These include intra- as well as inter-cluster measures of distance, centrality, and dispersion, profiles and cross tabulation of the clusters by variables (whether included or excluded from the clustering procedure). Thus, the identified groups in the sample population can be subject to extensive analysis in search of an explanation or a theory which provides meaning to the observed structure. But this falls short of possible inferences on the population not sampled and on the "real" groups in the sample not necessarily identified. In other words, the output is very sensitive to the input data and no direct probabilistic inference about the underlying population is available.

Cluster analysis, as indicated by the cautionary remarks of Anderberg (1973) cited above, cannot to date withstand tests of statistical reliability of the identified structure. Green and Tull (1978) suggest a number of reasons for this shortcoming. First is the problem that the universe of the content is not clearly known. Therefore, the "quality" or the goodness of fit of the obtained structure cannot be evaluated in absolute terms. Second, the clusters are formed from the data and not on the basis of outside criteria. Testing results on the data set used for obtaining the results is unacceptable. (This can be overcome by splitting the data set and using one part for clustering and the second for validation.) Third, the underlying distribution of the variables and observations are largely unknown, hence, "it would be dangerous to assume that the variables conform to some tractable model such as a set of multivariate normal distributions differing only in centroid locations" (Green and Tull, 1978). Consequently, cluster analyses should strictly be seen as an exploratory method for pre-classification. Among the possible outcomes, those clusters to which one ca ascribe a theoretical basis can be used for further analysis. There are no "right" or "wrong" outcomes in cluster analysis.

5.5.1.5 Cluster Analysis vs. Factor Analysis

Both cluster analysis and factor analysis are designed to reduce data matrices into smaller matrices which are manageable in size and (hopefully) logical in structure and content for the research purposes. The basic difference is that factor analysis reduces both dimensions of

the data matrices, i.e., first the number of variables and then the number of observations, while cluster analysis reduces only the latter into groups.

Factor analysis thus requires that the factors be interpretable, a requirement that is not always easily obtained. The fact that a number of variables describing an observation are correlated does not provide theoretical justification for assuming that all these variables have a consistent and similar effect on its behavior. Moreover, collapsing the data into factors involves some loss of information. Consider, for example, the case in which an individual has a very high income but low educational level. Since in most cases these variables are correlated and, hence, probably constitute the same factor, this particular individual may obtain a score on the appropriate factor similar to other individuals for whom the two variables are closely correlated. Behaviorally though, we can assume that this individual is different; but such a difference will be overlooked in the use of factor analysis.

Cluster analysis is less restrictive as it allows for more interactions between the variables. Despite the fact that income and education are correlated more can be learned from the use of both for each individual than from the collapsed factor. As we assume that life styles are sensitive to some very specific variables which may be lost in factor analysis, we chose to employ cluster analysis.

5.5.2 Application of Cluster Analysis

In attempting to identify groups of individuals which are distinguished by practicing different life styles, it was first necessary to decide what type of clustering algorithm to apply. Initially the hierarchical algorithm seems appealing as it has the potential of uncovering "natural groups" in the sample. But, as "natural groups" were not self evident in the output of preliminary hierarchical clustering, making judgments about the cutoff points so that the number of clusters will be of manageable size was necessary. Given the lack of information about the clusters, except the distance last clustered, making such judgments was not deemed appropriate. Consequently, we resorted to the K-means clustering procedure. A decision was made that a range of 5 to 7 clusters is the maximum workable size for further analysis.*

Consistent with the recommendations of Anderberg (1972) and others we treated the problem of identifying the desired groups in a truly exploratory manner. That is, the search for an acceptable clustering in the range of 2 to 7 groups involved a long series of experimentations of both changing the specification (the variables used in the clustering process) and the number of clusters.

Evaluation of the cluster analysis output is based on two main criteria. The first is the intuitive interpretation that can be ascribed to the identified clusters. The second is a set of statistical measures, none of which provides a measure of the total "quality" of the clustering. The statistical tests refer to the discriminatory power of individual

* Recall that this analysis is only of married couples' households so that an analysis of the total population would require a few more groups.

variables in a number of ways. The most simple one is the analysis of the contingency table in which cross tabulation of the clusters by various variables is provided. The test is for the independence of the distribution of the variable across the clusters and the evaluation is by means of a chi-square test of independence with the number of cells minus one degree of freedom. (This test can also be applied to variables which were not included in the clustering procedure.)

Another test for evaluating the discrimination between the clusters along each variable is an F-test. The ratio between the "between cluster sum of squares" over the "within cluster sum of squares" is F distributed with the number of clusters and the number of cases minus the number of clusters degrees of freedom.

A graphical display of the cluster profiles is also available indicating the dispersion of values around the mean of each variable.

The exploration of the universe of possible clusters involves an iterative procedure in which the weights of the input variables are changed and the number of clusters is changed. Each of these serves a different purpose but jointly they enable a reasonable non-exhaustive search process. Changing the specification of the variables to be used acts in effect as a change of the relative weight of each of the three types of data described in Section 5.4. For example, in light of the fragility of the time budget data we chose to reduce the number of entries of these variables or to eliminate them altogether. As the clustering is based on a metric distance in a K-dimensional space, the deletion of a variable reduces the implied weights assigned to it.

In addition, variables such as the life cycle variable

were represented by five dummy variables corresponding to five age groups. As a result, the implied relative weight given to age exceeds variables like income which is represented by one variable or education which is represented by four dummy variables. The effects of such changes are described in the following chapter.

Changing the number of clusters in an incremental manner is, as described above and in Appendix A, a necessary step in order to identify the group structure and outlying cases. In a pluralistic society we suggested that life styles probably vary on a continuum but probably not in a uniform distribution. That is, we assume that some life styles are more popular than others. Thus, the grouping procedure is likely to result in identifying groups of varying sizes, some of which may be too small to allow any further statistical analysis. But these smaller groups cannot be totally excluded from the analysis. The problem, though, is that we do not have any a priori knowledge about the nature of the distribution and the search procedure needs to identify the "stability" of the clusters across varying weights and cluster structures. While for statistical convenience clusters of approximately equal size are preferred and, certainly, small clusters are undesired because no further analysis of them can be carried out, persistent clusters indicate that these cases do have some peculiarity. An attempt can be made to eliminate such clusters by "brute force", i.e., drastic change in attribute weights or reduction of the number of clusters, but clearly, the effect is loss of information. Examples of this approach are provided in the following chapter.

5.5.3 Evaluation of Cluster Analysis Output

Evaluation of the cluster analysis output, as noted earlier, should be based on the interpretation that can be given to each cluster as well as on the statistical measures of discrimination of each variable. While the role of the statistical measure is clear, the intuitive interpretation requires further scrutiny. Interpretation of any cluster along a description of its characteristics is possible. All clusters are real combinations of true data matrices and therefore there are no "right" or "correct vs. "incorrect" combinations.

But, such combinations may not be groups which have any behavioral relevance. Consider for example a homogeneous group who vary only in a single variable like income, for which part of the group has a value of $30,000 and another part has $35,000. The cluster analysis will create 2 distinct clusters and the statistical significance will be high, yet we claim that this difference among the clusters is irrelevant for the purpose of defining behavioral groups. This is the point where intuition and judgement must prevail. A difference of 17% in income may not be relevant as may a difference of 20% or when the 17% difference is seen synoptically with other variables. The interpretability can also be a function of our ability to recognize the clusters as groups which are visible in the research population we know or hypothesize to exist.

The choice of "good" clusters is thus a matter of judgement. If some clustering scheme is discriminating between groups which seem behaviorally distinct they can and should be tested further. For the purpose of defining life styles clearly the appropriate time allocation data have a potential of being the test variables, as noted in Section 5.1.2. But given their poor representability of time allocation in the current study, emphasis is assigned to the demographic and socio-economic attributes and

the time allocation data can hardly even serve for testing the differences across groups.

The classification of cases into clusters is prone to a number of errors. The source of some of the errors is in the data preparation state: errors in measurement and errors in coding are the obvious examples. These include both human errors in the handling as well as errors inherent in the questionnaire design. The latter group includes, for example, the case of a person who works at home and in this analysis will be assumed to be home-oriented. All simultaneous activities are similarly lost and assigned to one category according to the respondent's or, worse yet, the interviewer's judgement.

Major errors or noise are introduced, in this analysis, where use of the time allocation data is made. Being a sample of activities for one day rather than a sample of a person's activities, deviations from the routinized activity patterns can be assumed to be significant. The only solution within the scope of this analysis was to decrease the weights of the time budget variables. Future development of this exploration into the life style concept will require elaboration on the role of these variables.

The effect of these errors on the clustering procedure is not only that cases are erroneously classified into the "wrong" cluster but that the clusters are erroneously characterized. Consider, for example, an observation which by k-1 of its attributes should be a member of cluster A, but at a marginal position. Because its kth attribute is erroneous, the observation becomes a member of cluster B, again at the margin. But because of the deterministic manner in which the allocation of cases operates and because the cluster characteristics, i.e., the mean values, are

affected by all members equally, cluster B will be characterized by attributes which are biased toward cluster A. The influence of such errors is obviously inversely related to the cluster size as the effect of an error in a single observation diminishes in a large group. It is also inversely related to the number of attributes used in the clustering procedure for a similar reason. Not having any clues regarding the presence of errors (beyond those cited above), a cautious strategy would be to increase the number of variables which account for each of the three types of attributes (as long as they describe different facets of the phenomena and are not highly correlated) and to avoid or be extremely cautious with the use of small clusters.

Chapter 6: Empirical Application of the Life Style Concept

This chapter presents the results of the cluster analyses in which the sample population was classified into groups which we suggest to be life style groups. Realizing that cluster analysis is basically an exploratory tool a large number of runs were performed in search of groups which are intuitively interpretable and statistically distinct.* The search is performed by varying the specification of variables used in the analysis and varying the number of clusters produced.

Data on 525 households which are headed by a married couple was used as input to a K-means clustering algorithm.** The data set included over 80 variables which potentially could serve as input variables. We stressed, consistent with our definition of life style, the demographic, socio-economic and to a lesser extent the time allocation data as input representing both the orientations and the constraints. Excluded from the definition of life style are all variables which relate to travel or mobility characteristics, as those were viewed as the dependent variables in this study. Cross tabulation of variables like residential location, automobile ownership, and trip rates by cluster are presented in Section 6.2. The variables used in the cluster analyses are defined in Table 6.1.

From the variety of clustering schemes experimented only those which were of interest for further analysis are reported here. Recall

* Statistical distinction is evaluated by F-ratio test of the ratio between the between clusters sums of squares and the within cluster sums of squares for each individual variable. There is not test of aggregate distinction among clusters.

** The BMDP-1979 PKM program was used.

Table 6.1 Variable Names and Definitions - Cluster Analysis Input

	Name	Definition	Comments
1	Age	Age of head of household, in categories 1 = 18-24 years 2 = 25-34 years 3 = 35-44 years 4 = 45-64 years 5 = 65+ years	Entered as 4 dummy variables
2	CHLDPR	Children under 6 years old = 1 if present in household = 0 otherwise	
3	JCHLD	Children over 6 under 18 = 1 if present = 0 otherwise	
4	TOTPER	Total household size	
5	IPERTR	Number of adults (over 18 years) in household	
6	PRNC1	Proportion (P) of household income earned by male head 1 = P > .85 2 = .85 > P > .7 3 = .7 > P > .6 4 = .6 > P	
7	PRNC2	Proportion (P) of household income earned by female head 1 = P > .35 2 = .35 > P > .20 3 = .20 > P > .10 4 = .10 > P	

Table 6.1 cont'd

	Name	Definition	Comments
8	HHED	Education level, highest velue in household 1 = Elementary 2 = High school 3 = College 4 = Graduate work	Entered as 3 dummy variables
9	Income	Annual household income in dollars 1 = less than $1000 2 = 1000 - 1995 3 = 2000 - 2999 4 = 3000 - 3999 5 = 4000 - 4999 6 = 5000 - 5999 7 6000 - 6999 8 7000 - 7999 9 8000 - 8999 10 9000 - 9999 11 10,000 - 11,000 12 12,000 - 14,999 13 15,000 - 16,999 14 17,000 - 18,999 15 19,000 - 20,999 16 21,000 - 24,999 17 25,000 - 34,999 18 35,000 - 49,999 19 50,000 or more	
10	HOME 1	Percent of 24 hours spent at home, male head	
11	HOME 2	Percent of 24 hours spent at home, female head	

able 6.1 cont'd

	Name	Definition
12	Leis 1	Percent of 24 hours spent at leisure activity male head
13	Leis 2	Percent of 24 hours spent at leisure activity female head
14	Srv 1	Percent of 24 hours spent at services, male head
15	Srv 2	Percent of 24 hours spent at services, female head
16	Wrk 1	Percent of 24 hours spent a work, male head
17	Wrk 2	Percent of 24 hours spent at work, female head
18	WCOL1	Occupation of male head 1 = white collar 0 = otherwise
19	EMP1	Employment status male head 1 = if fully employed or holding 2 positions 0 = otherwise
20	FEMP2	Employment status of female head 1 = if full employment 0 = otherwise
21	PRTEMP2	Employment status of female head 1 = if part-time employment 0 = otherwise

that for practical reasons we have constrained the search to a magnitude of 3-7 clusters to represent our sample population which excludes all households not headed by a married couple. Early in the analysis a group of four households was identified as outliers because of a very unusual time allocation pattern which consistently formed an independent cluster. In the subsequent runs these four cases were excluded, leaving 521 households in the sample.

The utilization of the life style concept is suggested as an advantageous alternative to the common methods of accounting for taste variations in disaggregate choice models, namely the use of socioeconomic variables in the model or as a basis for segmentation. Consequently, the course of the search for the desired clustering scheme involved the comparison of the performance of each scheme to schemes developed in the past and revision of the schemes based on the comparison results. In this chapter we present the search path we followed and the structure of those clusters which we chose to use further in the travel demand models.

6.1 Analysis Results

A summary of the analysis structure is presented in Table 6.2. Initially all runs were performed on the whole sample of 521 cases. The output of this type is presented as clustering schemes A, B and B'. Later, under the assumption (which is discussed in Chapter 8) that age is a crucial variable in defining life style, the sample was divided into two subsamples, consisting of 282 households with a head

Table 6.2 Organization of Cluster Analysis Results

Scheme	No.of cases	No.of clusters	No.of input variables	Cluster size					
A	521	5	20	161	75	71		108	106
B	521	6	17	18	110	105	68	81	139
B'	521	5	16	120	86	108	108	99	
C-1	282	3	21	14	171	97			
D-1	282	3	18	14	166	102			
E-1	282	3	15	108	63	111			
F-1	282	2	19	103	179				
G-1	282	2	17	102	180				
C-2	239	3	23	24	187	28			
D-2	239	3	20	24	183	32			
E-2	239	3	20	24	187	28			
F-2	239	3	18	24	180	35			
G-2	239	3	15	22	137	80			
H-2	239	2	18	24	215				

45 years or older and 239 households with a head between 18 and 44 years old. Subsequent runs were performed separately on each subsample where the older sample is denoted by 1 (e.g., Scheme C-1, D-1, etc.) and the younger by the subscript 2.

In an earlier discussion we noted the importance of obtaining clusters which are not too small because they are more vulnerable to data errors, as the relative weight of erroneous data is inversely related to the cluster size. Another reason mentioned was statistical, namely, small clusters cannot be used for further analysis due to the low confidence levels of the estimated coefficients in the travel models. In the context of this study, recall that further analysis is performed on the shopping trips made by members of each cluster, and the number of shopping trips per cluster is still smaller. Two possible approaches are available to deal with this problem. The first is to ignore the small clusters. For example, if as in clustering Scheme C-1 one cluster contains only 2.6% of the total sample, which corresponds to only 1% of the shopping trips, it could be ignored without a significant loss of information. If all small clusters combined constitute more than one to two percent, ignoring them would involve loss of relevant information. The alternative approach is to "force" the smaller clusters into larger ones. This can be done either by changing the specification of the input variables or by changing the number of clusters. The results of such attempts are shown in Table 6.2. A discussion of this issue is continued following the presentation of the cluster results.

6.1.1 Clustering Scheme A

Under this scheme five clusters were created based on 521 observations, each represented by twenty variables. The cluster means for each variable are presented in Table 6.3.* All five clusters are of reasonable size (over 10% of the sample) and all but two of the variables are significant in the F-ratio test at .999. The differences among the clusters can be characterized along a number of dimensions. For example, both cluster 1 and 2 are the upper income groups, yet they vary in household size, the latter being smaller and having children only in a small percentage of the sample. Also, the female spouse in cluster 2 is contributing significantly more than in any other cluster to the household income and consequently also spends the least time at home. Cluster 2 also includes the highest level of education and the largest share of services for the household by the male head.

Clusters 3 and 5 both include a high proportion of elderly people but they vary significantly in income, presence of children, education and occupation, and employment status. Cluster 4 is the youngest cluster, has a high proportion of workers among the males and is close to the

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* Notes for Tables 6.3 through 6.10

1. Age distribution and educational level are expressed as percent of cluster members in each category.
2. WCOL1, EMP1, CHLDPR, JCHLD, FEMP2 and PRTEMP are expressed in percent of cluster members.
3. PRNC1 and PRNC2 are categorical variables. The value given is the average location for the cluster members.
4. HOME, LEIS, and SRV are expressed as percent of 24 hour period.
5. The P-value is the probability with which the F-test can be accepted.
6. The age distribution and educational level are entered into the clustering procedure in (n-1) categories. The last category of each is the residual and therefore the P-value is not reported.

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Distribution (%)			CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	EMP 1	WCOL 1
					18-44	45-65	65+					1	2	3	4									
1	161	31	5.16	2.9	0	99	1	100	93	2.32	3.13	2	35	46	17	24726	61	79			1.66	2.93	37	52
2	75	14	2.47	2.3	21	71	8	13	11	3.47	1.61	13	37	27	23	25133	65	63			2.01	1.87	72	49
3	71	14	3.11	2.1	10	59	31	49	39	1.97	2.70	100	0	0	0	10176	77	87			.96	1.88	24	6
4	100	21	3.87	2.0	100	0	0	92	49	2.00	3.07	4	42	45	9	17337	59	81			1.59	3.09	81	50
5	106	20	2.58	2.5	0	70	30	8	1	2.28	3.49	1	49	42	8	20316	77	90			1.70	2.13	49	53
Total	521	100	3.70	2.5	25	63	12	60	46	2.36	2.92	17	35	36	12	20373	67	80			1.61	2.50	52	45
P-value			.999	.999	.999	.999		.999	.999	.999	.999	.999	.999	.999		.999	.999	.999		•	.58	.25	.999	.999

Table 6.3 Clustering Scheme A. Mean Values of Input Variables

average sample values on most attributes.

In more generalized terms cluster 1 is the large household headed by middle-aged educated persons. Women in this group rarely participate in the earning yet the household income is relatively high with most male workers holding white collar occupations.

Cluster 2 consists of very small households headed by middle-aged adults. This cluster includes the greatest proportion of highly educated persons but also a substantial number of low educated persons, which leads to the conclusion that this group is not discriminated from t others by level of education. Rather, it seems that this group differs from cluster 1 in the large share of women's contribution to the household income (in addition to the household size). It is impossible to infer from the data whether cluster 2 members were childless throughout their life or whether they are households which older children have already left.

Judging by income and education, clusters 1 and 2 probably belong to the same socio-economic class, yet they differ in the females' work statu and the activity pattern, and hence, in life style.

Cluster 3 is characterized primarily by its low income, low level of education, and its very low share of white collar workers. The demographic information indicates that a third of this group are elderly households and we tend to assume that actually two distinct household sizes constitute this group: elderly without children and middle-aged with children. The dimension discriminating this group is obviously the economic-educational so this group can probably be labelled the low

socio-economic class, which in terms of life style is a group on which the economic constraint is most binding. It is also typified by a very low share of household services performed by the male head.

Cluster 5 is similar to cluster 3 in its age composition yet differs significantly in its economic and educational status and presence of children. Only 9% of this group's members have children under 18 and again, it is impossible to determine whether this is a lifelong childlessness or whether it is late-life childlessness. In any case, despite the lack of severe economic constraints and commitment to children, the wives of this group do not work.

Cluster 4 is distinguished from the others mainly by its young household composition. One can speculate that this group is the younger version of cluster 1 where the differences in household size, income, and participation in the labor force can mostly be attributed to the age difference.

In summary, we suggest that all but cluster 3 are groups of similar socio-economic status which vary along demographic and activity dimensions to constitute different life style groups. Cluster 3 forms a separate group because of its economic constraints but could probably include some distinct life styles within it varying along similar lines that distinguish the rest of the clusters.

6.1.2 Clustering Scheme B

Scheme B is different in its specification from Scheme A. Among others,

it excludes the time allocation data. This exclusion, as discussed above, stems from the need to avoid the use of variables which are later to be used as a component of the dependent variable. It also serves as a first pass examination of the relation between the multivariate clusters based on socio-economic/demographic data and the time allocation pattern observed for these clusters. Table 6.4 summarizes the mean values of the input data for each of the six clusters produced. Six clusters were produced, one of which included only 3% of the sample and hence was useless for further analysis. The other clusters' sizes ranged between 13 and 27 percent of the sample.

Age was assigned a high weight in this clustering and it became a major discriminating dimension among five of the six clusters. (This is changed in Scheme B'.) All but one of the variables (females' full employment) are significantly differentiating between the clusters as evaluated by the F-ratio test.

Clusters 1 through 4 differ mainly in age and correlated with it are household size, income, and education, all increasing with age. Also correlated is a decrease in the female spouse's contribution to the household income. The presence of children is also positively correlated with age although in the eldest among the four clusters the ratio is already on the decrease.

Clusters 5 and 6 have a similar age composition of about two-thirds between 45 and 64 years old and the remaining over 65 years old. Yet they differ significantly in the presence of children in the household, education level, and income.

Abstracting from the results shown in Table 6.4 to some generalizations

ter	N	% of Sample	HH Size	Adults in HH	Age of Head Distribution (%)					CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	NCOL 1	FEMP 1	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					18-24	25-34	35-44	45-64	65+					1	2	3	4									
	18	3	2.78	1.94	100	0	0	0	0	61	11		2.17	22	33	39	6	11389	17	72					17	6
.	110	21	3.82	2.07	0	100	0	0	0	84	47		3.00	4	37	44	15	19573	56	82					30	12
	105	20	4.93	2.51	0	0	99	0	1	100	89		3.08	11	36	39	14	22171	49	48					26	13
	81	16	5.17	3.44	0	0	0	100	0	90	77		3.13	1	21	56	22	27975	51	36					20	25
:	68	13	2.79	2.12	0	4	1	60	35	32	29		2.54	100	0	0	0	10904	13	24					25	4
·	139	27	2.42	2.34	0	0	2	72	26	8	7		2.94	0	58	34	8	21014	49	52					29	8
1	521	100	3.71	2.45	3	22	21	43	11	60	46		2.93	17	35	36	12	20373	45	52					26	13
lue			.999	.999	.999	.999	.999	.999		.999	.999		.987	.999	.999	.999		.999	.999	.999					.314	.998

Table 6.4 Mean Values of Input Variables, Clustering Scheme B

we would speculate the following: the members of cluster 4 are the most educated, high income group or the highest socio-economic group in the sample. They have large households in which many children over 18 years are still present in the house. This group is clearly distinguished along the socio-economic dimension since other households of similar age and probably similar demographics as well who are economically disadvantaged and have a low education level are collapsed into cluster 5.

Cluster 5 probably includes the middle-aged and elderly economically disadvantaged households in the sample. This, again, is a well distinguished group along the socio-economic dimension differing from the middle age "well doing" households (in cluster 4) and the elderly "well doing" in cluster 6. We assume that cluster 5 collapses both low income families and elderly couples, thus resulting in values for household size and presence of children which are between the low value of the childless households of cluster 6 and the high values of clusters 1 through 4.

The middle aged households in clusters 4 and 6 probably vary along the demographic dimension, namely, the presence of children.

Clusters 1 through 3 probably consist of mixed socio-economic groups. Although we noted the consistent increase in socio-economic attributes through these clusters, which may imply that they are simply younger versions of cluster 4, we must reject this implication. Each of these clusters must consist of at least two socio-economic groups, one which is probably the younger version of cluster 5 members, i.e., the low income households and the second which is the younger version of

clusters 4 and 6 members. As the latter can be assumed to increase their earnings as they acquire more education and experience (more so than the low socio-economic class), they dominate the observed trend of increase noted across these clusters.

This clustering scheme fails to capture one distinct life style group which is identified by other schemes. The young dual career oriented childless couples are included in Scheme B as part of cluster 2, as is indicated by the somewhat higher labor force participation rate for women and the level of education.

Recall that this scheme excluded the time allocation data as ideally we quest to identify life style groups based on socio-economic and demographic data, so that the analysis of activity patterns will not be restricted. Yet, it is desired to test the relationship between this or similar schemes and the time allocation pattern practiced by the sample members.

Using the cluster membership of this scheme and cross tabulating with some of the time allocation data allowed the performance of a chi-square test of independence, testing whether the row frequencies are independent of the cluster membership. Used in the test were the time allocation to home by the female spouse, to work and leisure by both heads of the household, and services for the male head of the household. For all except the services by the male head, the null hypothesis that the time allocation is independent of cluster membership could not be rejected with .92 or higher probability.

These results indicate that while Scheme B is discriminating between

some socio-economic and demographic dimensions it is not necessarily discriminating among life style groups. But again, given the quality of the time allocation data, one should not accept this suggestion as conclusive. We will return to this issue in Section 6.2.

6.1.3 Clustering Scheme B'

Clustering scheme B' is identical in specification to that of scheme A except for the exclusion of the time allocation data. Five clusters were produced and they all constitute more than 15% of the sample. The mean values for the input variables are described in Table 6.5. All input variables were significantly different across the clusters at a level of .999 as evaluated by the F-ratio test.

Clusters 1 and 2 constitute the upper socio-economic classes as judged by their income and educational level. They are dissimilar in their demographic characteristics and employment status. Cluster 1 consists of middle aged households (35-64 years old), and very large households. By contrast, cluster 2 consists of much smaller households and one quarter of its members are young (under 34 years old). The difference in employment and occupation status is also noticeable. Cluster 1 male members are primarily occupied in white collar occupations and a very small number of that cluster's female heads of households participate in the full time labor force. In cluster 2, 95% of the female heads of the households work full time. Based on these differences it is plausible that these are, in fact, two distinct life styles, but it is assumed that cluster 2 is more heterogeneous than cluster 1 as it probably captured

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Distribution (%)			CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	EMP 1	WCOL 1	FEMP 2	PRT EMP 2
					18 - 34	35 -- 64	65+					1	2	3	4					
1	120	23	4.73	2.97	0	98	2	79	69	2.33	3.38	0	0	81	19	29749	45	68	11	27
2	86	17	2.49	2.28	24	70	6	17	12	3.52	1.76	20	34	27	19	24465	69	44	95	0
3	108	21	3.95	2.03	100	0	0	94	52	1.93	3.15	9	41	42	8	16810	81	48	15	13
4	108	21	4.75	2.75	0	99	1	91	81	2.25	3.09	23	69	0	8	18097	40	31	23	12
5	99	19	2.15	2.09	2	45	53	4	2	2.01	3.01	37	35	23	5	11823	27	30	0	8
Total	521	100	3.71	2.45	25	63	12	60	46	2.36	2.93	17	35	36	12	20373	52	45	26	13
P-value			.999	.999	.999	.999		.999	.999	.999	.999	.999	.999	.999		.999	.999	.999	.999	.999

Table 6.5 Mean Values of Input Variables, Clustering Scheme B'

both white and blue collar workers who have high income and whose female spouses work full time. Hence, it could probably be broken down to at least two distinct groups based on occupation and level of education.

Cluster 3 is the young group, mostly with young children and with very low rates of participation in the labor force. It is thus assumed to include a younger version of cluster 1 members for which the attainment of income and educational levels are a matter of time. Also, it includes a high proportion of blue collar workers which will eventually belong to clusters 2 or 4. It is obvious that in this case age is the dominant discriminatory dimension and this group, regardless of economic status, can be defined as the young childbearing families.

Cluster 4 is similar in its demographic characteristics to cluster 1 but they differ in the socio-economic attributes, where cluster 4 members constitute a lower income, lower educational level class. Women's participation in the labor force in cluster 4 is higher in the full employment category and lower in the part time category indicating that there are more working class households, earning less for their work and working despite the high incidence of the presence of young children.

Cluster 5 includes most of the elderly households of the sample but almost one half of it is middle aged households. This cluster is distinct from the others by its low income and educational levels, small household size (and almost no households with children), and very low levels of participation in the labor force. This cluster, it is assumed, captured both the retired low income elderly and the poor middle aged households. Thus it is a cluster based on both socio-economic and demographic attributes.

In summary, this scheme is discriminatory along a mixture of dimensions: purely socio-economic, employment status, and age. It is thus probably closer to a desired life style discrimination, compared with the more socio-economically based discrimination based scheme (B). Yet, it is obvious that some groups are still quite heterogeneous and the differentiation among them can only be obtained by increasing the number of clusters, which will result in identification of smaller but more distinct life style groups.

6.1.4 Cluster Scheme C-1

The first of the clustering schemes of the older households produced 3 clusters, summarized in Table 6.6, one of which includes only 5% of the older subsample. While in most attributes this small cluster "lies" in between the other two clusters and close to the mean values of the subsample, it varies considerably in the level of education (with 36% having graduate level education), in income (being higher than the subsample's mean), and in time budget. Most obvious in the latter category are the high values of time spent in leisure activities and the small amount of time spent at home.

The differences between clusters 2 and 3 under this scheme are very clear. The first includes a high proportion (33%) of elderly heads. Only very few (3-5%) of members of this cluster have children and consequently household size is smaller. A high proportion (30%) of the female heads in cluster 2 work full time but judging by the relatively low income and educational level these are probably "working class" households engaged more in blue collar occupations. By contrast, the members of cluster 3 are younger, have children, have higher income, and less than average participation of women in full time employment. Another contrast between these clusters (not statistically significant) is the sharing

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Distrib(%)		WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					45-64	65+							1	2	3	4									
1	14	5	3.36	2.71	79	21	57	43	57	57	2.79	3.00	7	21	36	36	27142	49	46	28.1	33.5	.6	.3	21	14
2	171	60	2.36	2.29	67	33	38	44	5	3	2.58	2.75	30	39	27	4	17312	80	84	1.9	2.2	1.9	2.1	30	8
3	97	35	4.92	3.16	99	1	46	35	89	78	2.53	3.19	12	28	42	18	25654	63	83	1.7	1.9	1.4	2.2	16	20
Total	282	100	3.29	2.61	79	21	42	41	37	32	2.59	2.91	23	34	33	10	20670	72	82	3.2	3.6	1.6	2.1	25	12
P-value			.999	.999	.999		.637	.428	.999	.999	.065	.930	.996	.762	.919		.999	.999	.999	.999	.999	.608	.575	.910	.963

Table 6.6 Clustering Scheme C-1, Mean Values of Input Variables

low value in the F-ratio test, and the other two because their effect is assumed to be captured by other attributes. The result of this attempt is insignificantly different from Scheme C-1. The small cluster of 14 cases is persistent. Between the other two clusters there is a reallocation of five cases from cluster 2 to 3, not significantly affecting the cluster characteristics.

6.1.6 Clustering Scheme E-1

In Scheme E-1 presented in Table 6.7 a major change in structure was accomplished by reducing the number of input variables to 15. Eliminated were the SRV variables and LEIS2, leaving HOME1 as the only time budget item included. Cluster 1 differs from the other two mainly in the average household size, with 4.79 persons compared with 2.48 and 2.3 in the other two. This is accounted for by the low number of households with children in clusters 2 and 3. Clusters 1 and 2 are the younger groups with more than 94% under 65 years old compared with cluster 3 which consists of 50% elderly. Clusters 1 and 2 earn a higher income than cluster 3 but differ among them in the proportion of income earned by the female head which is very high in cluster 2. This is also reflected by the high proportion of female participation in the labor force.

Cluster 3 is characterized by the high percentage of elderly, the low income, high percentage of time spent at home and low education levels. The current categorization of the age variable does not permit us to examine whether the 50% who are between 45 and 65 years old are

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Distrib(%)		WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					45-64	65+							1	2	3	4									
1	108	38	4.79	3.23	100	0	51	39	80	70	-	3.38	10	25	47	18	26430	61	-	-	-	-	-	12	20
2	63	22	2.48	2.29	94	6	37	62	14	13	-	1.84	22	46	24	8	23413	68	-	-	-	-	-	90	2
3	111	39	2.30	2.19	50	50	37	31	7	5	-	3.07	36	36	23	5	13509	86	-	-	-	-	-	1	10
Total	282	100	3.29	2.61	79	21	42	41	37	32	-	2.91	23	34	33	10	20670	72	-	-	-	-	-	25	12
P-value			.999	.999	.999		.886	.998	.999	.999		.999	.999	.958	.998	.999	.999	.999						.999	.997

Table 6.7 Clustering Scheme E-3, Means of Variables

closer to the upper bound or whether they are younger and are allocated to this cluster because of other attributes like income, education, and time spent at home.

Abstracting to some general terms, this scheme seems to discriminate between three socio-economic groups. Cluster 1 represents the educated, high income, mostly white collar households. Cluster 2 represents slightly lower income and educational level households in which women take an active role in the labor force. But, seemingly, there are more blue collar workers in this group, thus, despite the two incomes the total earnings are still lower than in cluster 1. Cluster 3 represents the lower socio-economic group with probably a high proportion of households already out of the labor force due to age, and those still active holding low income occupations.

6.1.7 Clustering Scheme F-1

A step further toward the elimination of small clusters was achieved by reducing the number of clusters to 2. The summary is presented in Table 6.8. The clusters vary in average household size, presence of children, education and income, all for which cluster 1 has higher values. Cluster 2 contains the older heads of households (32% over 65 years old) and higher proportions of participation in the labor force for both sexes, although it is probably in less well paid occupations. This indicates that the younger households in this cluster probably have significantly higher participation rates which are offset by the elderly retirees.

This scheme can be viewed as a very crude classification into two

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Distribution (%)		WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					45-64	65+							1	2	3	4									
1	103	37	4.88	3.10	98	2	43	32	95	84	2.62	3.09	16	27	39	18	24713	63	80	-	-	1.6	2.1	20	20
2	179	63	2.37	2.82	68	32	41	46	3	1	2.54	2.82	27	38	29	6	10344	78	83	-	-	1.7	2.0	28	7
Total	282	100	3.29	2.91	79	21	42	41	37	32	2.57	2.91	23	34	33	10	20670	72	82	-	-	1.6	2.0	25	12
P-value			.999	.999	.999		.024	.924	.999	.999	.096	.776	.925	.817	.758		.999	.999	.382	-	-	.034	.017	.626	.995

Table 6.8 Clustering Scheme F-1, Means of Variables

socio-economic groups which, at this level of generality, also coincide with differences in time allocation.

6.1.8 Clustering Scheme C-2

Table 6.9 presents the summary data for Scheme C-2 of the younger (18 to 44 years old) subsample. Three clusters are identified, containing 24, 187 and 28 cases respectively. The distinctions among the clusters lie in a number of dimensions. Cluster 3 clearly differs from the first two in household size, the absolute absence of children, the high level of education (32% graduate level) and the above average income. Also, this cluster contains the highest proportion of full time employment for women and men. Women spent the least time at home compared with the other two clusters and the male heads share more of the burden.

Clusters 1 and 2 are very similar in household size and the presence of children as well as in employment status and time allocation. Yet they differ significantly in the level of education obtained and, probably as a consequence, they also differ in income and the proportion of white collar employees. Cluster 1 members are the least educated in the subsample and have an income of about 30% less than their demographically similar counterparts in cluster 2. An additional difference is the low share of services that male heads have (or take) in cluster 1, about one-seventh of their female spouses, compared with a ratio of about 1:2 in cluster 2.

Clusters 1 and 2 represent two socio-economic groups which are indis-

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Dist. (%)			WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					18-24	25-34	35-44							1	2	3	4									
1	24	10	4.25	2.29	17	29	54	8	63	100	71	2.08	2.66	100	0	0	0	14979	57	79	4.1	4.1	.23	1.61	17	13
2	187	78	4.51	2.26	4	47	49	52	63	100	71	2.03	3.10	0	41	46	13	20270	60	80	4.3	4.6	1.74	3.51	23	16
3	28	12	2.18	2.18	25	64	11	57	79	0	0	2.75	2.21	0	32	36	32	22696	63	73	4.0	3.2	1.61	1.13	64	4
Total	239	100	4.21	2.25	7	47	45	49	65	88	63	2.95	2.25	10	36	40	14	20022	60	79	4.2	4.4	1.58	3.04	27	14
P-value			.999	.103	.999	.908	.998	.999	.544	.999	.999	.935	.995	.999	.998	.999		.969	.254	.534	.002	.075	.773	.949	.999	.599

Table 6.9 Means of Input Variables, Scheme C-2

tinguishable in terms of their demographic characteristics, yet, they differ significantly in economic and educational levels and hence are assumed to constitute two distinct life style groups. Noteworthy is the difference in the share of household services between these life styles. We found that almost consistently through the various schemes the low income group is characterized by a low share of the services burden carried out by the male spouse.

Cluster 3 of this scheme is probably the emerging life style of young professional couples who are career oriented and therefore defer childbearing or refrain from it altogether.

6.1.9 Clustering Scheme G-2

As can be seen in Table 6.2 the general clustering structure is almost identical in schemes C-2, D-2, E-2, and F-2 despite the gradual reduction of five variables. Only in scheme G-2, in which the number of variables is reduced to 15, is a change in the structure accomplished, creating 3 clusters of 22, 137 and 80 cases respectively. The summary results for this scheme are presented in Table 6.10. As may have been expected, the major change in structure was accomplished by the deletion of the education level. The three clusters produced are dissimilar from the previous runs, i.e., the previously persistent group of 24 is non-existent and diffused among the other clusters. Despite this change in structure one of the three clusters still remains too small to be further utilized. The major difference between clusters 1 and 2 is the very high value of the SRV variable for both heads of household in cluster 1.

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Dist. (%)		WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMP 2	PRT EMP 2
					18-24	25-44							1	2	3	4									
1	22	9	4.55	-	0	100	55	41	95	77	1.45	3.54	-	-	-	-	22045	-	73	-	-	9.68	9.35	9	23
2	137	57	4.52	-	0	100	61	68	98	69	1.85	3.57	-	-	-	-	18960	-	85	-	-	.56	2.61	4	19
3	80	33	3.58	-	23	77	26	66	70	48	2.78	1.74	-	-	-	-	21287	-	70	-	-	1.08	2.04	71	3
Total	239	100	4.21	-	8	92	48	65	88	63	2.12	2.95	-	-	-	-	20023	-	79	-	-	1.58	3.04	27	14
P-value			.999	-	.999	.999	.999	.896	.999	.995	.999	.999					.737	-	.999	-	-	.999	.999	.999	.996

Table 6.10 Means of Input Variables, Scheme G-2

Cluster 2, in contrast, has a very low value for SRV1, about one-fifth of that of their female spouses. Cluster 3 is the younger among the 3 clusters and is typified by somewhat lower proportions of children present (and hence household size), fewer white collar employees (26% compared with 55% and 61% in clusters 1 and 2 respectively), and a very high rate of women participating in the full time labor force (71% compared with 9% and 4% in the other clusters) and consequently a larger share in the household income.

The exclusion of the data on education involves a loss of relevant information. The group of young career oriented professionals identified in Scheme C-2 is lost in this scheme and an attribute which is of marginal value (the services variable) assumes a major role in discriminating between clusters 1 and 2.* Cluster 3 probably contains much of the young professional group (indicated by the high rate of female participation in the labor force) but it has obviously lost its uniqueness.

6.1.10 Clustering Scheme H-2

The last experiment with the young subsample involved the creation of only 2 clusters. Using 18 input variables, including education, the two clusters formed consisted of 24 and 215 cases respectively. The former is that of the same 24 cases visible in Schemes C-2 through F-2. Judging by the F-ratio probabilities shown in the summary results (Table 6.11) most variables are not significantly discriminating among the two clusters

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* In view of the theoretical construct the service variable is relevant not in its absolute value as much as in the ratio between the male and female heads of household.

Cluster No.	N	% of Sample	HH Size	Adults in HH	Age of Head Dist. (%)		WCOL 1	EMP 1	CHLDPR	JCHLD	PRNC1	PRNC2	Education Level Distribution (%)				INCOME	Home 1	Home 2	Leis 1	Leis 2	Srv 1	Srv 2	FEMF 2	PRT EMP 2
					18-24	25-44							1	2	3	4									
1	24	10	4.25	-	17	83	71	63	100	71	2.08	2.67	100	0	0	0	14980	-	79	-	-	.23	1.61	17	13
2	215	90	4.20	-	7	93	62	65	87	62	2.13	2.99	0	40	45	15	20586	-	79	-	-	1.73	3.20	28	14
Total	239	100	4.21	-	8	92	63	65	88	63	2.12	2.95	10	36	40	14	20022	-	79	-	-	1.58	3.04	27	14
P-value			.010	-	.797	.797	.309	.031	.829	.319	.010	.481	.999	.999	.999		.975	-	.001	-	-	.884	.645	.031	.797

Table 6.11 Mean Values of Input Variables, Scheme II-2

except for the education level and income.

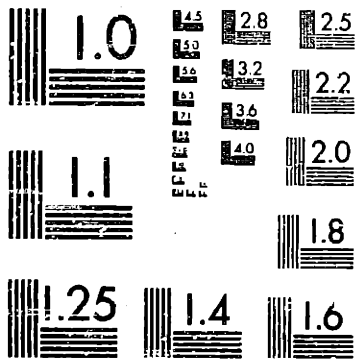
Thus, again, the reduction of the number of clusters reveals two groups which are distinguished by economic resources and education but similar in most other respects. Although these two attributes can be viewed as differentiating two life styles, relating mainly to the constraint component (and also to the control over time as represented by education), it is assessed to be too crude to represent existent life styles.

6.2 Assessment of Life Style Clustering

The experience gained in this empirical analysis has supported the cautionary notes suggested by Anderberg (1973) and cited in Section 5.5. From the virtually infinite number of possible clusters a cautious search based on intuition and judgement is necessary in order to identify the grouping which is of interest to the research problem. The exercise of judgement is necessary in order to accept or reject emerging patterns or results while intuition is required to direct the search procedure.

Searching for life style groups based on the conceptualization of life styles presented in Chapters 4 and 5 was the primary objective of this analysis. Life styles are assumed to be different from socio-economic classes, yet we have employed in this analysis primarily socio-economic and demographic attributes. This may result in a classification which is socio-economic rather than life style based. Where do the differences lie?

Socio-economic classes can probably serve as first cut proxies for



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life styles as they represent the constraints (income, family commitments, etc.) as well as the revealed preference for household type and occupation. But life styles are, on the one hand, more refined concepts than socio-economic classes and, on the other hand, they may cut across socio-economic classes (to a limited extent though). In other words, within socio-economic classes we expect to identify different life style groups and similar life style groups can cut across the socio-economic classes. Thus, an appropriate evaluation is that which best corresponds to the a priori notion of life style.

The time allocation data is, in principle, an efficient and consistent discriminating dimension among life styles, yet we chose to limit its utilization due to practical (quality of data) as well as conceptual (use as a dependent variable) considerations. This increases the risk of formulating clusters which are coinciding with socio-economic clustering and losing the discriminating dimension among life style groups, as most other variables except the employment related ones do not convey information on the actual behavioral pattern. Most strongly affected is the information on leisure activities which is one of the three major orientations which constitute the choice of life style but for which no information but time allocation is available in the data.

Some distinct life style groups may be identified without the use of time budget data. The most prominent example is the case of the young dual career, childless households, which has been identified in a number of schemes. But in some cases this group became part of a larger socio-economic class (as was the case in Scheme B).

The use of the time allocation data, in view of the considerations

cited above, was done cautiously, i.e., by assigning only small weights to these items, and with the explicit realization that where used as instrumental variables, the classification scheme cannot be used for further analysis of activity patterns. Yet, within this exploratory study we found it appropriate to use the most efficient and consistent data to identify life styles and to examine the relationship between them and travel behavior in a specific context of shopping trips. Once such a relationship is established, a second step attempted here is the identification of life styles without employing time allocation data.

The attempt made in Scheme B and B' to identify life style groups while totally excluding the time allocation data did not provide conclusive results on the difference in time allocation across groups. Time allocation was found to be independent of cluster membership for most activities but, given the quality of that particular type of data, we suggest pursuing this analysis.

Another issue raised by Anderberg (1973) is that in most cases a clustering output satisfies at best only some of the analyst's requirements, i.e., not all clusters in an acceptable scheme are equally well suited to the research problem. The empirical analysis presented in this chapter supports that view. Some examples will illustrate the issue. In Scheme A clusters 1 and 2 are assumed to be of similar socio-economic class yet they differ in time allocation and hence are assumed to be different life style groups. By contrast, in the same scheme cluster 3 is a socio-economic group including a wide age variation which leads to the plausible assumption that some distinct life styles could be identified within it. Another example, the distinction between

clusters 1 and 2 in Scheme G-2, is largely attributed to the time spent at services for the household. We cannot make a strong claim that this, in and of itself, is discriminating between life styles of the members of clusters 1 and 2, at this level of refinement. (This specific case demonstrates another problem which is quite obvious. When the number of input variables decreases there is a higher probability that the clustering will be affected by extreme values of the remaining variables. The obtained value of 9% spent in services is an extreme value when the sample mean is 1.58%.)

One solution to the problem of varying quality of clusters, with which we have not experimented, is to eliminate from further clustering schemes those observations which have formed theoretically plausible groups. This approach may incur costs which will prohibit its use in practical applications.

Another issue which needs to be addressed is that cluster analysis based classification is less rigid than classification methods which are based on a single or a few variables. The latter set rigid bounds for the class or segment membership, e.g., age or presence of children are defined in values which dominate the classification. By contrast, in cluster analysis if an observation is similar to a cluster along many dimensions but varies in a few, it will still be part of that cluster. This can be viewed as both an advantage and a disadvantage depending on the role we attribute to the specific variable for which the dissimilarity is observed. We have partially treated this problem by assigning higher weights to the crucial variables such as age in some of the schemes.

In view of the arguments in favor of intuitive judgement, the search procedure which attempted to identify larger groups is seen as somewhat useless. The appropriate search should rely more on judgement and change in the number of clusters rather than on the elimination of variables which, based on theoretical consideration, are deemed necessary. To overcome the problem of small but relevant life style groups which cannot be used for model estimation other methods are necessary. One possibility which will allow comparable analysis is to increase the sample rate for some population groups which are a priori or after an initial search identified as relevant but small groups.

In summary, cluster analysis, despite its shortcomings, is seen as a useful and appropriate tool for identification of life style groups, provided caution is practiced in the specification and interpretation. At this stage an "ideal" specification has not yet been identified but, as will be suggested in Chapter 9, it is conceivable that some efficient specification for a given social structure can be identified and recommended for practical application.

Chapter 7: The Travel Model

This study is concerned with the representation of the complex behavioral unit -- the human being in a model of travel behavior. To test the hypothesis that a particular representation, that of life style, is advantageous over others, a commonly used structure of a travel choice model was selected. There is no attempt to suggest a new model structure or to remedy all the deficiencies of the current models. On the contrary, isolating the issue of the representation of the behavioral unit allows us to focus on this problem alone and test the hypothesis, without confusing the results with additional structural changes.

Section 7.1 of this chapter presents some notions about the relationships between travel choices and life style, and some hypotheses are suggested. Section 7.2 deals with the model structure in terms of the theory, the choice set, the explanatory variables, and the model specification. The estimation results are presented in Chapter 8.

7.1 Models of Travel and Mobility Choice and Life Styles

In observing the development of disaggregate travel demand models over the last decade, one can note a consistent trend of broadening the scope and the capacity of the models to deal with choice situations which are increasingly complex.* Initially, models of binary choice applied to the choice of mode in work trips (e.g., McGillivary, 1972) were developed, but obviously they dealt with a reduced form of a real-

* Complexity, as defined in Chapter 2, is a function of the quantity of information that needs to be processed in the making of a decision.

istic situation which in most cases offers a wider than binary choice set. Ben Akiva (1973) and others broadened the capability of the models to deal with choice among more than two modes and Richards and Ben Akiva (1974), for example, have estimated models for the choice among six modes. Also, models which dealt with other choices, not only those of mode, were developed. CRA (1972) suggested a system of models for the choice of frequency of trip, destination and mode in a sequential structure. Ben Akiva (1973) has shown that the appropriate structure of some choice dimensions is not sequential but joint, as the concept of the choice hierarchy (Figure 4.2) suggests. Building upon that, Adler and Ben Akiva (1975) have estimated models of the joint choice of frequency destination and mode for non-work trips. At the same time, models for residential locations in a context of mobility choices were developed by Lerman (1975) and McFadden (1978). Both the latter types of models demonstrate the advancement of the modeling efforts into choice situations which are significantly more complex than the initial models of a single dimension of modal choice.

Further pursuit of the disaggregate approach has brought about the development of models of both auto ownership rate (Ben Akiva and Lerman, 1976; Train, 1976) and type (Sherman and Manski, 1979). A different direction is that of modeling activities. Jacobson (1979) estimated models for activity duration for non-work activities. Damm (1979) suggested models for scheduling of activities. A related type of modeling is that of trip chaining to which Ben Akiva and Adler (1979) and Horowitz (1979) are recent contributors.

Drawing upon the conceptualization of life style developed in Chapters 4 and 5, it is suggested that life style can be a significant explanatory factor for all types of mobility and travel behavior. Yet, one can assume that life style will have a more evident effect on some choices relative to others. For example, the choice of a destination for a shopping or recreation trip is probably affected by life style more than the choice of mode to work. The major effect of life style on the latter is probably indirect and must be identified in the context of a broader choice situation, that of the mobility bundle (residential location, auto ownership, and mode to work).

Consistent with the arguments brought in Section 2.2, we suggest that the differential effect of life style is a result of the varying quantities of information processed in these decisions. The more information processed, the higher is the probability that it will be affected by subjective preferences which are manifested in life style.

In a very loose sense, one could rank the range of choices by the possible effects of life style in the order illustrated in Figure 7.1. Note that the decreasing effect of life style is not equivalent to a decrease in the number of socio-economic variables that can or should be used in the model. For example, an auto type choice model may require more socio-economic variables for a correct specification than the two choices above it, but the choices of mode and destination for recreational and shopping trips are assumed to be more dependent on life styles as conceived in this study.

decreasing effect of life style ↓	residential location
	activity pattern (trip chaining)
	destination for recreation trips
	destination for shopping trips
	auto type
	auto ownership
	mode to work

Figure 7.1 A Possible Ranking of Mobility and Travel Choices by the Effect of Life Style

As this study is concerned with the identification of the existence of an effect of life style on travel behavior, the selection of the appropriate choice situation had to withstand the following criteria: a) the choice situation should be in the range (of Figure 7.1) in which the effect of life style is deemed evident, b) the choice situation model structure is established enough, based on previous research, so that the test of the hypothesis on the effect of life style will not be confused with the test of the model structure, c) the number of alternatives needs to be large enough so that the actual effect of life style (in a moderate size sample) can be identified, and d) availability of data compatible with that used for identification of life styles.

Given these criteria the joint choice of mode and destination for

shopping trips was selected for testing the hypothesis on life style effects. The effects of life style on choice of destinations and modes were hypothesized to be:

I. Different life style groups demonstrate differential preference for all identified attributes of the decision. Operationally, this hypothesis means that different life style groups will produce different sets of significant estimated coefficients.

II. Different life style groups assign different weights to particular attributes of the choice of a destination/mode combination. For example, different life style groups are hypothesized to weigh differently the size of the retail opportunities at the destination, namely, some groups may be more attracted to large clusters of shops such as in the central business district or in shopping centers, while other groups may be more attracted to neighborhood retail stores. Specific hypotheses could be made about any of the attributes, but not all such differences are interesting. We chose to test those attributes which have some policy relevance. Specifically,

1) The level of service attributes (in-vehicle-travel-time, out-of-vehicle-travel-time, out-of-pocket-travel-costs over income) are hypothesized to have significantly different coefficients across life style groups.

2) The size of the retail opportunities at the destination is hypothesized to be differently weighed by different life style groups.

3) Different life style groups assign different weights to walk time.

4) Different life style groups assign different weights to shopping at a destination within the zone at which the decision maker is present.*

Disaggregate models for the choice of shopping destination have been developed for a number of years and to date enough experience has accumulated so that the basic model structure (described in the following section) is not disputed.

A destination choice model by its nature must include a large number of alternatives, and thus it is appropriate for the test of the effect of life styles, provided enough information on the alternatives is relevant to the different tastes which life styles represent. If, for example, the variation among alternatives is only in level of service then the effect of life style is not expected to be as significant as in a case in which qualitative differences among alternatives (e.g., quality of stores or shopping centers, comfort, etc.) are measured as well.

The last criterion, that of availability of data, is self-explanatory. As noted in Section 5.2, two separate subsets were derived from the Baltimore Travel Demand Data Set (BTDDS). The first is the one used to cluster life style groups (Chapters 5 and 6) and the second is a trip file set for shopping trips described in the following section.

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* The models estimated in this study include both home-based and non-home-based trips due to the prohibitively small sample size of each type separately.

7.2 Model Structure

The model selected for testing the hypotheses on the effects of life styles on travel behavior is a joint choice model for the choice of destination and mode. Although the estimation and hypothesis testing is done only on these types of choices, it should be noted that the objective of this study is the demonstration of the relevance of life style and not the prediction of specific effects on shopping behavior.

The choice of destination and mode for shopping trip is short term in its nature. It is one of the choices made in the lower block of the choice hierarchy depicted in Figure 4.2. As discussed in Chapter 3, a multinomial logit type model was selected because of its relative computational ease as well as the fact that to date it is in wider use than other functional forms.

The joint choice model has the following form:

$$P(d,m) = \frac{e^{V_{d\,m}}}{\sum\limits_{d'm' \in DM} e^{V_{d'm}}} \qquad (7.1)$$

where:

$P(d,m)$ = the probability of choice of a combination of destination d and mode m of a set of feasible alternative combinations DM.

V_{dm} = the systematic utility of alternative dm identified by an array of attributes.

e = the base of natural logarithm.

The systematic utility of each alternative can be assumed to be comprised of a number of variable types. Some variables can represent the attributes of destinations, like attraction. Some variables can represent attributes of modes like the preference for automobile over transit. And still other variables may represent the attributes of specific alternatives, i.e., combinations of destinations and mode, as for example, level of service offered by each mode to each destination. Formally, the utility function is:

$$V_{dm} = X'_{dm}\Theta^{dm} + X'_{d}\Theta^{d} + X'_{m}\Theta^{m} \qquad (7.2)$$

where:

X's are vectors of independent variables, and

Θ's are vectors of estimated coefficients.

To estimate the values of the coefficients it is first necessary to define the choice set, i.e., the universe within which the choices can vary and to identify a set of relevant variables of the three types mentioned above which can contribute to the explanation of the observed behavior. The observed behavior, i.e., the actual choice of destination/mode combination, is the dependent variable.

The estimation procedure most widely applied is the maximum likelihood method* which is currently available in some user oriented computer packages (e.g., TROLL**). McFadden (1968) has shown that the

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* For a description of maximum likelihood estimation method see Hoel, Port and Stone (1971) or Theil (1971).

** TROLL (Time-shared Reactive On Line Laboratory) is an econometrics oriented computer package developed by the National Bureau of Economic Research (NBER).

maximum likelihood method for the linear in the parameters logit model provides estimates which are consistent, asymptotically efficient and asymptotically normal. In this research the TROLL programs were employed.*

7.2.1 The Choice Set

Consideration of the choice set is, in practice, inseparable from the available data. As discussed in Chapter 1, conceptually the choice set definition is one of the "soft spots" of the disaggregate approach. Given the conceptual problem as well as the limitation imposed by any data set, and given that no alternative approach is currently providing an improved performance, it is necessary to make a series of judgements and assumptions in an explicit manner.

The range of alternative destination mode combinations for shopping trips open to urban travellers is very wide. For every single trip** an individual can make a choice of a particular combination of mode and destination, although it is clear at the outset that not all possible combinations are available to all sample members. We will return to this issue below.

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* In retrospect, the employment of TROLL was a mistake, as despite its convenience of use, it is inefficient and expensive in treating a large number of alternatives. (A model of 25 variables and 20 alternatives requires a virtual core space of approximately 2 mega-bytes on an IBM 370.

** In this model we will deal only with simple trips defined as the movement from an origin to a destination for the purpose of shopping at the destination. Trips made in a chain are broken down to individual simple movements.

A number of travel modes are generally available for shopping trips. The private motorized modes include driving an automobile, riding as a passenger, and riding motorcycles. The public motorized modes include bus, various types of rail vehicles, taxi cabs, and paratransit services such as rides provided for special needs groups. The non-motorized modes, which need not be overlooked, include walking and bicycles. While most available disaggregate data sets ignore these modes, in the context of study in life styles in general and shopping behavior in particular, we deem it necessary to include non-motorized modes.*

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* I am assuming a strong normative approach in advocating for the inclusion of non-motorized travel modes, specifically walking, in future analyses and planning of urban transportation for the following reasons: Although only scarce data on walking is available in the United States, and the European data is assumed to be dissimilar, some available information does call for attention. Some illustrative examples are given by Maring (1972), who presents data on pedestrian trips from a small sample in Washington, D.C. He found that 89% of all walk trips were under 1 mile (95% for females and only 80% for males) and 46% of walk trips are for shopping purposes, compared with 14.6% for outdoor recreation and 11.5% for work. In the BTDDS, 18.6% of all trips were walk trips and 15% of all shopping trips were by foot.

Although the figures indicate that in the U.S. walking cannot be assumed to be a viable alternative to significant proportions of motorized travel, two important conclusions can be drawn. First, the exclusion of walk trips from conventional analysis causes a distortion of our understanding of people's mobility needs, the solutions some of them find and their activity patterns. Second, it indicates that if activity opportunities were available in walk distance (i.e., within a mile) the walk trips may substitute motorized trips. Given that such substitution is consistent with a variety of public policies (e.g., energy conservation, pollution reductions, central city revitalization) the interest in accommodating more walk trips should be growing. Accommodating for pedestrian traffic may include weather protection (e.g., the skywalk in Minneapolis-St. Paul downtown, Downtown People Movers), crime prevention, physical amenities and a distribution of services which will provide more options within walking distances from residential and employment locations.

The sample of households headed by a married couple included 371 person trips of which 280 (75%) were made by auto drivers, 25 (7%) were made by auto passengers, 1 trip was made on motorcycle, 9 trips (2.4%) were made by bus and 55 trips (15%) were walk trips. As these are person trips, most of the auto driver and auto passenger trips were found to actually be the same vehicle trips made by two or more individuals of the same household. Only 7 trips were made as passengers in another household's vehicle. The small number of these latter type of trips, as well as the single motorcycle trip, were assumed to be of no statistical value and were thus deleted from the data set. Further deletion of cases* resulted in a final set of 353 trips which included 3 modes: 291 (82%) auto trips (driver and passenger combined), 53 (15%) walk trips, and 9 (2.55%) bus trips. These three modes were assumed available to all except for some restrictions mentioned at the end of the following section.

Defining the choice set of destinations is more complicated and requires some simplifying assumptions. The two main problems are the definition of the elemental alternative and the representation of the large number of possible alternative destinations in a manageable model for estimation.

The elemental alternative, following the disaggregate approach to its extreme, is an individual store (in the case of a shopping destina-

* Additional 7 auto trips were deleted because either the origin or the destination were outside the Baltimore SMSA. Two additional walk trips were deleted due to undetectable errors (walk speed of over one mile per minute).

tion model). But two issues are raised by this extreme view. The first, at the conceptual level, is that there is no information about the nature of the elemental alternative perceived by the decision maker. Different assumptions may be acceptable, varying basically by the type of shopping. Shopping for food can be assumed to involve a selection of a particular store. Similarly, shopping for any specialty commodity (e.g., jewelry, furniture, appliances) can be assumed to be predetermined to a particular store. At the other extreme, data on convenience shopping (e.g., cigarettes, newspapers, etc.) trips probably involve significant noise, as these can be either to a predetermined particular store or to a store on route to another activity. This latter choice is interrelated with the route choice for the final destination. Midway between those are the multi-purpose shopping trips which are naturally oriented to concentrations of shopping facilities such as shopping centers or commercial streets. Shopping trips in which browsing is intended belong to the latter category. So, the first problem is that the nature of the destination is differentially perceived as a function of shopping type, but probably also as a function of additional conditions. As the approach of revealed preference is assumed, no information on the individual's perception is available.

The second problem is of a pragmatic nature. Even if individuals were in fact considering individual stores as alternatives, still two issues need to be resolved. First, it is inconceivable that information on all single alternatives would be available in a large urban area. The data commonly available provides information (usually a mean or a

count) for geographical units like census tracts, traffic zones, blocks, etc. Second, if the latter "group data" is used, there may still be a large number of zones in the choice set, larger than can be incorporated in a manageable choice model.

The use of group data instead of elemental destinations has been demonstrated by Lerman (1975) and McFadden (1978). They concluded that in estimating logit form models with grouped data, where the mean of group members and the natural logarithm of the groups size are used (the latter with a coefficient constrained to unity), estimates of the underlying utility parameters are obtained.

Given this, it is possible to use the traffic zone data available in the BTDDS. The Baltimore area (SMSA) is divided into 498 traffic zones.

The representation of the choice set in the model structure involves two considerations which need to be accounted for. One is the behavioral basis for selecting and including alternatives in the model and the other is the statistical consideration. Alternatives should be included if they are assumed to be viable to the decision maker. A number of assumptions on the feasibility of alternatives can be made and followed. The statistical issue, though, is that representation of the actual choice set, which may include hundreds of alternative destinations, involves high computational costs. Therefore, some sampling of destinations is used and caution is required to ensure the compatibility of the two considerations.

McFadden (1978) has shown that using a random sample of the large number of alternatives can produce consistent estimates of the coefficient of the utility functions. A subset of alternatives can randomly be chosen out of the total choice set and with the addition of the observed choice of the individual, the subset is considered as the choice set in model estimation. There are a number of possible approaches to the sampling of alternatives. A simple approach is to assign equal weights to all destinations having non zero retail employment. The alternative approach is that of "importance sampling", in which weights are assigned to destinations by some criterion which has a behavioral basis. This can be radial distance from origin, implying that the likelihood of selecting destinations close to the origin is greater than far away. Further sophistication of the assignment of weights can be done by sampling from a subset of destinations defined by assumed or observed familiarity or opportunities an individual perceives, such as defined by a mental map. The simpler equal-weight sampling approach offers significant computational cost reduction and therefore was chosen in this study.

Given the limitation of 20 alternatives of the logit estimation procedure used in this study (in TROLL), and given that the alternatives in a joint choice model are combinations of modes and destinations, twenty alternatives were structured in the following form. Each individual was assumed to have the alternative of making an intra-zone shopping trip (70 out of 354 trips (20%) were intra-zone trips). Also, each individual was assumed to have the alternative of shopping at the Central Business District (CBD)

(which consists of 12 traffic zones in Baltimore; Olsen, 1976). The underlying assumption is that the intra-zone and the CBD are known as optional shopping destinations to every resident and are accessible to most and hence are assumed to be in the choice set of all sample members. In addition to these two, four to five more destinations, depending on whether one of the first two was the chosen alternative, were randomly sampled from the total set of traffic zones with the restriction that zones which have no retail opportunities (59 out of 498) were excluded. In sum, each individual was assumed to face a choice set consisting of 20 alternatives, 7 for auto trips, 6 for walk trips and 7 for transit. For each of three modes the chosen destination, the intra-zone, and the CBD were included.

This basic set being similar in structure over all individuals, needs yet to be refined by the elimination of options which one can assume do not exist. For example, if a household does not have an automobile available, then the members of that household do not have the set of seven alternatives associated with that mode. Similarly, if an origin and destination pair is not served by transit, that particular alternative is not viable. Last, walk trips were assumed to be limited to a maximum of 5 miles beyond which alternatives associated with walking were eliminated.

These types of deterministic constraints capture some of the main variations in availability of alternatives. Yet, following a more detailed approach would require, as discussed by Brog (1980), the construction of a choice set for each individual depending on detailed

information describing the individual's situation. Available data sets lack, at this stage, the option of pursuing Brog's suggestion despite its conceptual appeal.

In the process of estimating models additional eliminations were required. As there are only 9 transit trips, in some life style segments their incidence is zero and hence transit specific coefficients are not estimable. Consequently, at a second stage the nine transit trips were deleted and the choice set reduced to 7 auto alternatives and 6 walk alternatives.

7.2.2 The Explanatory Variables

Explaining the choice of a destination-mode combination requires, as shown in equation 7.2, the utilization of variables which describe the destinations, variables which describe the modes, and variables which account for interactions of the above two.

Three types of variables can be used to account for the three components of the utility function (7.2). The first is variables which describe the physical attributes, some of which are commonly labelled "level of service" attributes. The second type are the attributes of the decision makers or the socio-economic variables. The third type are the constant terms. Each of the three types is briefly described below and the variables' labels and definitions are given in Table 7.1.

The first category is the variables which provide information on the physical setting, namely destination attraction attributes and costs. This type of information is, in most cases, as in this study, derived

Table 7.1 List of Variable Names and Definitions

	Name	Definition
1	IVTTA	in vehicle travel time for auto, minutes, one way
2	IVTTTR	in vehicle travel time for transit, minutes, one way
3	OVTTA	out of vehicle travel time for auto, minutes, one way
4	OVTTTR	out of vehicle travel time for transit, minutes, one way
5	ACSTI	out of pocket travel cost for auto, one way, in dollars, divided by annual income
6	COSTIN	out of pocket travel cost, all modes, one way, in dollars, divided by annual income
7	WLKTT	walk trip time for interzonal trips 0 for intrazonal trips
8	LNRET	natural LOG of retail employment in destination zone
9	RTDNS	retail employment divided by total employment at destination zone
10	AUTOCON	constant = 1 if auto alternative = 0 otherwise
11	WLKCON	constant = 1 if walk alternative = 0 otherwise
12	CBDDUM	constant = 1 if CBD destination - 0 otherwise
13	INZDUM	constant = 1 if trip destination equal to origin zone = 0 otherwise
14	INZWDM	dummy for intrazonal walk trip = 1 if intrazonal walk trip = 0 otherwise
15	AAVAPR	automobile availability divided by number of adults in household for auto alternatives
16	AAVWPR	automobile availability divided by number of adults in household for walk alternatives

Table 7.1 (continued)

	Name	Definition
17	ORESW	dummy for residential zone origin for walk alternatives = 1 if origin in zone of residence = 0 otherwise
18	SUBWLK	dummy for walk alternatives in suburbs = 1 if origin in suburb = 0 otherwise
19	EMPAUTO	dummy for employment status for auto alternatives = 1 if fully employed = 0 otherwise

Note: variable names which include numbers indicate the variable applies only to the life style segment.

from "objective" or "engineering" measurements done separately from the survey of households and usually maintained as data sets by planning agencies.

Variables which describe the destinations need to account for the attraction of the destination for shopping trips. Although attraction is in its nature subject to qualitative attributes such as amenities, prestige and the like, the lack of information on these attributes compels the use of quantitative surrogates. Following Adler and Ben Akiva (1976) retail employment in each traffic zone has been chosen to account for the size of the zone which is a proxy for the number of retail opportunities in the zone. It appears, as discussed earlier, in a logarithmic form (LNRET). In addition, in an attempt to identify zones which have major shopping centers, a variable describing the ratio between retail employment and total employment was used (RETDENS).

Most variables in this category describe the conventional level of service attributes. They include travel time and costs. In this study the following have been employed: in-vehicle-travel time (IVTT)*, out-of-vehicle travel time (OVTT), and out-of-pocket travel cost (OPTC).** In addition, trip time for walk trips was calculated in the following way: assuming an average walking speed of 83 meters per minute (273 feet/minute), the division of zone to zone distance by the speed produced the walk time (WLKTT). Assuming that distances of walk trips may be slightly shorter than highway distances reported in the skim file, due

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* The attributes of the auto mode are denoted by A (e.g., IVTTA) and transit by TR.

** All level of service attributes are for one-way trips.

to the fact that pedestrians are not constrained by one-way streets, parks, etc., the walk time figure was reduced by 5%. A problem was foreseen with the walk time data for intra-zonal trips. In general, intra-zonal trips were assigned time and distance equal to half the value to the nearest zone. Recall that the skim data provides information on costs between zone centroids. Consequently, we assumed that by using the skim data for intra-zonal walk trips there is an upward bias of distances. To eliminate this bias, walk time was calculated only for interzonal trips and a dummy variable (INZWDM) was applied to the intra-zonal walk trips. Out-of-pocket travel cost for auto was calculated by assuming an 8¢ per mile operating cost (for 1977) and adding one hour parking fee (non-work rates) where applicable.

The second category is that of variables describing the decision makers. They include such attributes as income, household size, automobile availability, etc., and they, too, can appear as interacting with any of the three components of the utility function (7.2). In the models estimated for this study the following variables were used: annual household income (in interaction with out-of-pocket travel cost to form cost divided by income (COSTINC)). Auto availability is divided by the number of adults (over 18 years old) in the household to account for competition for vehicular use (AAV-PR). Additional socio-economic variables explored but finally excluded from the final model due to lack of significant contribution to the explanation were: age interacted with walk trips, and income interacted with walk trips.

The third type of variables are the constant terms and dummy variables, again applicable to the three components of the utility function. Here two subtypes should be distinguished. Constant terms are assigned to the utility function of each alternative. The role of the constant terms is to capture the effects of non-observed or excluded variables. In the models estimated in this study modal constants and destination constants have been assigned, as shown in the utility functions in Chapter 9, to two of three modes (and one of the two modes in the reduced model) and to the intra-zonal and CBD bound trips. A related type of variables are the dummy variables, which are applied to specific situations in a binary (zero/one) form. These are employed to capture variations which result from certain conditions which are assumed to affect the choice, but they were either not measured or they are qualitative in nature. Such variables are, for example, a penalty applied to walk trips if the origin is in the suburbs (defined as outside city limits, SUBWALK), or a dummy which captures the effect of originating a trip from the zone of residence.

7.2.3 The Specification of the Utility Functions

Two basic models were used throughout this analysis. The first is a choice model for mode/destination combination including all three modes (auto, walk, and transit) in which the two motorized modes had 7 alternative destinations each and the walk mode had 6 alternative destinations. This model was used with the pooled sample (354 observations) for testing the hypothesis that some specific attributes are

Table 7.2 Specification of Utility Function - 3 Mode Model

Alternative	θ_1	θ_2	θ_3	θ_4	θ_{11}	θ_{10}	θ_{13}	θ_{14}	θ_{19}	θ_6	θ_{17}	θ_{18}	θ_{15}	θ_{16}	θ_{12}	θ_9	θ_8	θ_7
Auto, in-zone	IVTTA	0	OVTTA	0	0	1	1	0	EMPA	COSTIN	0	0	AAVAPR	0	0	RTONS	LNRET	0
Auto, CBD	IVTTA	0	OVTTA	0	0	1	0	0	EMPA	COSTIN	0	0	AAVAPR	0	1	RTONS	LNRET	0
Auto, other	IVTTA	0	OVTTA	0	0	1	0	0	EMPA	COSTIN	0	0	AAVAPR	0	0	RTONS	LNRET	0
Transit, in zone	0	IVTTTR	0	OVTTTR	0	0	1	0	0	COSTIN	0	0	0	0	0	RTONS	LNRET	0
Transit, CBD	0	IVTTTR	0	OVTTTR	0	0	0	0	0	COSTIN	0	0	0	0	1	RTONS	LNRET	0
Transit, other	0	IVTTTR	0	OVTTTR	0	0	0	0	0	COSTIN	0	0	0	0	0	RTONS	LNRET	0
Walk in zone	0	0	0	0	1	0	1	1	0	0	ORESW	SUBWLK	0	AAVWPR	0	RTONS	LNRET	WLKTT
Walk, CBD	0	0	0	0	1	0	0	0	0	0	ORESW	SUBWLK	0	AAVWPR	1	RTONS	LNRET	WLKTT
Walk, other	0	0	0	0	1	0	0	0	0	0	ORESW	SUBWLK	0	AAVWPR	0	RTONS	LNRET	WLKTT

	θ_1	θ_3	θ_{18}	θ_{14}	θ_{13}	θ_{15}	θ_{10}	θ_5	θ_8	θ_9	θ_7	θ_{17}	θ_{19}	θ_{12}
Auto, in zone	IVTTA	OVTTA	0	0	1	AAVAPR	1	ACSTI	LNRET	RTDNS	0	0	EMPA	0
Auto, CBD	IVTTA	OVTTA	0	0	0	AAVAPR	1	ACSTI	LNRET	RTDNS	0	0	EMPA	1
Auto, other	IVTTA	OVTTA	0	0	0	AAVAPR	1	ACSTI	LNRET	RTDNS	0	0	EMPA	0
Walk in zone	0	0	SUBWLK	1	1	0	0	0	LNRET	RTDNS	WLKTT	ORESW	0	0
Walk, CBD	0	0	SUBWLK	0	0	0	0	0	LNRET	RTDNS	WLKTT	ORESW	0	1
Walk, other	0	0	SUBWLK	0	0	0	0	0	LNRET	RTDNS	WLKTT	ORESW	0	0

Table 7.3 Specification of Utility Function - 2 Mode Model

different across life style groups. The model specification is shown in Table 7.2.

Testing hypotheses about differences across all attributes among life style groups were carried out by segmenting the sample on the basis of life styles. The segmentation, as noted above, required the exclusion of the transit mode and the resulting model structure is presented in Table 7.3.

Chapter 8: The Integration of Life Style in Travel Behavior Models

The test of the hypotheses suggested in this study is carried out by assessing the effects of life styles on travel behavior as manifested in the choice of mode and destination for shopping trips.

At least three methods can be applied to perform such a test, varying in their power of explanation of the effects. The first and most simple one is the comparison of the travel and locational characteristics (e.g., residential location, auto ownership, mode, etc.) across the life style groups. This is briefly shown in Section 8.2 below. The two more powerful methods are the estimation of choice models. Models can be estimated using the pooled sample and interacting some variables with life styles or, alternatively, models can be estimated for market segments based on life style groups. The latter is the more restrictive test of the hypotheses as it implies that all attributes are weighted differently across market segments. The performance of the life style segments is compared to that obtained by two market segmentation schemes which were developed in the past and are described in Section 8.1.

The results are presented in the following order. Section 8.2 presents the summary tables of cross tabulation of travel and locational characteristics based on various life style grouping schemes. Section 8.3.1 presents the 3 mode model estimated for the pooled sample in which the interaction of some variables with the life styles identified in scheme A is performed. Section 8.3.2 provides the description of various estimations by market segments based on life styles and a comparison of these results with other segmentation schemes.

Recall that the shopping trip data file used included 354 trips for the 3 modes and 345 for the 2 mode case.

8.1 Methods

Three methods are applied to test the hypothesis on the effects of life style on travel behavior. The first cross tabulations of some trip characteristics with the life style groups are given here more for illustrative purposes than for hypothesis testing. Given that a more efficient use of the data can be applied, we did not perform statistical tests on the cross tabulations but the tables and some intuitive inferences are presented in Section 8.2.1.

Testing the hypothesis that different life style groups have completely different sets of tastes can be done by estimating models which are identical in specification for each of the life style groups or market segments. The hypothesis can then be tested against the null hypothesis which states that the coefficients are identical across the life style segments. Also, the combined explanatory power of the segmented models can be compared with that of the pooled model.

The identification of differences among life style groups is captured by using an identical model specification for all. While this is valid for this exploratory study it is conceivable that different life style groups have different sets of attributes in their choice process. That would mean that different specifications of the utility function may apply to different groups. Despite its plausibility, such an approach incurs high estimation costs which make it less desirable for practical purposes.

A less restrictive test is that which assumes that life styles affect some of the attributes of the utility function but not all. To test such an hypothesis, the pooled sample is used and those attributes hypothesized to have a differential effect are interacted with the life style groups.

The evaluation of the estimated models can be done first by evaluating the significance of each individual variable. The value of the t-statistic (the ratio between the estimated coefficient and the standard error) is provided by the estimation package and is reported in parentheses with each coefficient). The performance of the model as a whole is evaluated by a goodness-of-fit statistic ρ^2 (or pseudo R^2) which is

$$\rho^2 = 1 - \frac{L^*(\Theta)}{L^*(0)} \tag{8.1}$$

where: $L^*(\Theta)$ is the value of the likelihood function for the estimated Θ's, and

$L^*(0)$ is the value of the likelihood function for $\underline{\Theta} = 0$.

This measure should be adjusted for degrees of freedom by the following:

$$\bar{\rho}^2 = 1 - \frac{L^*(\Theta)/\left\{\sum_{t=1}^{T} (J_t-1) - k\right\}}{L^*(0)/\sum_{t=1}^{T} (J_t-1)} \tag{8.2}$$

where: J_t is the number of alternatives in the feasible choice set for individual t, and

k is the number of estimated coefficients.

Another measure for the models' performance is a chi-square statistic which is equal to $-2(L^*(0) - L^*(\theta))$. It is chi-square distributed with degrees of freedom equal to the number of estimated coefficients. It tests the null hypothesis that all coefficients are equal to zero. For comparison between models this test is found to be very useful.

As the general hypothesis suggested throughout this thesis is that life style is a more powerful descriptor of decision makers than descriptors commonly used to date, it became necessary to evaluate not only the mere effects of life styles on travel behavior but also to compare the performance of alternative schemes used for market segmentation.

Two segmentation schemes were selected as benchmarks for comparison and evaluation of the life style based segmentation. The first is based on annual household income. It was chosen because it is based on a predominant socio-economic variable which is relevant to travel behavior as well as shopping behavior, and it represents a simple segmentation approach which is in use (cf. Dobson, 1979). The structure of this segmentation scheme is depicted in Table 8.1.

As a second benchmark a segmentation scheme developed by Ben Akiva and Lerman (1976) was chosen (denoted as"life cycle-occupation scheme" throughout this chapter). It was developed for an automobile ownership model and it is based on two dimensions: life cycle and occupation. Life cycle is divided into two categories: young and old, each of which is further divided to indicate the presence or absence of children. Occupation is in a binary form, distinguishing between white and blue collar workers. A total of 8 segments is formed. In applying this scheme the

Table 8.1

Income Based Segmentation Scheme

Segment	Income Range ($)	No. of Households	No. of trips
1	Under $10,000	87	42
2	$10,000-$14,999	100	70
3	$15,000-$20,999	130	104
4	$21,000-$24,999	69	59
5	$25,000 and more	135	79

age of 45 years old was chosen as the boundary between young and old.

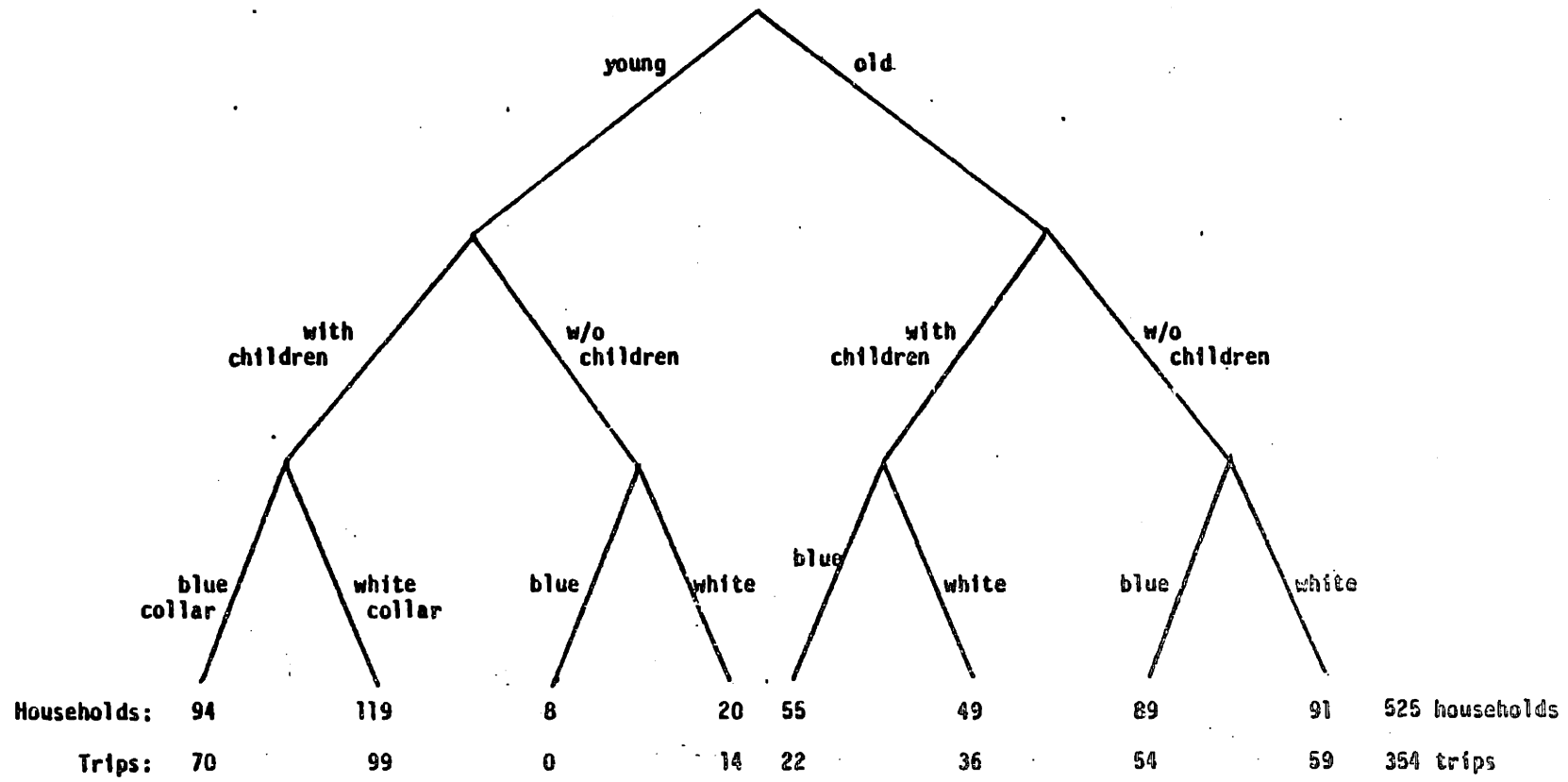
The life cycle-occupation segmentation scheme is not based on variables which are in and of themselves powerful explanatory dimensions, but rather, there is an implicit (or explicit) assumption that these three variables are nighly correlated with a variety of other socio-economic and behavioral attributes. For example, occupational status can be expected to be correlated with income, educational level, and to a lesser extent control over time. The life cycle dimension is correlated with levels of activities, commitment (or constraint) to the household due to the presence of children, etc. So, in a sense, such a multidimensional segmentation can be viewed as a simple application of our operational definition of life style in which the input variables are only the above three, and computationally it is very inexpensive.

The distribution of the sample population by the life cycle-occupation scheme is shown in Figure 8.1.

Models were estimated for 5 segments, collapsing the segments of young white collar members with and without children and also the segments of older members with children, over both occupational status. The estimated coefficients for these and a pooled model are presented in Table 8.10. (As will be discussed below the collapsed segment of young white collar members was later separated into two subgroups and a model was estimated only for the larger group of 99 members who have children.)

The following section presents the estimation of models for the benchmark segmentations as well as a number of life style based segmentations and discusses their merits.

Figure 8.1 Structure of Life Cycle-Occupation Segmentation



8.2 Travel and Locational Characteristics by Cluster

One test of the hypotheses about the effects of life style on travel and locational behavior can be performed by using cross tabulation of the characteristics by the clusters. Tables 8.2 through 8.8 summarize these characteristics for some of the clustering schemes. Although we did not perform statistical tests on the tables' content, some differences across life style clusters are clear.

The characteristics included are:

(a) the number of shopping trips per person making a shopping trip (column 4). The range is between 1.14 for the "uneducated" cluster of scheme C-2 to 1.75 for the young dual-career childless households.

(b) percent of cluster making a shopping trip (column 5) is the percent of shopping trip makers out of the total cluster members for the sampled day. This value varies from 29% for both the "uneducated" and the young dual employment groups in scheme C-2, to 77% in cluster 1 of scheme G-2 (high income, low women participation in labor force and very high proportion of time spent in services - shopping included).

(c) modal split (column 6 through 8) expressed as percentages. The total shares are 82% auto, 2% transit and 15% walk. Some clusters demonstrate significant deviations from these values, mainly in favor of walk trips and related to lower income.

(d) complexity (column 9) is the average number of links in a sequence of non-home based trips. (A home-shop-home sequence

equals a complexity value of 2.) Noticeable is the high value of 4.29 for the young dual couples, indicating a higher level of planning and scheduling activities and trip chaining, compared with the low value of 2.88 for the "uneducated" group in scheme C-2.

(e) travel time (column 10) is the average length of trip in minutes. No major differences are observed here but if it were adjusted for the modes it would probably produce different ranges for shopping trips by clusters.

(f) percent made by male head (column 11) ranges from 25% in the case of the "uneducated" cluster to 93% in the young dual employment childless group of scheme C-2.

(g) percent made alone (column 12) indicates whether the trip maker was accompanied by any other household member. This variable ranges from 35% to 83%. Its relevance is not clear because there is a mixed effect of life styles in which the accompanying person is the spouse while in others it may be the children, each case having different implications.

(h) auto ownership (column 13) ranges from 1.0 per household for the low income clusters to 2.42 for the high income clusters.

(i) suburban residence (column 14) indicates the percentage of group members residing in the suburbs. The suburbs are defined as those traffic zones (208 through 498) which are outside the Baltimore city limits. While the total sample of married couple households includes 51% suburban residents, the deviations in

Table 8.2

Travel and Locational Characteristics, Scheme A

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Suburban Residents %	Origin in Suburb	Destination in Suburb	Origin in Residence Zone	Intrazone Trip %
					auto	transit	walk										
1	111	84	1.32	52	91	1	8	3.15	14.8	36	60	2.2	54	57	69	66	12
2	51	31	1.65	41	90	4	6	3.92	13.4	55	69	1.8	41	43	51	43	20
3	35	26	1.35	37	54	6	40	3.25	15.6	51	69	1.0	43	43	40	66	20
4	86	56	1.54	52	85	2	13	3.83	12.3	31	44	1.7	49	54	63	62	24
5	70	53	1.32	50	76	3	21	3.02	13.3	50	83	1.8	59	59	66	70	20

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Sub-urban Resi-dents %	Origin in Suburb	Desti-nation in Suburb	Origin in Residence Zone	Intra-zone Trip %
					auto	transit	walk										
1	5	2	2.50	.11	40	20	40	5.60	12.6	60	80	1.80	60	60	60	40	40
2	93	60	1.55	.85	88	1	11	3.83	12.75	38	46	1.73	47	53	62	59	22
3	83	58	1.43	.55	94	0	6	3.42	14.2	33	48	2.00	55	55	69	61	12
4	51	42	1.21	.52	82	2	16	2.86	15.7	39	67	2.55	55	59	71	73	16
5	40	27	1.48	.40	60	5	35	3.32	15.0	58	70	1.17	38	40	38	63	23
6	81	66	1.23	.48	79	5	16	3.20	12.7	40	89	1.65	53	53	58	62	20

Table 8.3 Travel and Locational Characteristics, Scheme B

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Owner-ship	Sub-urban Resi-dents %	Origin in Suburb	Desti-nation in Suburb	Origin in Residence Zone	Intra-zone Trip %
					auto	transit	walk										
1	84	60	1.4	50	89	1	9	3.35	14.0	39	71	2.37	63	63	68	63	13
2	52	36	1.4	42	88	4	8	3.44	13.5	52	65	1.81	33	37	42	52	19
3	84	53	1.6	49	83	2	14	3.90	12.6	32	46	1.63	48	52	62	60	24
4	78	58	1.3	54	90	1	9	2.90	14.5	37	60	1.88	50	55	72	71	20
5	55	40	1.4	40	56	6	38	3.47	14.3	58	75	1.27	55	51	53	64	20

Table 8.4 Travel and Locational Characteristics, Scheme B'

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Suburban Residents %	Origin in Suburb	Destination in Suburb	Origin in Residence Zone	Intrazone Trip %
					auto	transit	walk										
1	67	55	1.22	51	84	3	13	2.85	15.4	39	76	2.36	54	55	66	72	13
2	35	26	1.35	41	86	6	9	3.60	12.2	60	74	1.69	37	43	49	51	23
3	68	52	1.31	47	65	4	31	3.13	13.9	38	81	1.37	54	54	54	68	24
4	8	7	1.14	29	63	0	37	2.88	16.5	25	63	1.38	50	38	50	75	25
5	161	119	1.35	64	90	1	9	3.60	13.1	32	46	1.84	52	55	67	60	18
6	14	8	1.75	29	85	0	14	4.29	14.7	93	71	2.07	36	43	50	36	7

Table 8.5 Travel and Locational Characteristics, Scheme E-1, C-2

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Sub-urban Resi-dents %	Origin in Suburb	Desti-nation in Suburb	Origin in Residence Zone	Intra-zone Trip %
					auto	transit	walk										
1	59	46	1.28	47	85	3	12	2.92	15.32	39	71	2.42	56	63	71	70	15
2	111	82	1.35	65	72	5	23	3.23	13.54	53	81	1.50	48	47	51	64	22
3	8	7	1.14	57	63	0	38	2.88	16.50	25	63	1.38	50	38	50	75	25
4	175	127	1.38	59	90	1	9	3.73	13.21	37	48	1.86	51	54	65	58	17

Table 8.6 Travel and Locational Characteristics, Clustering Schemes C-1, C-2

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Sub-urban Resi-dents %	Origin in Suburb	Desti-nation in Suburb	Origin in Residence Zone	Intra-zone Trip %
					auto	transit	walk										
1	26	17	1.53	77	92	0	8	3.73	13.27	46	35	1.73	69	69	85	58	15
2	58	37	1.57	46	90	2	9	4.00	14.33	43	57	2.07	41	43	57	52	19
3	99	64	1.55	47	87	1	12	3.51	12.81	29	48	1.74	52	56	64	64	17

Table 8.7 Travel and Locational Characteristics, Scheme 6-2

Cluster No.	Number of Shopping Trips	Number of Persons	Trips per Person	% of Cluster Making Trip	Mode %			Complexity	Travel Time	Made by Male %	Made Alone %	Auto Ownership	Sub-urban Resi-dents %	Origin in Suburb	Dosti-nation in Suburb	Origin in Residence Zone	Intra-zone Trip %
					auto	transit	walk										
1	42	30	1.40	.71	45	10	45	3.21	13.12	50	67	.98	17	17	17	71	24
2	70	42	1.67	.42	83	3	14	3.60	13.47	47	63	1.77	70	70	70	61	24
3	104	77	1.35	.592	85	2	13	3.19	13.04	58	62	1.70	53	62	73	64	18
4	59	41	1.20	.59	88	2	10	3.64	13.37	66	53	1.93	46	44	56	61	20
5	79	58	1.36	.43	96	0	4	3.40	15.41	39	70	2.44	53	53	66	58	10

Table 8.8 Travel and Locational Characteristics, Income Based Segmentation.

the life style groups range from 36% for the young dual employment childless households (cluster 6 in Table 8.4) to 69% in cluster 1 of scheme G-2 which is composed of middle aged, with children members, with slightly higher than the mean income ($22,000 vs. $20,000) and whose female heads do not work but spent 9% of their time in serving the household. A more careful analysis of this variable may reveal the extent to which life style is correlated with environmental factors (as has been assumed by Wachs, 1979).

(j) origin in suburbs (column 15) is expressed as percentage of trips made by that cluster's members.

(k) destination in suburbs (column 16) is also expressed as percentage of trips made by the cluster members. From this and the former column some information can be derived on the aggregate pattern of shopping trips. First, it is noticeable that more trips are destined to the suburbs (61%) than originate there (53%). Among the clusters there is also a large variance ranging from 85% destined to suburbs to only 40%. The origins in suburbs vary from an upper bound of 69% to a lower bound of 38%. This indicates rot only that there are significantly more trips outbound for shopping purposes than inbound but also that different life style groups vary in their attraction to suburban shopping opportunities.

(l) origin in residential zone (column 17) is expressed as percent of trips made by the cluster members. It is also used as a

dummy variable in the models (ORESW) as a proxy to account for home based trips. It ranges across clusters from a high of 75% to a low of 36% (for the young dual employment childless households). The sample mean is 62%.

(m) intra-zonal trips (column 18) is expressed as percent of trips made by cluster members. The sample mean is 19% and across clusters it varies from 7% (for the young dual employment childless households) to 25% for some other clusters.

Tables 8.2 through 8.8 demonstrate, even without detailed statistical analysis, variations across life style groups in the trip characteristics. This provides just another indication that life styles are relevant behavioral groups for travel demand analysis. This statement, though, is qualified by the fact that the variables presented in the tables are interdependent. Therefore they may indicate more differences than those associated with the life style group membership.

8.3 Estimation of Travel Models using the Life Style Concept

The travel demand model chosen for the testing of the hypothesis is the joint choice of destination and mode for shopping trips. The input variables were described in Chapter 8 and defined in Table 7.1. Two types of models were used. A three mode model (auto-transit-walk) with 20 alternatives was first estimated. On this model we tested the hypothesis that specific attributes are affected by life style by allowing interaction of these attributes with the life style groups.

The second type of model estimated was for market segments for which the model structure was reduced to 2 modes (and 13 alternatives) due to the small number of transit trips which prohibited estimating a 3 mode model for the segments. The structure of the utility functions was described in Tables 7.2 and 7.3.

8.3.1 Interaction of Variables with Life Style - The Three Mode Model

Hypotheses II2 through II4 (Section 7.2) suggest that specific attributes of the choice of destination and mode for shopping trips are differentially weighted by decision makers who vary in taste, as manifested by their life style. Model 1 is the three mode model which includes 18 attributes, shown in Table 8.9. Using the life style groups of scheme A, four attributes were deleted from model 1 and reentered as interaction with the five life style groups, resulting in model A1 which includes 34 variables. The t-statistics provided in Table 8.9 demonstrate that most of these interaction variables are highly significant, i.e., $|t| > 2.0$. The model as a whole performs, as expected, better judging by the ρ^2. The difference in the chi-square statistic between both models equals 43.70 with 16 d.f. which leads to the conclusion that model A1 is significantly (at .001) better than model 1.

This improvement in the model is a result of a more detailed specification of the distribution of the sample population's tastes. As is apparent in Table 8.9, the differences in the values of some of the

estimated coefficients are in an order of magnitude. For example, the coefficients for out-of-vehicle travel time for groups 1 and 2 are -1.078 and -.242 respectively. As these two groups have similar incomes ($24,726 and $25,133 respectively) the difference in the coefficients indicates a significant difference in the value of time among these groups. Recall that these groups vary mainly in the presence of children, which is very low in group 2 and in the employment rate of the head which is very high in that group. This result must be qualified because of the relatively low t-statistic for the OVTTA of group 2. The qualification is warranted in view of the fact that it is not very clear why this group should have the lowest weight for OVTTA. Also, group 2 has a relatively high value for the coefficient of walk time (again with a low t-statistic).

The weight assigned to walk time also varies considerably between the life style groups with group 3, which is the poorest, least educated and least holding white collar occupations, holding the lowest negative value and group 4, which is the youngest and has the highest employment rate accounting for the highest negative value.

The LNRET variable accounts for the size of the shopping opportunities at the destination. The variance in the coefficients among the groups should indicate varying preference for shopping at large shopping concentrations where group 1 is least sensitive to size. The sensitivity of group 4 may be explained by the fact that the members of this group make the least trips alone, i.e., 56% of the trips are accompanied by at least one family member. If that member is a child it is plausible

that the choice of destination will allow many shopping opportunities in proximity.

The last attribute assumed to be different among life style groups is the dummy for intra-zonal trips. This variable is the constant for intra-zonal trips and accounts for otherwise unaccounted attributes of the intra-zonal destination compared with the other alternatives.* With all coefficients highly significant we find a range of coefficients varying from -3.79 for group 1 to -2.38 for group 3. The fact that the latter is the group with the lowest auto ownership level and the lowest coefficient for walk time explains, in part, its low negative value for the intra-zonal shopping trip.

In summary, models 1 and A1 demonstrate that the values of the coefficients estimated in a model can sometimes be disaggregated into very different values by interacting the variables with group indicators which are a priori assumed to be behaviorally different. The effect of this disaggregation on the remaining variables must also be noted. The improved accounting for the distractions to walk trips by separating the walk time variables results in the reduction of the magnitude of the walk constant, as more of the variance is explained by the interaction variables. Similar effects are visible in the case of the intra-zonal walk dummy and the out-of-pocket cost variable (the latter is statistically insignificant). The observed differences in the estimated coefficients lead to the conclusion that the life style groups are behaviorally relevant and that utilizing knowledge of life style membership improves the performance of the model.

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* Note that by including the intra-zonal destination in choice set for all observations this (and the CBD destination) are disproportionately represented in the sample and therefore have biased coefficients.

8.3.2 Market Segmentation Based on Life Styles

A variety of market segmentation schemes based on life style clusterings were experimented. The performance of the models estimated for the market segments was compared with the appropriate pooled model in which no account of the underlying groups is made, and with the models based on the "benchmark" market segmentations (by income and by life cycle-occupation).

Before presenting the models based on life style segmentation the benchmark scheme based on income classification is presented in the following subsection. The second benchmark scheme, that based on the life cycle-occupation segmentation, is presented in Section 8.3.2.2 together with the first life style segmentation scheme.

All models presented in this section are 2 mode models (Table 7.3).

8.3.2.1 Segmentation Based on Income

The single dimensional segmentation based on household income produced 5 groups with 38, 68, 102, 58 and 79 trips respectively. (Note that compared with the number of trips reported in Table 8.1, the numbers given here are after elimination of the transit trips which were unevenly distributed among these groups.) Table 8.10 presents the estimated coefficients for each of the five groups as well as for the pooled sample.* Comparing the performance of the five models combined with that of the pooled model reveals that the sum of the likelihood functions for the estimated models (373.938) is improved over the value for the pooled model, yet this difference, with 49 degrees of freedom, is not

* Note: asterisks (*) in all tables describing estimation results indicate that a variable has been omitted due to small (or nil) cases in the data.

Table 8.10

Estimated Coefficients for Models based on Income Segmentation and Pooled Model

	Pooled Model	(Low Income) 1	2	3	4	(High Income) 5
# of observations	345	38	68	102	58	79
IVTTA	-.173	-0.389	-0.122	-0.168	-0.130	-0.194
	(-8.17)	(-1.74)	(-2.39)	(-4.29)	(-1.93)	(-4.54)
OVTTA	-.496	-1.365	-0.354	*	-1.016	-0.315
	(-3.91)	(-1.55)	(-1.37)	*	(-2.04)	(-1.14)
SUBWLK	-1.052	*	0.499	-1.499	-0.897	*
	(-2.42)	*	(0.41)	(-1.97)	(-0.71)	*
INZWDM	.691	0.033	-2.522	3.694	-4.379	3.465
	1.26	(0.02)	(-0.96)	(3.31)	(-1.76)	(1.07)
INZDUM	-3.147	-4.182	-2.717	-3.460	-2.394	-3.970
	(-12.33)	(-3.25)	(-4.82)	(-6.86)	(-4.35)	(-6.73)
AAVAPR	.126	0.561	6.631	-0.646	-2.155	-3.760
	(.20)	(0.31)	(2.47)	(-0.58)	(-1.55)	(-1.37)
ATCN	1.629	1.166	-3.822	3.891	0.241	9.620
	(2.24)	(0.63)	(-1.37)	(2.84)	(0.10)	(2.07)
ACSTI	-6449.	-48398.8	-20961.9	-10989.7	-27802.0	-6140.63
	(-.97)	(-0.67)	(-1.29)	(-0.95)	(-0.87)	(-0.40)
LNRET	.407	0.769	0.529	0.236	0.303	0.268
	(5.53)	(1.54)	(2.76)	(2.05)	(1.87)	(1.95)
RTDNS	.893	1.361	1.769	2.684	0.427	0.578
	(2.29)	(0.77)	(1.83)	(3.93)	(0.55)	(0.63)
WLKTT	-.065	-0.131	-0.195	-0.001	-0.332	-0.021
	(-4.59)	(-3.03)	(-1.89)	(-0.08)	(-1.86)	(-0.37)
ORESW	2.333	*	3.758	1.577	*	5.821
	(4.31)	*	(2.69)	(1.70)	*	(2.83)
EMPA	.609	0.612	-2.958	0.799	*	1.248
	(1.44)	(0.54)	(-2.29)	(1.03)	*	(0.74)
CBDDUM	-1.482	-3.883	-1.417	*	-1.257	-0.862
	(.2165)	(-2.24)	(-0.87)	*	(-0.64)	(-0.46)
$L^*(0)$	753.785	74.2404	150.219	223.517	130.679	175.13
$L^*(\theta)$	401.312	25.427	71.982	123.095	67.569	85.865
ρ^2	.468	.658	.521	.449	.483	.510

* variable excluded

statistically significant (it is at $p = .75$).

The five models evaluated by their corresponding goodness-of-fit statistic, the ρ^2, perform reasonably well and most coefficients have the expected signs. Those which do not are coefficients which have very low t-statistics. The value of time (calculated by the ratio between the travel time coefficient and the cost coefficient) ranges from $2.40 per hour to $56.90 for the lowest and highest income groups respectively.

8.3.2.2 Segmentation Based on Scheme A

Clustering scheme A produced 5 groups containing 110, 49, 33, 84 and 68 trips. A pooled model and 5 models for the segments were estimated and are summarized in Table 8.12. While the average size of the segments is similar to that obtained by the life cycle-occupation segmentation (Table 8.11) the life style groups have a greater variance in size. In general terms, the life style segmentation performs slightly better than the life cycle-occupation segmentation, as evaluated by the ρ^2's and the chi-square statistic. The sum of the log likelihood values for the latter segmentation compared with the pooled model produces a chi-square value of 80.98 with 54 d.f.* The life style segmentation produces a chi-square value of 81.86 with 51 d.f. The first is significant with a probability of .02 of rejecting the hypothesis that the coefficients are different from zero while the second is significant with a probability of .007 (!).

The greater variance in coefficients of group size in life style segmentation

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* Note that the size of the pooled sample varies due to the exclusion of some households which belonged to very small clusters.

Table 8.11

Estimated coefficients for Life Cycle-Occupation Segments and Pooled Model

Variable	Pooled Model	Segment 1 Young white collar w/ & w/o children	Segment 2 Young blue collar w/ children	Segment 3 Old white collar w/o children	Segment 4 Old blue collar w/o children	Segment 5 Old blue & white collar w/children
# of observation	345	113	68	57	51	56
IVTTA	-.173	-.142	-.240	-.225	-.057	-.261
	(-8.17)	(-4.14)	(-4.08)	(-3.24)	(-1.04)	(-4.63)
OVTTA	-.496	-1.356	-.315	-.153	-.660	-2.00
	(-3.91)	(-2.56)	(-1.10)	(-.88)	(-2.02)	(-1.80)
SUBWLK	-1.052	-.768	-.937	-.949	-.465	-2.54
	(-2.42)	(.88)	(-.77)	(-.78)	(.37)	(-1.95)
INZWDM	.691	1.169	3.950	-2.33	-5.222	.242
	1.26	(.76)	(3.29)	(-1.28)	(-2.11)	(.14)
INZDUM	-3.147	-3.660	-3.442	-3.08	-2.169	-4.039
	(-12.33)	(-7.45)	(-5.72)	(-4.75)	(-3.39)	(-5.30)
AAVAPR	.126	-.614	-1.223	-.742	3.968	2.712
	(.20)	(-.50)	(-.73)	(-.42)	(1.42)	(1.33)
ATCN	1.629	3.164	7.586	.910	-5.388	-.230
	(2.24)	(1.70)	(3.45)	(.42)	(-1.86)	(-.09)
ACSTI	-6449.	-12493.	-398.	-2545.	-31560.	10120.
	(-.97)	(-1.05)	(-.02)	(-.11)	(-1.59)	(.96)
LNRET	.407	.487	.431	.426	.569	.295
	(5.53)	(3.89)	(2.08)	(2.09)	(2.61)	(1.70)
RTONS	.893	1.403	1.007	1.219	.294	.215
	(2.29)	(2.11)	(1.03)	(1.05)	(.29)	(.18)
WLKTT	-.065	-.100	.009	-.114	-.409	-.083
	(-4.59)	(-1.90)	(.71)	(-2.49)	(-2.64)	(-2.00)
ORESW	2.333	3.144	1.627	4.442	2.530	-.412
	(4.31)	(2.52)	(1.10)	(2.35)	(1.96)	(-.222)
EMPA	.609	1.683	-1.42	-.030	-1.307	1.843
	(1.44)	(1.48)	(-1.11)	(-.03)	(-1.04)	(1.40)
CBDDUM	-1.482	*	-2.41	-1.892	*	-.742
	(.2165)		(-1.59)	(-1.77)		(-.51)
L^*0	753.777	251.066	146.088	124.485	108.624	123.515
$L^*\theta$	401.312	116.551	70.9242	66.729	54.3713	57.2442
ρ^2	.468	.536	.515	.464	.499	.537

* Variable excluded.

Table 8.12

Estimated Coefficients for Segments Based on Scheme A and Pooled Model

Variable	Pooled	A2a	A2b	A2c	A2d	A2e
# of observations	344	110	49	33	84	68
IVTTA	-0.172	-0.248	-0.048	-0.334	-0.162	-0.142
	(-8.13)	(-6.06)	(-0.96)	(-1.95)	(-3.90)	(-2.76)
OVTTA	-0.493	-1.450	-0.128	-2.956	-1.731	-0.301
	(-3.90)	(-3.18)	(0.60)	(-1.90)	(-2.05)	(-1.09)
SUBWLK	-1.043	-1.912	0.497	0.609	-2.811	-0.889
	(-2.40)	(-1.93)	(0.37)	(0.53)	(-2.21)	(-1.00)
INZWDM	0.708	-0.198	*	2.087	0.583	-0.877
	(1.29)	(-0.15)	*	(1.48)	(0.32)	(-0.57)
INZDUM	-3.161	-4.124	-2.427	-4.209	-2.966	-3.087
	(-12.34)	(-7.77)	(-3.90)	(-3.37)	(-5.69)	(-5.16)
AAVAPR	0.135	0.155	*	*	0.146	0.591
	(0.21)	(0.11)	*	*	(0.09)	(0.46)
ATCN	1.619	1.585	1.823	8.007	2.424	-1.084
	(2.23)	(0.82)	(1.40)	(2.76)	(1.10)	(-0.60)
ACSTI	-6668.26	7824.98	-67764.2	5158.12	-4673.95	-13971.9
	(-1.00)	(0.87)	(-2.43)	(0.12)	(-0.36)	(-0.85)
LNRET	0.403	0.249	0.368	1.316	0.679	0.516
	(5.47)	(2.11)	(1.74)	(2.66)	(3.96)	(2.98)
RTDNS	0.889	1.074	1.530	-1.437	0.948	-0.053
	(2.28)	(1.48)	(1.40)	(-0.60)	(1.05)	(-0.06)
WLKTT	-0.065	-0.103	-0.123	-0.004	-0.135	-0.163
	(-4.58)	(-2.65)	(-1.81)	(-0.30)	(-2.04)	(-2.17)
OBESW	2.328	1.405	*	3.406	2.986	2.666
	(4.31)	(0.91)	*	(1.26)	(2.45)	(2.45)
EMPA	0.599	1.196	0.370	1.195	-0.236	-0.212
	(1.42)	(1.31)	(0.28)	(0.69)	(-0.23)	(-0.26)
CBDDUM	-1.476	0.060	-1.100	-5.748	*	-2.615
	(-2.63)	(0.05)	(-0.79)	(-2.71)	*	(-1.74)
L^*0	731.560	244.656	108.879	63.177	184.166	150.702
$L^*\theta$	400.462	106.887	58.577	28.454	84.135	81.310
$\bar{\rho}^2$	0.467	.363	.462	.550	.543	.545

*Variable excluded.

indicates that some discriminatory dimension, additional to those applied in the simpler segmentation, is in effect. The differences in the values of the estimated coefficients are also larger in the life style segments compared with the simpler segmentation. For example, a coefficient which is statistically significant across the models, like the LNRET, varies from a low of .249 to a high of 1.316 compared with a range between .295 and .569 in the life cycle-occupation segmentation. The outstanding life style group (A3) is apparent in its extreme values across most coefficients. This group falls mostly with the older, with-children group. It is characterized by a very low share of white collar workers and probably constitutes all of that shown in Figure 8.1 and 16 additional cases which do not belong to that category. What the life cycle-occupation segmentation fails to capture are the extremely low income and education levels of that group which have the effects of imposing economic constraints on the group members and probably informational constraints as well. The economic constraints are manifested by the low auto ownership level (1.0 per household) and the modal share of auto (54%) being the lowest of all clusters. Forty percent of the shopping trips of this group are walk trips and the least number of trips to suburban destinations are generated by this group's members. This is manifested in the model by the negative coefficient of variable RTDNS which is assumed to capture the effect of shopping centers' attraction.

The high value of the LNRET variable may be indicative of an infor-

mation gap which affects this group's members. A value of this variable below unity indicates that the grouped alternatives are perceived as separate elemental alternatives. A value high above unity may be indicative of a lack of information on alternatives.

A more detailed evaluation of the models reveals that although most coefficients have the expected signs, some do not. This is of particular interest if counter-intuitive signs are statistically significant. The variable INZWDM, which is a dummy variable for intra-zonal walk trips, attains positive and negative significant values in the model of the life cycle-occupation segmentation (Table 8.11) and similarly, though not statistically significant, in models A2a through A2e (Table 8.12). This variable was introduced to account for the walking time of intra-zonal trips as the WLKTT variable for these trips is assigned zero. But it may capture other unobserved attributes as well. The difference in the values shown in Table 8.11 indicates that for young people and old people there is a differential effect of this variable. The result of this difference is that in the pooled model the value of the coefficient is small and has a low t-statistic value.

A similar phenomenon can be seen in the case of auto availability per adult member for auto trips (AAVAPR), again, a differential effect along the age dimension although all coefficients have low statistical significance. Other cases of counter-intuitive signs have very low significance. Yet, still unclear is the positive cost coefficient for segment 5 (older household with children of both blue and white collar occupations).

Counter-intuitive signs across models of different life style segments are also visible in Table 8.12 but in contrast to the previous case all such differences are statistically insignificant. The stability of this phenomenon can be tested by using larger sample sizes.

General conclusions to be drawn from these counter-intuitive signs are that segmentation, on any relevant basis, is an important tool for revealing intra-sample differences and that low values of estimated coefficients in pooled models may indicate not just a low weight assigned to that attribute but rather that conflicting preferences are revealed. This could be examined, without creating market segments, by separating the variables into interaction variables with any other attribute that might be suspected to be influential.

8.3.2.3 Segmentation Based on Scheme B

Clustering scheme B produced 6 clusters based on socio-economic and demographic data, explicitly excluding the time allocation data. Five of the clusters were large enough to enable model estimation. A comparison of the combined explanatory power of the segmented models compared with that of the pooled model, based on the log likelihood test, demonstrates that the former are significantly more powerful (at .999). Compared with the life cycle-occupation segmentation scheme this model, evaluated by the same test, performs better at the .98 level.

The coefficients estimated for the five models are presented in Table 8.13. In general, all variables have the expected signs, with some exceptions. Again, one can note that the pooled model coefficients

Table 8.13

Estimated Coefficients for Segments based on Scheme 8 and Pooled Model

	Pooled	B_a	B_b	B_c	B_d	B_e
# of observations	340	92	83	50	38	77
IVTTA	-0.174	-0.138	-0.206	-0.246	-0.301	-0.149
	(-8.13)	(-3.53)	(-4.70)	(-3.24)	(-2.20)	(-4.13)
OVTTA	-.492	-1.762	-0.540	-1.796	-0.209	-0.249
	(-3.89)	(-2.13)	(-1.80)	(-1.63)	(-0.80)	(-1.08)
SUBWLK	-1.067	-2.709	0.438	-2.979	2.995	-0.884
	(-2.41)	(-2.13)	(0.31)	(-1.90)	(0.94)	(-1.02)
INZWNM	0.643	1.230	4.703	-1.181	-3.054	-1.318
	(1.16)	(0.73)	(2.48)	(-0.67)	(-1.57)	(0.87)
INZDUM	-3.135	-3.067	-3.800	-4.453	-3.295	-2.425
	(-12.27)	(-6.01)	(-6.92)	(-5.01)	(-3.21)	(-4.86)
AAVAPR	0.299	0.350	-1.683	3.251	7.007	0.155
	(0.46)	(0.21)	(-0.98)	(1.65)	(1.45)	(0.16)
ATCN	1.495	2.889	8.997	-2.378	-1.958	-0.903
	(2.04)	(1.38)	(3.49)	(-0.84)	(-0.83)	(-0.50)
ACSTI	-5543.16	-12561.5	-5923.28	-6860.5	-7676.66	-578.708
	(-0.81)	(0.73)	(-0.36)	(-0.27)	(-0.20)	(-0.06)
LNRET	0.396	0.675	0.257	0.348	0.967	0.356
	(5.36)	(4.10)	(1.75)	(1.87)	(2.28)	(2.45)
RTDNS	0.903	1.172	1.029	0.198	1.547	0.688
	(2.31)	(1.36)	(1.43)	(0.15)	(0.90)	(0.89)
WLKTT	-0.065	-0.118	0.011	-0.108	-0.171	-0.168
	(-4.55)	(-1.91)	(0.70)	(-2.24)	(-2.47)	(-2.13)
ORESW	2.309	3.108	2.863	*	5.443	2.054
	(4.26)	(2.54)	(1.62)	*	(1.74)	(2.12)
EMPA	0.564	-0.127	0.210	2.427	-2.865	0.014
	(1.32)	(-0.13)	(0.19)	(1.80)	(-1.19)	(0.02)
CBDDUM	-1.483	*	-0.533	-0.681	-3.068	-2.593
	(-2.65)	*	(-0.30)	(-0.49)	(-2.04)	(-1.81)
$L^*(0)$	743.72	201.285	183.002	109.375	75.9482	173.11
$L^*(\theta)$	397.909	91.9678	83.5001	44.8827	28.2205	103.16
ρ^2	.465	.545	.544	.590	.628	.404

* variable excluded

reflect some averaging over the range of the coefficients estimated for the groups. The differences in the coefficients' values across the groups are in some cases very noticeable. For example, the LNRET values for segment B_b and B_d are in a ratio of about 1:4. Other variables demonstrate even larger variations but, due to their low t-statistic values, citing them requires qualification. The difference in the LNRET values indicates that group B_d, which is the low income, middle aged and elderly group, prefers shopping at destinations which have a large number of shopping opportunities, a claim which is supported by its high value in the RTDNS variable which is intended to capture the effect of shopping centers. As for segment B_b, it is not quite obvious why it obtained a low value of LNRET. Both of these cases are not intuitively expected.

The value of time as calculated by the ratio between the in-vehicle-travel time and the cost ranges from $12 per hour for segment B_a, which consists of young people and probably includes both high and low income members, to $60 per hour for segment B_c, which is the high income middle aged group. (Segment B_e has a value of time of $325 per hour which is assumed to be insignificant considering the extremely low value of the t-statistic for the cost coefficients.)

Of interest for policy implications are the differences in the level of service variables. Section 8.3.2.7 below deals specifically with this question. At this point it is noteworthy to observe the differences between the time coefficient, both across the segments and in the ratio between the in-vehicle and out-of-vehicle time for each segment.

Across the segments, the IVTT ranges in a ratio of more than 1:2 between segments B_a and B_d. The ratio between IVTT and OVTT for segment B_a is extremely small (about 1:12) with both coefficients statistically significant, whereas in segment B_d OVTT is valued less than IVTT (with the former not statistically significant). Comparing the OVTT across the segments demonstrates, as expected, that segment B_c would have the highest negative value and segment B_d the lowest negative value.

This segmentation scheme, in summary, performs better than the life cycle-occupation scheme and is an acceptable (with reservations) life style segmentation. The reservations noted in Chapter 6 stem from its resemblance to socio-economic and demographic classification, overlooking some life style indicators. We speculatively attribute some of the counter-intuitive or unexplained differences in the estimated coefficients across the models to the very fact hypothesized in this thesis, namely, that socio-economic classification which is inconsistent with life style, as is the case in some of these segments, does not result in homogeneous taste groups.

8.3.2.4 Segmentation Based on Scheme B'

Clustering Scheme B', summarized in Table 6.5, was used to segment the sample population into five segments consisting of 84, 52, 84, 78 and 55 trips, respectively. The estimated coefficients of the five segmented models and the pooled model are presented in Table 8.14. Among all sets of models estimated for market segments this scheme performed best as judged by the log likelihood ratio. The five models combined

Table 8.14

Estimated Coefficients for Scheme B' and pooled model

	Pooled	1	2	3	4	5
# of observations	344	50	83	82	77	52
IVITA	-0.172	-.247	-.056	-.152	-.266	-.149
	(-8.13)	(-4.32)	(-1.28)	(-3.43)	(-5.42)	(-2.12)
OVITA	-0.493	-.832	-.110	-1.655	-1.631	-1.891
	(-3.90)	(-2.02)	(-.57)	(-1.96)	(-2.31)	(-1.72)
SUBWLK	-1.043	-3.303	2.268	-2.546	1.25	-.320
	(-2.40)	(-1.92)	(1.33)	(-2.03)	(.72)	(-.33)
INZWDM	0.708	-2.415	-7.798	.689	4.636	-.462
	(1.29)	(-.67)	(-1.47)	(.44)	(2.99)	(-.36)
INZDUM	-3.161	-4.484	-1.995	-2.901	-3.742	-3.943
	(-12.34)	(-6.69)	(-3.570)	(-5.54)	(-6.34)	(-4.53)
AAVAPR	0.135	-4.152	2.582	.140	3.718	.449
	(0.21)	(-2.19)	(.89)	(.01)	(1.52)	(.37)
ATCH	1.619	2.566	-6.534	2.571	6.682	1.009
	(2.23)	(.58)	(-1.10)	(1.25)	(3.09)	(.60)
ACSTI	-6668.26	1183.	-49043.	-6966.	9852.	-16533.
	(-1.00)	(.07)	(-2.07)	(-.51)	(.99)	(-.84)
LNRET	0.403	.401	.231	.637	.114	.761
	(5.47)	(2.84)	(1.25)	(3.82)	(.679)	(3.18)
RTDNS	0.889	1.023	.836	1.323	1.89	-.044
	(2.28)	(1.10)	(.80)	(1.45)	(2.2)	(-.04)
WLKTT	-0.065	-.402	-.555	-.109	.013	-.128
	(-4.58)	(-1.47)	(-1.23)	(-2.19)	(.86)	(-3.04)
ORESW	2.328	5.451	3.243	3.187	3.024	1.97
	(4.31)	(2.33)	(1.63)	(2.47)	(2.13)	(1.63)
EMPA	0.599	.973	2.000	-.398	.498	-1.107
	(1.42)	(.727)	(1.30)	(-.38)	(.43)	(-1.15)
CBDDUM	-1.476	-.203	-1.158	*	*	-3.726
	(-2.63)	(-.09)	(-.85)	*	*	(-2.54)
$L^*(0)$	731.380	182.291	111.793	105.252	170.52	107.874
$L^*(\theta)$	400.462	70.102	66.667	84.4181	72.3614	49.3453
ρ^2	0.467	.62	.40	.53	.58	.54

* Variable excluded.

have a log likelihood value of 342.89 compared with 351.73 for Scheme B and 401.312 for the pooled model. (Given that Scheme B' is based on 344 observations compared with 340 of Scheme B, this difference in values is even more impressive.) The segmented models are performing better than the pooled model at a significant level of p = .999 (chi-square value of 116.84 with 54 d.f.).

Assessing the individual models one notices that they vary in their explanatory power as evaluated by the ρ^2 statistic. The range is from ρ^2 = .62 for model 1 to ρ^2 = .40 for model 2. Recall that segment 2 is that of a relatively high socio-economic class which is distinguished from segment 1 mainly by the high rate of females' full employment and small household size. It was speculated in Chapter 6 that segment 2 includes at least two distinct groups which vary in life style and in tastes and constraining the model coefficients to be identical for these two (or more) groups results in a relatively low explanatory power.

Most coefficients have the expected sign and those which do not have very low t-statistic values. Overall, the problem of sample size becomes obvious once again, as each segment is based on less than 100 observations and 14 coefficients are estimated, the standard errors for most being very large.

The coefficients for in-vehicle-travel time all have the expected signs and all but one have t-statistic values greater than 2. The highest negative values are for segment 4 which is the "working class" large families and segment 1 which is the "upper middle class" large family group. In both, most shopping trips (over 60%) were made by women and

in both there is a low rate of women's participation in the labor force. Consequently, one could expect that non-working women would have a low value of time, which is not supported by these coefficients. What may be in effect here is that the coefficient is strongly affected by the working males who do 30+% of the shopping trips, and/or that the effect of household income on the value of time of non-working women is also strong.

Noteworthy in this set of models is the ratio between in-vehicle and out-of-vehicle travel times. Based on experience elsewhere one expects a ratio in the range of 1:2 to 1:3, as is the case in the pooled model and in model 1. Yet, in the models for 3, 4 and 5 the ratio ranges between 1:6 and 1:12. While one could expect the value of time to correlate with the out-of-vehicle travel time (OVTT), all three of these groups constitute the lower income group in this sample which is often assumed to have lower values of time. (Values of time could not be calculated for this scheme because of the large standard error in the cost coefficients.) The high negative value of OVTT in segment 5 could be attributed to the large number of elderly in this segment but this argument does not apply to the other two groups. Also, one could expect a high positive correlation between OVTT and walk time, but that is not supported by the estimated walk time coefficients. Thus, to the extent that the OVTT coefficients are statistically significant, their magnitude and ratio to IVTT are intuitively clear.

The walk time coefficients vary (among the statistically significant values) from a low of -.065 in the pooled model to a high of -.128 for

segment 5. The latter is probably influenced by the age composition. The values of the coefficients for segments 1 and 2 indicate (though with a large standard error) much higher negative values associated with walk time. These may be consistent with higher values of time expected for the higher income groups.

Although other coefficients seem to be of noticeable difference in magnitude, the relatively large standard errors associated with them do not allow the drawing of more specific conclusions about the differences between the market segments.

8.3.2.5 Segmentation Based on Schemes E-1 and C-2

Schemes E-1 and C-2 are clustering schemes run separately for the older (over 45 years) and younger (under 45 years) subsamples. The subsample structure was employed under the assumptions, partially supported by the results shown in Tables 8.11 and 8.12, that age is a crucial factor in discriminating between life styles.*

Four market segments were created, the first three accounting for all 163 trips made by the older subsample and one segment accounting for 159 out of 181 trips made by the younger subsample. Deleted were 14 trips made by the young dual career childless households and 8 trips made by members of cluster 1, the "uneducated" cluster (see Section 6.1.7).

The estimated coefficients for these models and the pooled model for the 322 trips combined are shown in Table 8.15. Each model by itself,

* In retrospect, this assumption should have qualified to hold true not necessarily as dichotomic (above and below 45 years old) but more probably as a trichonomy: under 35, 35 to 60, and 60+. This, however, could not be tested due to the small sample size.

Table 8.15

Estimated Coefficients for Segments Based on Schemes E-1, C-2 and Pooled Model

Variable	Pooled	E1C2-6a	E1C2-6b	E1C2-6c	E1C2-6d
# of Observations	322	65	33	65	159
IVTTA	-0.186	-0.246	-0.054	-0.266	-0.191
	(-8.44)	(-4.39)	(-1.05)	(-4.21)	(-6.05)
OVTTA	-0.478	-0.628	-0.350	-0.342	-0.683
	(-3.72)	(-2.23)	(-1.68)	(-1.54)	(-2.63)
SUBWLK	-1.385	-2.180	0.115	-1.013	-1.853
	(-2.75)	(-1.68)	(0.07)	(-1.04)	(-2.32)
INZWDM	-0.667	-1.115	*	-0.435	0.488
	(-0.99)	(-0.73)	*	(-0.36)	(0.34)
INZDUM	-3.168	-3.990	-1.842	-3.353	-3.434
	(-12.02)	(-5.72)	(-2.72)	(-4.97)	(-8.90)
AAVAPR	0.447	-0.447	1.239	2.695	-0.660
	(0.66)	(-0.26)	(0.50)	(1.69)	(-0.59)
ATCN	0.003	0.606	0.806	-1.116	1.970
	(0.30)	(0.27)	(0.42)	(-0.82)	(1.17)
ACSTI	-2127.56	7105.28	-38286.7	6567.29	-1567.49
	(-0.32)	(0.49)	(-1.57)	(0.55)	(-0.16)
LNRET	0.396	0.360	0.188	0.547	0.436
	(5.22)	(2.18)	(0.88)	(2.88)	(3.99)
RTDMS	0.800	0.400	2.025	0.278	1.093
	(1.98)	(0.37)	(1.55)	(0.31)	(1.95)
WLKTT	-0.131	-0.108	-0.135	-0.131	-0.139
	(-5.08)	(-2.60)	(-1.69)	(-2.94)	(-2.22)
OBESW	2.369	2.500	2.244	2.783	2.347
	(4.02)	(1.31)	(1.45)	(2.55)	(2.29)
EMPA	0.543	1.243	-0.202	-1.109	0.708
	(1.18)	(0.98)	(-0.18)	(-1.17)	(0.93)
CBDDUM	-1.473	-1.014	*	-2.134	-0.649
	(-2.37)	(-0.38)	*	(-2.01)	(-0.44)
L^{*0}	705.227	143.515	74.144	136.767	350.801
$L^{*\theta}$	360.715	68.086	43.220	65.354	166.343
ρ^2	.489	.526	.417	.522	.526

* Variable excluded.

evaluated by the chi-square statistic, is significant at .001, thus the null hypothesis that the coefficients are equal to zero can be rejected. Evaluation by the ρ^2 reveals low performance for model b which is based on only 33 observations. The four segmented models do perform better, judging by the likelihood ratio, than the pooled model but the difference (a chi-square of 35.42 with 40 d.f.) is significant only at the .70 level. The overall low values of the t-statistics across most variables and segments prohobit the drawing of conclusions on their differential effects, with some exceptions. Segment 6 appears to have a significantly lower coefficient for in-vehicle travel time and an extremely low value of time (about $2.00 per hour compared with $54.00 for members of model a). This seems inconsistent with the expectations based on the life style group's characteristics (shown in Table 6.6) of full employment for both household heads and higher income. But, again, it may be a result of the large standard error of the cost coefficients.

The problem of defining life style groups by the method suggested in this study and, moreover, the problem of testing the hypotheses of this study are demonstrated by this set of models. The performance of 4 models is compared with that of 5 models of the simple segmentation. A priori one can expect a more detailed segmentation to perform better as more (relevant) attributes are accounted for. Yet, there is no simple way in which clusters evaluated as interpretable can be tailored in number to be comparable, aside from an increased sample size. In

this specific case two clusters which, based on our hypotheses, may in fact demonstrate difference in behavior, were eliminated due to sample size restrictions and the remaining sample may be a behavioral "silent majority" group for which differences in behavior cannot be identified.

8.3.2.6 Revised Segmentation

Based on the identification of two distinct but small clusters in Scheme C-2, the young dual worker, highly educated, childless couples and the "uneducated" low income clusters (cluster 3 and 1 in Table 6.8) which were eliminated from the models described in the previous section (8.3.2.5), these cases were eliminated from the simple segmentation and the models reestimated for the life cycle-occupation segmentation. Cluster 3 of scheme C-2 accounted for 14 trips which constituted the "young, without children, white collar" cases shown in Figure 8.1. Cluster 1 of that scheme constituted 8 trips of the 70 accounted for by the "young with children blue collar" cases in Figure 8.1. All other segments remained unchanged and two models were estimated for the two changed segments, shown in Table 8.16. The argument for this approach is that if a group is too small to be estimable by itself, it may be possible to demonstrate its effect by a negative approach, i.e., the elimination of its members from a larger group. In other words, if a large group consists of two homogeneous subgroups, the estimated coefficients are constrained to account for all variations. If one group is eliminated, the remaining cases will produce new estimated

Table 8.16-Estimated Coefficients for Revised Life Cycle-Occupation Segments

	Segment 1 Young white collar w/ & w/o children	Segment 2 Young white collar w/ children	Segment 3 Young blue collar w/ children	Segment 4 Young blue collar w/ children (1)
# of observations	113	99	68	60
IVTTA	-.142 (-4.14)	-0.159 (-4.32)	-.240 (-4.08)	-0.241 (-4.76)
OVTTA	-1.356 (-2.56)	-1.242 (-2.35)	-.315 (-1.10)	-0.210 (0.82)
SUBWLK	-.768 (.88)	-1.427 (-1.42)	-.937 (-.77)	0.812 (0.60)
INZWDM	1.169 1.767	2.170 (1.03)	3.950 (3.29)	-2.617 (-1.42)
INZDUM	-3.660 (-7.45)	-3.510 (-7.01)	-3.442 (-5.72)	-3.060 (-5.12)
AAVAPR	-.614 (-.50)	0.028 (0.02)	-1.223 (-.73)	3.298 (1.71)
ATCN	3.164 (1.70)	3.411 (1.42)	7.586 (3.45)	-2.565 (1.10)
ACSTI	-12493.00 (-1.05)	-6245.66 (-0.53)	-398.00 (-.02)	17264.4 (1.44)
LNRET	.487 (3.82)	0.460 (3.56)	.431 (2.08)	0.471 (2.29)
RTDNS	1.403 (2.11)	1.259 (1.83)	1.007 (1.03)	1.383 (1.31)
WLKTT	-.100 (-1.90)	-0.077 (-1.32)	.009 (.71)	-0.175 (-2.29)
ORESW	3.144 (2.52)	2.642 (2.11)	1.627 (1.10)	2.823 (1.83)
EMPA	1.683 (1.48)	1.351 (1.15)	-1.42 (-1.11)	*
CBDDUM	*	*	-2.41 (-1.59)	-2.675 (-1.63)
L^*0	251.066	220.387	146.088	129.581
$L^*\theta$	116.551	103.675	70.9242	67.6145
ρ^2	.536	.530	.515	.478

* Variable excluded.

(1) excluding 8 cases which form a separate life style group.

coefficients. Conceivably, not only should the values of the coefficients differ but the performance of the model should improve, as the eliminated data produced "noise" compared with the homogeneous data of the remaining observations.

Segment 1 in Table 8.16 is identical to that presented in Table 8.11. Segment 2 is the remaining group after the elimination of the 14 trips. Similarly, segment 3 is identical to segment 2 of Table 8.11 and segment 4 is the remaining part after the elimination of 8 trips.

In general terms, quite unexpectedly both models performed "worse" than their predecessors which were based on the larger sample, although not by a large difference. Both new models are highly significant in rejecting the hypothesis that the coefficients equal zero.

The differences among the coefficients in segments 1 and 2 are only in those cases in which the t-statistic is very low and consequently inference would be highly speculative. For example, the 14 eliminated cases have "lowered" the negative weight assigned to suburban walk trips by segment 2 members. Also surprising is their effect on reducing the value of time.

In the case of segments 3 and 4, again, none of the differences are significant and their meaning is not clearly interpretable.

This experiment does not support our hypotheses but, once again, it can be attributed to the small sample size. Yet, it is capable of demonstrating that the grouping by life style does incur large changes on the estimated coefficients.

8.3.2.7 A Constrained Model

For the purpose of devising transportation policies we are interested specifically, though not exclusively, in the variables which account for the level of service, on which the planner has leverage. Three such variables used in the models presented here are the in-vehicle travel time, the out-of-vehicle travel time, and the out-of-pocket travel cost. Evaluating the relevance of life style segmentation for planning purposes lies to some extent in its ability to distinguish the values associated with these variables by different segments. In other words, accepting the plausible hypothesis that different life style groups have different values for the various constants still does not mean that the concept is relevant for planning purposes. This led us to specifically test the hypothesis that the level of service variables are significantly different across the segments.

Testing this hypothesis is done by estimating a model using a sample pooled over four segments and constraining the level of service variables to be identical. This model is thus specified by 44 variables which are segment-specific (denoted as 1, 2, 3 or 4, respectively, in Table 8.17) and 3 additional variables which are the constrained level of service variables. The log likelihood value of the estimated model can be compared with that of the four separated segments and if the latter is not significantly better (evaluated by the chi-square test) then the hypothesis that the level of service variables are identical across segments cannot be rejected.

Table 8.17 presents the estimated coefficients for the pooled segments B_a, B_b, B_c and Be of scheme B. The chi-square value for the

Table 8.17

Estimated Coefficients for a Constrained Model

	Coefficient	t-statistic		Coefficient	t-statistic
IVTT	-.172	-7.76	LNRET 1	.672	4.12
OVTT	-.677	-4.44	" 2	.236	1.70
ACSTI	-5288.	-.75	" 3	.288	1.72
SUBWLK 1	-2.752	-2.16	" 4	.375	2.48
" 2	.586	.43	RTDHS 1	1.483	1.73
" 3	-2.653	-1.86	" 2	1.031	1.49
" 4	-1.00	-1.10	" 3	.428	.37
INZMDM 1	1.361	.81	" 4	.562	.68
" 2	4.651	2.47	WLKTT 1	-.118	-1.91
" 3	-1.919	-1.10	" 2	.012	.80
" 4	-.730	-.50	" 3	-.112	-2.25
INZDUM 1	-3.261	-7.41	" 4	-.156	-2.19
" 2	-3.401	-7.73	ORESW 1	3.12	2.53
" 3	-3.423	-6.08	" 2	2.809	1.61
" 4	-2.842	-6.38	" 4	1.924	1.982
AAVAPR 1	.291	.17	CBDDUM 2	.198	.15
" 2	-1.511	-.90	" 3	-.917	-.73
" 3	3.189	1.64	" 4	-2.106	-1.51
" 4	.219	.18	EMPA 1	-.052	-.05
ATCN 1	1.955	1.00	" 2	.295	.26
" 2	8.908	3.56	" 3	2.618	1.90
" 3	-4.373	-1.71	" 4	-.061	-.07
" 4	.131	.08			
$L^*(0)$	662.772				
$L^*(\theta)$	331.125				
ρ^2	.50				

difference is 15.23 with 9 d.f., which is significant at p = .91. Consequently, the null hypothesis (that all level of service variables are identical across segments) can be rejected.

8.4 Summary

The integration of the life style concept in the travel model has indicated that life style groups are relevant behavioral groups which share similar tastes in the choice of mode and destination for shopping trips. The various specification schemes used to define the life style groups result in models of different qualities some of which have demonstrated advantages over the benchmark segmentation schemes. A by-product of this analysis is the assessment of the explanatory power of the life cycle-occupation segmenting scheme.

One qualification that needs to be noted here is that an extremely small sample was available. Many of the cross-segment differences could not yield conclusive statements because of the small number of observations in many of the segments and the consequent large standard errors.

Chapter 9: Conclusions

This study is another attempt to improve the understanding of travel behavior and the ability to develop models for prediction purposes. Focusing on the representation of the individual decision maker in the travel models, the concept of life style is suggested as a useful construct which is based on sound theoretical structure and therefore is potentially a powerful explanatory tool.

Section 9.1 presents an assessment of three different aspects of the results. First, the theoretical development is evaluated, followed by an assessment of the empirical analysis. The third part of Section 9.1 assesses the utility of the concept of life style as a practical forecasting tool, as well as the conclusions about market segmentation that can be drawn from this study. Section 9.2 deals with policy implications at two levels. First, the relevance of life styles to policy decisions is discussed, followed by some notes on specific policy implications which can be drawn from the empirical analysis performed. The concluding section of this chapter deals with some ideas for further research on life style and travel behavior.

9.1 Assessment of Results

A number of separate contributions can be identified in this study. The first is the development of a theory that places travel behavior in the context of life decisions and life styles. The second contribution is the empirical results of the analysis which serve as both a test of the hypotheses about the effects of life style on travel behavior and

a demonstration of a prototypical application of the concept of life style for planning purposes. The third contribution, a by-product of the last, is an assessment of life style and some approaches to market segmentation as practical forecasting aids. An assessment of each is discussed below.

9.1.1 The Theoretical Development

The theoretical construct developed in this thesis suggests that life style is a high level descriptor of decision makers which synoptically integrates over "low level" socio-economic and demographic attributes. The concept of life style is developed in a framework of a number of behavioral dimensions and as such is assumed to account for some dimensions which are overlooked in alternative forms of representing the decision makers.

The theoretical development also provides a framework for incorporating a concept which is, in many cases, loosely defined in econometrically based models.

In principle, the assessment of a theoretical development is inseparable from its empirical validation. But occasionally the theoretical development may extend beyond what is validated in the empirical analysis carried out in the framework of a single project. I contend that this is a case in which, based on the current state of the theory, further empirical analysis should be carried out to broaden and hopefully support the relevance of the theory suggested here.

A basic premise of this study was that it attempts to extend the capability of the presently existing analysis methods, stopping short of developing new methods which would, for example, require the use of attitudinal data. In other words, it is an attempt to push the limit of the existing methods without drawing on methods which are not yet applicable to practical planning. The theory developed is consistent with this premise and it is deemed necessary to broaden the scope of the

empirical analysis in order to identify the most efficient utilization of the existing methodology.

9.1.2 Assessment of the Empirical Results

The empirical results have demonstrated that life styles, as defined, are relevant behavioral factors and can thus be used as a basis for segmentation of the travelers market. Based on a sound theoretical basis the life style segmentation has the potential of explaining behavior in a more accurate manner than the alternative schemes tested here. Life style segmentation is capable of identifying groups which are overlooked by other classification schemes as was demonstrated in some of the clustering schemes described in Chapter 6.

The evaluation of the empirical results should include three main considerations. The first, and conceptually most important, is the theoretical interpretability. Not all of the clusters obtained could be perceived as life style groups and in some cases one could observe that the groups are fully or partially correlated with socio-economic classes. The quality of the empirical results indicates that in this study the full potential of the concept was not yet captured.

Second is the cost-effectiveness of the concept of life style. If a relatively inexpensive segmentation scheme, such as that based on life cycle-occupation, performs equally well in explaining behavior it would hardly be justifiable to develop the more costly life style segmentation for the marginal explanatory power obtained. This leads to the third consideration. If the contention that life styles are

becoming the differentiating traits in society, substituting for the traditional socio-economic classification, is true, then for prediction purposes life style would provide more than a marginal benefit in its explanatory capability. If one accepts the assumption that forming a single parent household is a life style more than simply having a socio-economic or demographic attribute, then using current trends to forecast household type distributions and models estimated for life style will probably perform better than those estimated for socio-economic segments.

One qualification needs to be noted on the quality of the empirical results. The use of an extremely small sample has incurred costs in terms of the statistical significance of the results. Using a larger data set or, alternatively, sampling higher rates in population groups which can a priori be assumed to be of different life styles could have demonstrated the relevance of the concept in a more conclusive manner.

9.1.3 Assessment of Life Style and Other Segmentation Schemes for Planning

Recalling that this study is concerned not only with improving the explanatory power of travel behavior models but also with providing a practical tool to be used in forecasting, a question arises as to whether the methodology suggested is at all practical. While current data provide information on the current joint distribution of all relevant attributes, for forecasting purposes it becomes necessary to identify the target date joint distribution so that life style groups can be identified.

Although it is impossible to predict the joint distribution with complete certainty, it is contended that use of information about current trends combined with professional judgement can yield a probable future joint distribution which is acceptable and comparable in quality to other predicted distributions.

In observing the trends of change in the various attributes used in defining life style groups, it is possible to identify some patterns which can reasonably be assumed to persist for a period of twenty to twenty-five years, which is the uppermost bound at which forecasting of travel should be exercised. For example, given the current population trends the age composition of households (or at the very least the age distribution of adult population) can be projected with a high degree of certainty. Similarly, the distribution of educational levels can be projected. By contrast, more uncertainty is involved in predicting future income distributions, although this can also be done.

The method suggested for predicting the joint distributions employs the information which the analyst/planner is, by exercising his or her professional judgement, accepting as reasonable. Using the Iterative Proportional Fit (IPF) method for updating matrices of joint distributions, it is possible to update any cell of the matrix based on newly available (i.e., predicted) marginal probabilities. For example, the current joint distribution matrix can be updated to reflect a future distribution by changing the marginal values of the age composition and then iteratively changing all cells of the matrix so that they will correspond to the new marginals. Obviously, the more marginal distribu-

tions predicted independently, the more accurate the revised matrix. The choice of which attributes (marginals) should be predicted independently and which should be updated by IPF is a matter of judgement depending on the user's "comfort" with the quality of the predicted attributes.

It should be clear that the updated joint distribution is only probabilistic and is subject to errors, but it does provide a reasonable basis for identifying future life style groups.

A by-product of the empirical analysis is the assessment of three alternative segmentation schemes. The three schemes are the simple single dimension segmentation based on income, the life cycle-occupation scheme, and the more elaborate and costly life style-based scheme which has been assessed above.

The first is based on the assumption that income accounts for cross-sectional variation in taste. The arguments brought throughout this thesis against the use of income as a sole taste indicator have been partially supported by the "poor" performance of this scheme.

The life cycle-occupation scheme has proved to be very powerful. The two dimensions can in fact be interpreted, as noted earlier, as a simple representation of life style. Each one of them represents, in a loose sense, an array of attributes which have been suggested in this thesis as attributes of life style. This result should support the application of this scheme in future analysis even when analysis funds are limited.

Short of using the methodology suggested in this study for identifying life style groups, one can apply some lessons learned from the structure of the life style clusters as heuristics to segmentation which can be expected to be more sensitive to taste variations than the methods commonly used. It is suggested, for example, that the working status of both heads of a household is an important variable which is often overlooked. With the increase in women's participation in the labor force, and particularly in the career-oriented market, it is plausible to assume that the journey to work as well as other household maintenance trips are allocated between the heads of the household differently if both are employed than if one is only regarded as a "secondary worker".

Another attribute which is suggested for use as segmentation basis is the household type. Although not empirically tested in this research, the theoretical concept developed here suggests that different household types (e.g., family, single parent, single person, unrelated individuals, etc.) practice different life styles which will result in different tastes for various attributes of travel and mobility. The significant growth rate of some of these types justifies the use of this dimension as a partial (i.e., combined with other) basis for market segmentation.

9.2 Policy Implications

The concept of life style as developed throughout this research offers two types of policy implications. One could argue that by virtue of the definition of life style, almost any policy which affects life style would have implications on travel behavior. In observing both current public and private sector policies it is possible to denote many of them as oriented to emerging life styles, although in most cases they are not so labelled. Some prominent examples are new approaches to child care services, legal and other support services to single parent households, services for elderly people, flexible work hours and a host more. What is common to all is the objective of facilitating and accomodating a diversity of life styles which is emerging "in the market place".

In an analysis of policy implications of California's changing life styles Bradshaw and Blakely (1978) point out that "increasing levels of affluence and education create intensified demand for public support facilities and services required by the life styles". Also they point out that new diverse life style groups become organized and can exert political influence and that individuals who attempt to find meaning in new life styles become an interest of the state and obtain its protection. So, in practical terms, almost any public policy has some effects on the way in which people adjust to their preferred life style, for better or worse.

Of interest in the context of this study are the policy implications which may mutually reinforce other public concerns which are on the policy agenda. In this line, policies which would, for exam-

ple, accomodate the demand for high quality central city residences may well have positive effects on central city revitalization and some effects (not necessarily positive) on traffic congestion, energy consumption, and pollutant emissions. Precisely for this reason it is necessary to understand travel demand characteristics of life style groups so that the market place processes may be encouraged, discouraged or accomodated by public policies. An elaboration of the last example will illustrate this matter.

A group of young, career oriented childless professionals has been observed to relocate in the proximity of city centers (see Section 2.1.6). This is definitely a life style group. By identifying the characteristics of its demand for services it can be accomodated by requirement for certain quotas of land use for recreational facilities of certain types, shopping facilities, etc. If demographic and social trends indicate that there is a potential for growth of this group, such public policies may enhance and intensify the relocation trend. The positive effects on central city revitalization resulting from the relocation trend may be reversed if higher congestion levels materialize. This in turn can be accomodated by innovative solutions to central city movement such as auto restricted zones, downtown people movers, etc., only if it is clear that the demand for the amenities of downtown is inelastic enough to attract people out of their automobiles. The amenities of the central cities are mainly the cultural facilities and activities they provide and the specialized services which they provide in terms of leisure activity centers such as the Quincy Market in Boston, Georgetown in Washington, D.C. or Greenwich Village in New York City. These types of amenities are growing attractions but mainly to some specific life style

groups. It is noteworthy here again that the consumers of such amenities cannot be characterized by social status or economic class as well as they are characterized by life styles.

Another example can be drawn from the suburban setting. Suburban women were often described as the family's or the children's "chauffeur" and such constraining commitments prohibited many women from engaging in activities of their own interest, work or other. Providing paratransit services for suburban children (as the bus service in Westport, Connecticut, proved to be) may accomodate for new life styles and new travel patterns for both the mothers and the children. This example is of a case in which the demand is probably existent but it was not accomodated by appropriate solutions.

At a more detailed level some policy implications can be drawn from the empirical analysis performed in this study, although this is done with some hesitation because of the generally low statistical significance of those variables which have policy relevance.

In clustering scheme A, for example, the in-vehicle-travel time and out-of-vehicle travel time coefficients vary considerably (although the significance of these differences was not tested). Assuming that they are different to a statistically significant degree, some policy implications can be drawn. Cluster 1 members assign a negative weight to in-vehicle-travel time which is about 30% greater than that assigned by other segments (which have acceptable t-statistic values) as well as the pooled sample. The members of this cluster have a low rate of transit usage and most of their shopping trips (69%) are to suburban shopping opportunities. Depending on the planner's objectives he or she can devise policies to improve on auto accessibility or, alternatively, to offer paratransit services which will provide service at a level compatible with

the value of time of this particular group.

The weight assigned to walk time (or distance) also varies among clusters, and for all but one cluster the value of the coefficient is about twice the magnitude of the pooled model coefficient. Cluster 1 members assign a negative value of -.103 as compared with -.165 of cluster 5 members, the difference probably being rooted in the age differential. Possible implications of this difference are to improve amenities and safety for walk trips for elderly, under the assumption supported by the out-of-vehicle travel time coefficient that the elderly can practice more flexible schedules and have a relatively low value of time. Simultaneously, the planner may wish to exploit the relatively low negative weight assigned to walk trips by members of cluster 1 and accomodate, through land use policies, a spatial distribution of shopping services which will encourage walk trips.

Another approach to assessing the policy implications of the life based segmentation is by comparing the elasticities derived from the pooled model with those derived from the segmented models. The elasticity with respect to any attribute k for an individual i is defined in the multinomial logit model as:

$$E_i = (1-P_i)\ \beta_k\ Z_k^{li} \qquad (9.1)$$

where: β_k is the estimated coefficient for attribute k, and

P_i is the probability that individual i will choose alternative l.

To demonstrate the difference in elasticity for members of the various life style groups consider the elasticity of choosing a CBD bound

auto trip with respect to in-vehicle-travel time. The point elasticities for five individuals, representing each of the life style groups of scheme B', are summarized in Table 9.1

Table 9.1 Point Elasticities for the Choice of a CBD bound Auto Trip for 5 Individuals

Individual from segment	Elasticity Using Pooled Model	Elasticity Using Life Style Segmentation
1	-3.55	-4.93
2	-3.65	-1.19
3	-1.82	-1.61
4	-5.44	-8.26
5	-2.98	-2.58

The noticeable difference in the point elasticities between the pooled model and the life style segmentation model, specifically for segments 1, 2 and 4, indicates that the behavioral response across life style segments is very different. That difference makes this segmentation scheme useful for analysis of policy options.

These examples demonstrate the type of differential life style specific policy implications which may be drawn from this type of analysis. As the emerging new life styles, which were a motivating source for this study, appeared only in small numbers which did not permit the estimation of models, the more interesting policy implications for the near future could not be inferred. But, as the concept proved viable,

it is now possible to perform small scale surveys which will focus on sampling members of the emerging new life styles.

9.3 Further Research

This study is in many ways an exploration into a new concept. As noted earlier, the theoretical development was carried far enough to offer a framework in which high level behavioral factors can be utilized for purposes of prediction. Yet both the operationalization of the concept and the empirical application deserve further study.

Two directions suggested to be further pursued emerge directly from this research. One is the development of the operational concept and the other is further empirical applications. Two other suggestions are directed to alternative approaches.

In the operationalization of the life style concept two conflicting forces were guiding the choice of variables used for the definition of life style. This conflict focused on the use of time allocation data. The major argument in favor of their inclusion was their instrumental value as efficient and consistent (in the sense defined in Chapter 5) indicators of life styles. On the other hand, their employment is conceptually problematic as they are a component of the dependent variables which are to be explained by life styles. In addition, two pragmatic problems arose - the fact that their measurement involved a large error and that they are not always available in the required detail in commonly used disaggregate data sets.

Clustering the data while totally excluding the time allocation data resulted in clusters which were somewhat less satisfactory in terms of identifying assumed life style groups, although the obtained structure did perform well in explaining the choice behavior.

Ideally, one would like to identify a set of attributes which is obtainable through commonly used data collection methods and which correlates well with time allocation patterns or life styles. To proceed in this direction it is suggested that models be estimated in which the dependent variable would be allocation of time to various categories of activities and the explanatory variables would be socio-economic and demographic variables. The time allocation data should be based on diary data for a period of at least a week. Such data sets are available and, despite the fact that long term diaries suffer from errors due to attrition in response rate, they may serve better than a single day's observation. (Alternatively, a single day's observation can be used if in the questionnaire design information about frequency of participation in activities is properly incorporated.)

Among the explanatory variables it is suggested to search and define variables which are sensitive to the new emerging life styles, such as the relative contribution of earning among members, household types, availability of child care, availability of flexible schedules, etc.

Once such models are established, future data collection efforts can be designed to include the relevant "new" variables and a set of commonly available variables which, when combined, will hopefully identify life style groups.

The second direction for research is the application of the concept to other choice situations. It was assumed that the effect of life style varies across different choice situations and, due mainly to logistical considerations, the choice of mode and destination for shopping trips was selected for testing the hypotheses and for the prototypical applications. A suggestion is made to test the hypotheses in the context of those choice situations in which the relevance of taste variations plays a larger role. Specifically, the choice of residential location in view of the emerging trend of relocation in the central city seems to be an interesting candidate for such an application. This application may indicate some policy implications which advocates of either central city revitalization, energy conservation or environmental causes may pursue.

A different direction for research in the longer run is attempting to identify variations in life style as a function of attitudinal data. This involves reaching into a territory which, by the premise of the current study, was excluded. Yet there is undoubtedly some explanatory power in these attributes. If, similar to what was suggested above for the time budget, reasonable correlates for the attitudinal variables can be identified by commonly used data collection methods, then without direct use of attitudinal data some new aspects could be uncovered. I view this approach as highly speculative yet it may be worth exploration.

Yet another approach suggested for research is what can be labelled the supply-side approach. Consistent with the nature of the concept of

life style as an attribute of an individual which relates to his or her personality, orientations, and aspirations, this study focused on the "demand side" of life style. The constraints within which life styles are evolving were viewed in a narrow sense (time commitments or economic constraints) or in a loose sense as relating to the social context in which the individual lives. But, the constraints can also be viewed in another way, as "supply attributes" to life style choices.

In the context of policy analysis, understanding the effect of specific policy measures on life styles is of special interest. For example, what would be the effects on life styles of a significant change in the working schedule due to energy shortages? Having some understanding of the demand side of life style it may be possible to predict changes in behavioral patterns for each life style group. Carried further, it may be possible to devise policies so that patterns of behavior will be affected in a desired manner, e.g., the possibly larger blocks of time devoted to leisure will be accomodated by mixed facilities which will not require long rides and could serve all household members simultaneously.

Another example of interest in the context of this study is what could be the effect of an increase in the supply of high quality central city apartments on life styles? Consider the possibility of a supply which exceeds the demand by the particular groups which currently seek such accomodations. Would additional groups make use of such housing or would it only facilitate the growth of the groups currently demanding it?

Although the current understanding of the life style choice is limited and therefore it is not clear how one should approach the supply side studies, recognizing the existence of such effects in future research, and possibly studying it in a later stage seem to be warranted.

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Appendix A

The number of cases in clusters and the reallocation of cases as a function of the number of clusters
(arrows mark changes in cluster composition)

Number of clusters	Number of cases											
5	36		10	36		51			67			
6	36		10	36		51			65			2
7	36		10	36		45		70			1	2
8	36		10	35		40	29		47		1	2
9	38		10	33	8	37	28		43		1	2
10	12	27	10	33	8	35	28		44		1	2
11	19	18	10	33	8	29	15	27		38	1	2
12	19	18	10	33	8	29	15	17	11	37	1	2

Note the early identification of some small clusters which are outlying cases.