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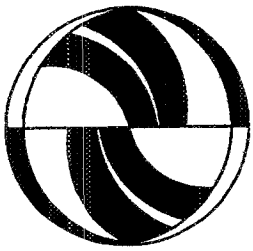

Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning

Randall Crane

Working Paper
UCTC No 239

The University of California
Transportation Center

University of California
Berkeley, CA 94720

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Cars and Drivers in the New Suburbs: Linking Access to Travel in Neotraditional Planning

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Abstract
Various 'new suburb' land use designs have recently been proposed to address a number of social and environmental problems, including the dominance of automobile travel Transportation benefits are to be accomplished by reducing the surface street distance between locations, mixing land uses, and promoting walking, bicycling and transit via redesigned streets and street-scapes That auto travel will fall is a largely unchallenged premise of these designs, though what little evidence exists is either weak or contrary. This paper presents a simple behavioral model to explain why. Generally speaking, driving is both discouraged and facilitated in the new suburbs, with the net effect being an empirical matter. In particular, both the number of automobile trips and vehicle-miles traveled can actually increase with an increase in access, such as a move to a more grid-like land use pattern. Whatever the merits of neotraditional and transit-oriented designs, and there are many, their transportation benefits have thus been oversold. Each development must be evaluated on a case by case basis to determine whether its net impact on auto use is positive or negative An analytical framework for doing so is suggested.

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"A street is a street, and one lives there in a certain way not because architects have imagined streets in certain ways" (Culot and Krier, 1978, p 42)

1. Introduction

Planning practitioners and traffic engineers are increasingly enamored of a new and little studied school of urban design. Often lumped under the umbrella label of Neotraditional Town Planning, these ambitious efforts have accepted the challenge of rethinking the relationship between form, scale, and movement in modern suburban environments The most visible proponents have been architects, especially the Miami team of Andres Duany and Elizabeth Plater-Zyberk (1991, 1992), best known for their work on the community of Seaside, Florida, and San Francisco-based Peter Calthorpe (1993), the author of the 'pedestrian pocket' concept.[1] While the proposals and projects differ in many respects, they share an emphasis on establishing a sense of community often missing in newly developed neighborhoods, in large part by mixing land uses and getting people out of their cars and onto the street The street pattern has played a central role in many of these designs and discussions, and a growing number of policy documents embrace a grid-like layout as a direct means of reducing automobile travel. The grid has thus experienced a rebirth of sorts, in part because it is perhaps the single 'new suburb' feature most compatible with both standard subdivision regulations and traditional practice (Reps, 1965, Ryan and McNally, 1994). The problem for planners and residents alike is that transportation problems may worsen rather than improve as a result. This paper argues that while many elements of the new designs likely do discourage driving for some kinds of trips, the aggregate effect is uncertain

It is easy for neotraditional complaints regarding cars and neighborhood form to get our attention. Cars do pollute the air and eat up our time, whatever their overall value in a mobile society They likewise tend to monopolize the 'public space' of the street, historically a key element of the social fabric (Appleyard, 1981, Lynch, 1981; Kostof, 1992) Even freshly built neighborhoods seem to lack charm, and perhaps in certain respects functionality as well. In place of the friendly front porch of older times, for example, the main exterior feature of new residential developments is most often the garage door (Southworth and Owens, 1993). It can be difficult to argue that many new developments possess true 'neighborhoods' in the social sense, as there is little in their physical surroundings to link residents privately or publicly beyond broad streets and the common architectural theme of their homes.[2]

The new proposals are also quite amiable. They are easy on the eyes, for one thing, and self-

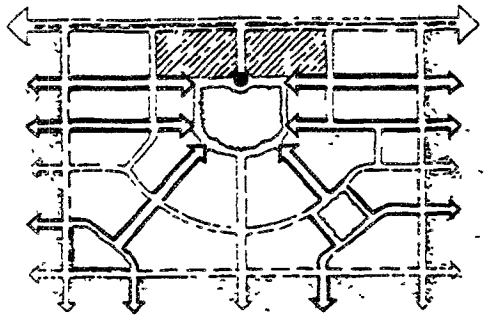
consciously familiar To coax people to walk more, the designers realized that neighborhoods must be more pleasant to walk through and destinations must be closer A major contribution of the path breaking work in this field was to recognize that the prototypical New England or Southern small town fits the bill quite well [3] Some survey evidence suggests that many suburbanites prefer to live in such towns, or at least in communities resembling them (Inman, 1993), and this is more or less what neotraditional plans try to deliver A physical environment inviting neighborhood interaction, rather than obstructing it, and land use and street patterns permitting more travel by foot, all in a manner and appearance consistent with our collective sense of the traditional small town.[4] In principle, the new designs thus confirm, rather than challenge, how many people feel about where and how they would like to live

The impacts of such thinking on professional practice have, roughly speaking, followed two lines One is principally 'architectural' in the sense that design and scale elements dominate. The community of Seaside, for example, is justly noted for the clapboard beauty of its homes, white picket fence character, and weathered old-town feel, though it is barely ten years old (Dunlop, 1989, Mahoney and Easterling, 1991) The look is sensitive to local context, however The newer and larger Duany/Plater-Zyberk project of Kentlands, in Gaithersburg, Maryland, is based on the mid-Atlantic look and feel of Annapolis and Georgetown In addition, Calthorpe has stressed the importance of bringing human scale not only to individual housing tracts, but also to the linkages between residential and commercial activities (Calthorpe, 1993). The renewed emphasis on front porches, sidewalks and common community areas as spatial focal points are the most visible examples, as well as the half-mile wide 'village scale' of each community The last feature is strongly reminiscent of the 'neighborhood unit' approach to planning first popularized in the 1920s and 1930s (Perry, 1939, Dahir, 1947, Banerjee and Baer, 1984)

The second major area in which these designs have found popular acceptance is transportation policy Public complaints regarding automobile congestion and air quality have left planners intensely receptive to new ways of reducing car use, yet their options are limited. Mass transit is ballooning in cost, and conventional transportation planning strategies have not changed the affection most people continue

Illustration 1: Seaside, Florida (Photo: Xavier Iglesias, © Duany/Plater-Zyberk)

Illustration 2: Photo of Laguna West, California (Photo: Calthorpe Associates)



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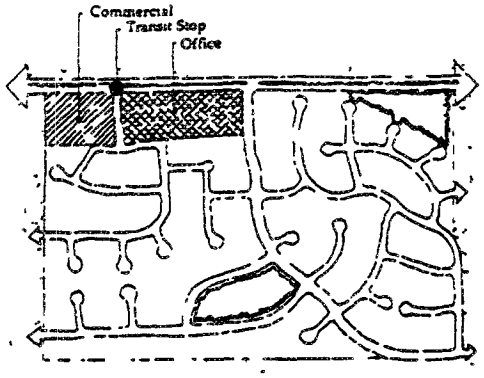


Discouraged

Guideline 1J:

STREET AND CIRCULATION SYSTEM

The TOD street system should be clear, formalized, and inter-connected, converging to transit stops, core commercial areas, schools and parks. Cul-de-sac and "dead end" streets should be avoided or connected by pedestrian passages and/or bicycle paths. Multiple and parallel routes between the core commercial area, the TOD, and surrounding Secondary Areas must be provided so that local trips are not forced onto arterial streets.

Illustration 3: Pedestrian Pocket vs. Standard Development Design

From "Transit Oriented Development Guidelines," p. 18, City of San Diego (1992), Calthorpe Associates.

to feel for their cars (Giuliano, 1989, Deakin, 1991, Wachs, 1993a, 1993b) A fundamental change in land use patterns is seen as a potentially more promising tool, and this idea has found its way into an increasing number of public planning and policy documents aimed at improving air quality via land use/transportation linkages (e.g , see San Diego (1992), Los Angeles (1993) and San Bernardino (1993)). Perhaps the most typical transportation feature of this new design trend has been a grid-like street layout, in contrast to the conventional 'loopy' cul-de-sac pattern The main intent is to shorten trip lengths for pedestrians as well as increase community legibility [5] The conclusion that auto travel will decrease in more compact and grid-like land use developments is so appealing it has been reported as a virtual fact in virtually all discussions of neotraditional design principles.[6] The strong appeal of neotraditional planning is that in some respects, then, it kills two birds with one very attractive stone

This paper focuses on the conventional neotraditional wisdom that a return to a grid circulation pattern has unambiguous transportation benefits The popularity and growing influence of these planning theories on community transportation and land-use policy justifies the attention, especially since what little evidence exists regarding the transportation benefits of the grid pattern is weak at best, and contradictory at worst. As shown in the following section, the most consistent empirical finding has been that a change in land use increasing 'access', measured any number of ways, invariably leads to shorter trips — a result following essentially by definition. A measurable impact of access on induced behavior, such as trip frequency, mode split or total travel has proven more elusive In some cases, trip frequency has risen with improved access rather than fallen In other instances, variation in access has had no measurable effect on travel patterns other than average trip length.

The discussion and analysis below offer both an explanation for these somewhat contrary results and a framework for consistently evaluating the net travel impacts of changing land use patterns, such as the new suburban designs. Generally speaking, neotraditional designs in part both promote and discourage auto use, with the net effect being mixed. The analysis suggests the generic transportation benefits of neotraditional and transit-oriented designs have been oversold, and that each development must be carefully evaluated on a case-by-case basis to determine whether its net impact on auto use is

positive or negative

Note the paper does *not* argue that neotraditional or transit-based urban and suburban designs are wrong headed. On the contrary, it is easy to be enthusiastic about the thoughtful and imaginative ways they provoke planners to rethink the physical and aesthetic organization of both residential and mixed-use space. Neither does the paper imply these plans necessarily lack transportation benefits. Rather, it demonstrates that such benefits are not self-evident, depending as they do on the particular mix of features in each development The primary purpose of this paper is to identify the source of the misunderstanding, and suggest a framework for evaluating the various design features by measuring their net benefits more reliably

The story has two main parts The next section reviews the literature on the transportation benefits of neotraditional designs, concluding that past work is either incomplete or problematic While these designs are typically promoted as having transportation benefits in every element, the evidence is mixed at best The following section then clarifies how street patterns affect travel behavior, and what that implies for efforts to measure the transportation benefits of new suburbs An appendix contains a more detailed presentation of the main argument, adapting the intuition to a specific empirical framework

2. Streets, Travel and Access: The Literature

The promise of nearly all new suburban design strategies has included a reduction in automobile use (e g , Duany and Plater-Zyberk, 1992, Calthorpe, 1993) This is to be accomplished by reducing the surface street distance between locations, mixing land uses, and supporting alternative transportation modes such as walking, bicycling and transit In many cases, a narrowing of streets and changes in the street-scape to reduce auto access and build at a more human scale are also plan components The intent is to increase the interaction of residents by increasing pedestrian traffic, as well as to reduce air pollution and traffic congestion problems Neotraditional designs thus often feature elements of both transit-based and grid-like circulation patterns, which make more efficient use of neighborhood streets and improve overall neighborhood access

A principal goal in each case is to move many trip destinations within walking distance to homes The higher densities and increased mixing of land uses accomplishing this also allow individuals to accomplish more with each local trip. The thinking is that these elements, alone and in tandem, will

encourage people to walk more and so enjoy their neighborhoods more (See the accompanying diagrams and photograph of the circulation patterns in Seaside) In some cases, these features are expected to encourage increased use of transit for commuting, which also involves pedestrian travel to and from transit stops and stations In either instance, it is typically assumed that residents will both take fewer trips and drive fewer miles overall (Calthorpe, 1993, Duany and Plater-Zyberk, 1992).

The available evidence on these questions is difficult to synthesize, as the literature commonly addresses aesthetic, social and transportation issues simultaneously In addition, the various design types grouped under the rubric of Neotraditional Town Planning differ in fundamental respects, often making generalizations about the style as a whole inappropriate. As our interest is with transportation issues, the following discussion focuses on those design attributes meant to influence travel At the risk then of ignoring some distinguishing traits, and overemphasizing others, we characterize 'new suburb' designs as those attempting to influence travel behavior in at least three ways.[7]

- Land uses will be better integrated, thus reducing the number of trips,
- The effective travel distance between any two points will fall, and
- Pedestrian- and transit-oriented features will be promoted over car-oriented features

The success of the first of these will clearly depend on a number of factors, including the compatibility of both land uses and trip purposes. This 'mixed-use' argument is straightforward, and the paper does not address it.[8]

Rather, the paper sorts out the behavioral impacts of the last two features regarding the travel impacts of changes in circulation patterns. Two problems with these arguments are immediately apparent Available supportive evidence is scanty, and most studies are grounded on either questionable assumptions or comparisons of dissimilar communities Studies of actual neotraditional developments have not been published, as few developments are fully built out at this time Hence, even careful quantitative evaluations tend to be based on either hypothetical situations, as in the case of engineering simulations, or data obtained from older 'traditional' communities sharing some characteristics with

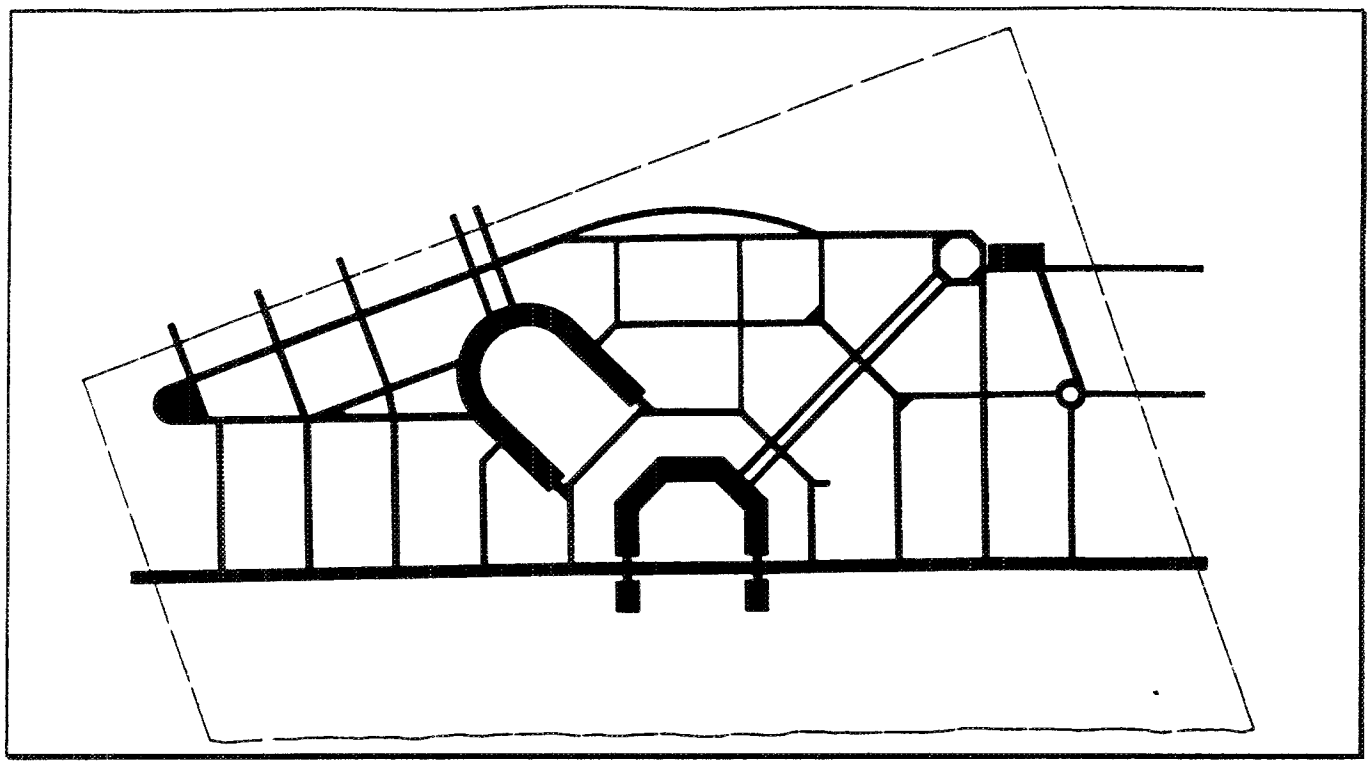


Illustration 4a: Street Network, Seaside Master Plan (Duany/Plater-Zyberk)

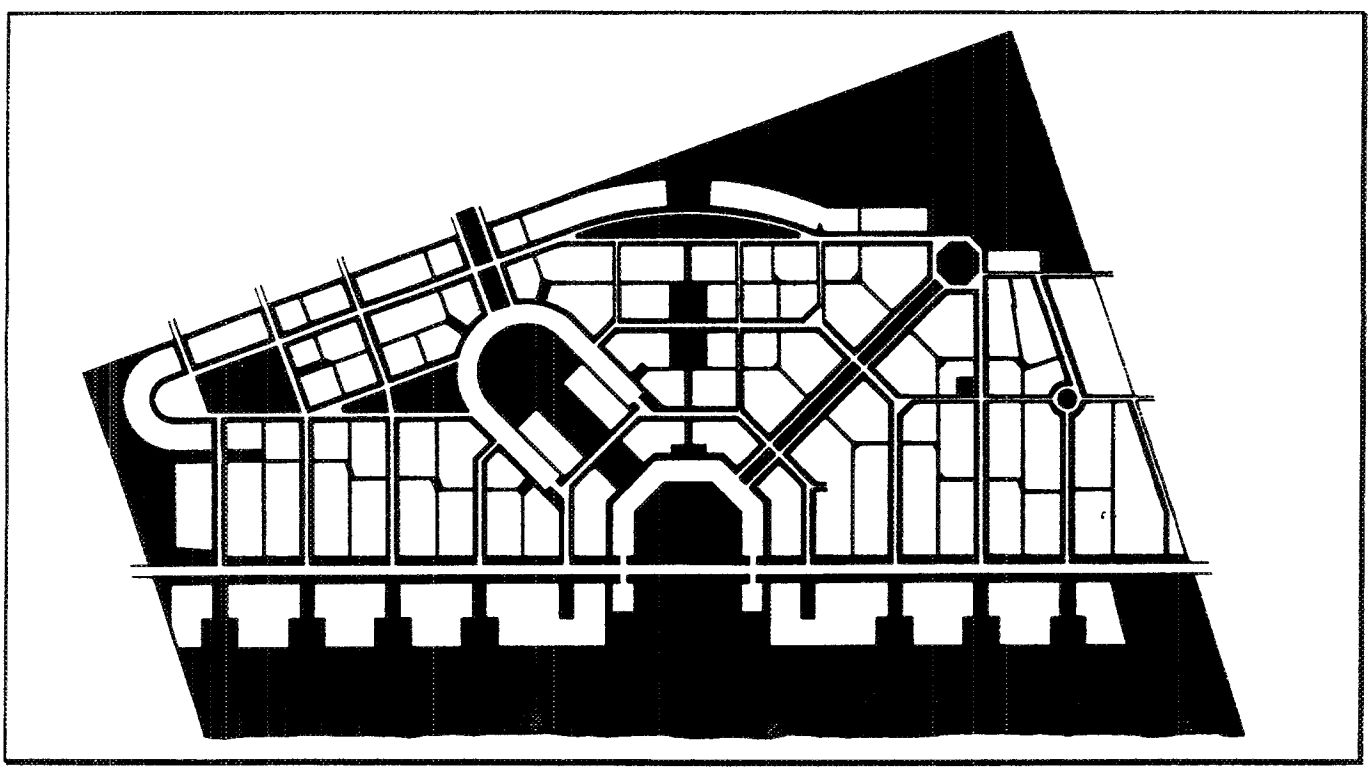


Illustration 4b: Pedestrian Network, Seaside Master Plan (Duany/Plater-Zyberk)

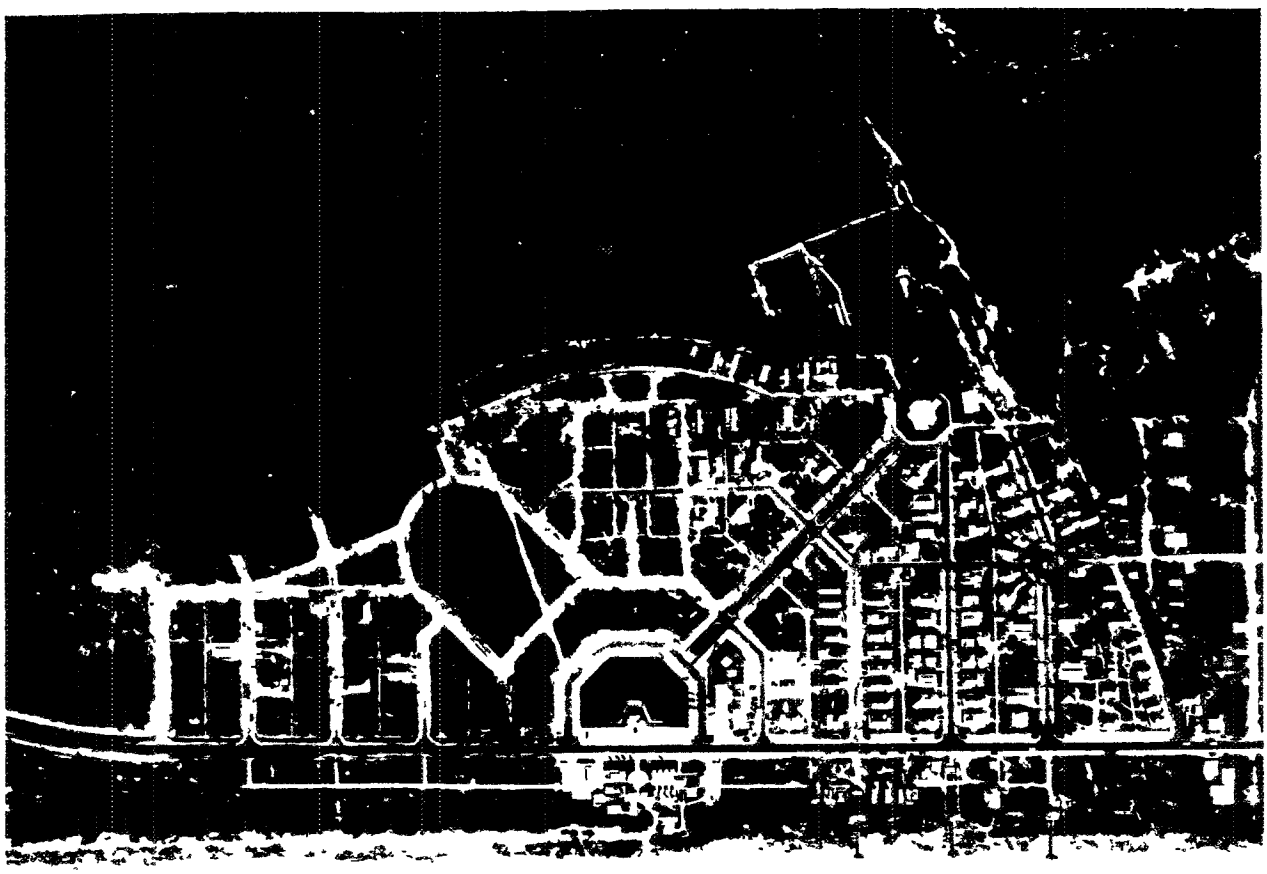


Illustration 4c: Aerial Photo of Seaside (Photo: Michael Moran)

proposed 'neotraditional' communities The three methodological approaches used thus far include Simulation studies, descriptive studies, and analytical studies based on observed behavior Those studies supportive of the 'grid patterns reduce car use' result tend to have serious flaws, such as assuming trip frequencies do not vary from one design to another or failing to isolate the independent influence of the street pattern on travel behavior They are briefly reviewed below

Simulation Studies

Peter Calthorpe's (1993) assertions regarding the transportation benefits of his suburban designs depend heavily on a simulation study by Kulash, Anglin and Marks (1990) finding that traditional grid-like circulation patterns reduce vehicle miles traveled (VMT) by 57 percent compared to more conventional networks. The usefulness of this result is limited, however, as the authors assume trip frequencies are fixed. They also assume average travel speeds are slower in a grid-based network, which in turn requires nonstandard street design standards Calthorpe (1993) and Duany and Plater-Zyberk (1992) often mention their desire to slow cars down, via narrower streets and reduced parking, but not all designs do — particularly where they must comply with conventional traffic engineering standards

The more elaborate simulation studies of McNally and Ryan (1993) similarly report less driving in a rectilinear grid street system, yet they also assume trip frequencies are unchanged. As a consequence, the result more or less follows directly from the statement of the problem As you move trip origins and destinations closer together, which the grid system does, the length of the trip must decrease The unanswered question is whether the number of trips is also affected by the change in trip length The lack of a transparent behavioral framework, a problem shared by most engineering simulations, and the neglect of trip generation issues makes the conclusions of both sets of studies difficult to assess

Descriptive Studies

Another study often used to document the transportation merits of traditional or neotraditional street patterns is the descriptive work of Friedman, Gordon and Peers (1992). While their work is not analytical, it does have the dual advantage of addressing the question of trip generation and being based on actual behavior, rather than simulations. Working from household travel surveys in the San Francisco Bay Area, the authors categorize the observations into either 'Standard Suburban' or 'Traditional',

depending on whether each area possessed a hierarchy of roads and highly segregated land uses (the former) or had more of a street grid and mixed uses (the latter) They then compared travel behavior in the two groups Average auto trip rates were about 60 percent higher in the 'Standard Suburban' zones for all trips, and about 30 percent higher for home-based nonwork trips It is impossible to separate out the relative importance of the many differences between the groups of communities, however, and thus to identify how much of the observed behavior is influenced by the street configuration alone. The 'Traditional' areas included those with employment and commercial centers, and with close proximity to transit networks servicing major employment centers, such as downtown San Francisco and Oakland

In a qualitatively similar kind of comparison, but one restricted to residential neighborhoods of similar ages and other characteristics, Handy (1992b, 1992c) found survey evidence that more grid-like communities in the San Francisco Bay Area generated more local automobile trips rather than fewer She also provides limited evidence that VMT are greater in traditional areas for certain types of trips, but without much explanation. In addition, while the number of walking trips per survey respondent was highest in neotraditional-type communities, "it could not be determined whether these walking trips replace or are in addition to driving trips" (Handy, 1992c, p 266). The relationship between different types of trips remains unclear in these simple comparisons of average trips per day per person, by mode, across communities broadly characterized as traditional or modern. (Handy also estimated models of pedestrian behavior for her sample, but with little success.)

Analytical Studies

Holtzclaw (1994) recently examined the issue somewhat more directly, by measuring the influence of neighborhood characteristics on auto use and transportation costs generally The neighborhood characteristics used in the study are residential density, household income, household size, and three constructed indices· 'Transit accessibility', 'pedestrian accessibility', and 'neighborhood shopping'. These are in turn used to explain the pattern of two measures of auto use: the number of cars per household, and total VMT per household. The data are from the 1990 U S Census of Population and Housing for 28 California communities. The reported regression coefficient on density in each case is -0.25, suggesting that doubling the density will *reduce* both the number of cars per household and the VMT per household by about 25 percent. The results also argue that a doubling of 'transit access', defined as the number of bus and

rail seats per hour weighted by the share of the population within a quarter-mile of the transit stop, will reduce the number of autos per household and the VMT per household by nearly 8 percent Changes in the degree of 'pedestrian access' — based on street patterns, topography, and traffic[9] — or 'neighborhood shopping' had no significant effect on the dependent variables in this sample, however The street configuration is only one component of the pedestrian access measure, so this result does not in itself imply that a more grid like pattern has no impact on VMT or number of autos

A 1993 study of Portland, Oregon, is similar in approach to the Holtzclaw report, but has the advantage of using household level survey data (1000 Friends, 1993) The analysis also attempts to explain the pattern of VMT, as well as the number of vehicle trips, using household size, household income, the number of cars in the household, the number of workers in the household, and constructed measures of the 'pedestrian environment', 'auto access' and 'transit access' The auto and transit access variables were defined as simple measures of the number of jobs available within a given commute time: 20 minutes by car and 30 minutes by transit. As an example, an increase in 20,000 jobs within a 20 minute commute by car was estimated to reduce daily household VMT by half a mile while increasing the number of daily auto trips by one-tenth of a trip The same increase in jobs within a 30 minute commute by transit reduced daily VMT a bit more, at six-tenths of a mile, and decreasing the number of daily car trips by one-tenth of a trip

The pedestrian access variable was more complex, based on an equal weighting of subjective evaluations of four characteristics in each of 400 zones in Portland. Ease of street crossings, sidewalk continuity, whether local streets were primarily grids or a cul-de-sacs, and topography The final score for each zone ranged from a low of 4 to a high of 12, with 12 being the most pedestrian friendly The regression model reported that an increase of one step in this index, from 4 to 5 say, decreased the daily household VMT by 0 7 miles, and decreased the daily car trips by 0.4 trips These point estimates are used to predict the impacts of changes in the independent variables, such as access to employment by transit. Although this result is consistent with the theory that more pedestrian friendly and transit oriented development will reduce both car trip frequency and overall auto travel, it does not directly measure the effects of street patterns. The difficulty is that the impacts of a grid over an alternative street pattern is not separated out from the 'sidewalk', 'street crossing' and topography variables.

In a related look at how access affects trip generation within urban areas, Hanson and Schwab (1987) present evidence for Sweden that better access, measured as more retail and service establishments within a

specified distance, decreases the proportion of trips by automobile However, they found little or no influence of access on overall trip frequency, and hence on VMT Another set of studies looks at the impact of residential densities and development near transit stations on transit ridership. These are summarized in Cervero (1993, 1994) and Holtzclaw (1994), and mainly conclude that people are more likely to make use of transit the closer stations are to their home and where they work Thus, transit ridership is positively related to the density of both residential developments and employment sites near stations

In sum, the studies measuring both trip frequency and VMT in grided communities have found that auto use is either higher or no different than in comparable nongrid settings (Hanson and Schwab, 1987, Handy, 1992b, 1992c). Most other work has *assumed* trip frequencies fall or do not change, or the data are insufficiently disaggregated In virtually each case, a straightforward framework for sorting out the independent effects of each component of neighborhood design on travel behavior is lacking All three groups of studies have lumped several design and travel characteristics together, making conclusions about the travel properties of individual street and neighborhood design features impossible to isolate. The clearest pitfall is the failure to separate out the effects of a grid-like circulation pattern, which in principle increases access for both cars and pedestrians, from the effect of street width and street-scape features explicitly intended to slow cars and reduce traffic The next section clarifies this first point, how more access can lead to more travel in all modes. In so doing, the discussion identifies the main behavioral parameters designers should account for in their plans.

3. Measuring the Travel Impacts of Improved Access

This paper offers both an explanation for these somewhat contrary results and a framework for consistently evaluating the net travel impacts of changing land use patterns, such as the new suburban designs The main result is simple, and well known to transportation analysts in other contexts (e g , Domencich and McFadden, 1975; Wachs, 1993b), yet has been inexplicably overlooked in past evaluations of the transportation benefits of neotraditional plans Any neighborhood configuration of land uses and street patterns improving local access will also increase trip frequencies, perhaps enough to increase overall travel. The consequence is that a change in land use improving community access, even if transit- and pedestrian-oriented access improve the most, may not reduce auto travel In contrast to the conventional wisdom, it may well increase it Moreover, even if travel by car falls with improvements in

access, ignoring the higher trip frequency associated with more open circulation patterns is misleading as it overstates the potential transportation benefits of the design

The literature on the transportation impacts of neotraditional design has yet to employ a strong conceptual framework when investigating these issues, making both supportive and contrary empirical results difficult to interpret. In particular, an analysis of trip frequency and mode choice requires a discussion of the *demand* for trips, but this is often lacking in land use studies at even a superficial level That approach would permit us to explore the behavioral question, for example, of how a change in trip distance influences the individual desire and ability to take trips by each mode The tools of microeconomics provide perhaps the most straightforward framework for such a discussion, by emphasizing how overall resource constraints enforce tradeoffs among available alternatives, such as travel modes, and how the relative attractiveness of those alternatives in turn depends on relative costs, such as trip times (e g , Domencich and McFadden, 1975)

The discussion below abstracts from the many other aspects of this topic to address the effect of improved access on travel distance, trip frequency, and mode split. Three sets of assumptions focus the analysis on the questions at hand:

- 'Access' is interpreted solely as a price or cost characteristic, related to trip length [10]
- Travel behavior is described by a standard microeconomic model of individual demand.
- New suburban designs are assumed to reduce the distance required to make any local trip

In a sense, the last assumption characterizes these designs as a compression of existing land use patterns which, most particularly, shrink the effective travel distances between potential nodes. Compared to an alternative design, this improvement in access has three somewhat countervailing effects. It reduces the absolute cost of a trip in each mode, it may change the relative cost of each mode, and it increases the purchasing power of any individual making that trip by freeing up time and money resources Although the literature on neotraditional design has tended to suggest otherwise, the first and third of these will typically increase the demand for trips in all modes rather than reduce it.[11] The second may or may not The presumption would be that pedestrian travel could become more attractive in comparison with driving than before, through the design of better pathways and so on.

As benchmarks, the potential effects of the price changes on mode choice are illustrated in Charts

1, 2 and 3 for trips by car and by foot [12] For any given trip frequency these plot the cost of a trip, for some unspecified purpose, against trip length This cost summarizes all the relevant features of the trip, including the aesthetic aspects so critical to the neotraditional planners The purpose of the trip has obvious implications for the relative merits of walking and driving, and how those merits vary with the length of the trip As often noted, people rarely walk to the grocery store when they can drive. Each chart assumes that the marginal cost of travel is everywhere rising, both the total trip cost and the marginal cost of walking are initially lower than for driving, and the cost of walking rises more quickly than for driving Hence people will tend to walk for short trips, and drive for longer trips, all things considered. These idealizations are intended only to clarify how access can influence the means of travel

Chart 1 presents an initial situation, wildly simplified for the sake of legibility For short trips, walking is the preferred mode. When the cost of (or time required for) the trip gets to a certain point, however, this person prefers to drive. In the example, that cost is labeled α and corresponds to a trip of length δ. For trips of distance δ or more, say one quarter of a mile, it is less costly overall to drive and the car becomes the best mode The lower envelope of the two total cost curves is the mode demand curve at any distance.[13] Hence, any change in land use patterns that reduces trip length from above to below δ will substitute pedestrian traffic for automobile traffic, for this trip.

By characterizing the change in land-use patterns as a decrease in the cost of a trip to a certain distance, the relative attractiveness of driving versus walking depends on the relative change in the cost of each Charts 2 and 3 illustrate two such cases. The cost of traveling any given distance decreases for both modes in each example. An asterisk denotes the post-improvement trip cost, so that walking trips to any distance have fallen from a cost of w to w^*. In Chart 2, the pedestrian cost falls the most at any distance, so that the trip length where modes change (δ^*) becomes longer, i.e , $\delta < \delta^*$. For any given number of trips, the mode split now features more trips by walking and fewer by car than before. This is consistent with the work on pedestrian travel by Untermann (1984), Guy and Wrigley (1987), and 1000 Friends (1993), all of whom show that walking trips rise with an improvement in pedestrian access

CHART 1· A COMPARISON OF THE COST OF WALKING AND DRIVING BY TRIP LENGTH
In this example, walking is the least cost mode for trips shorter than δ miles.

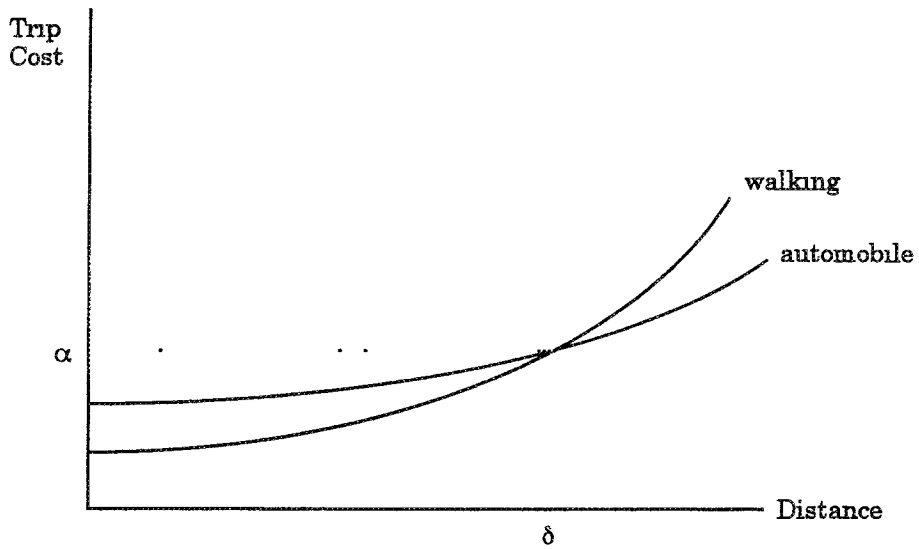
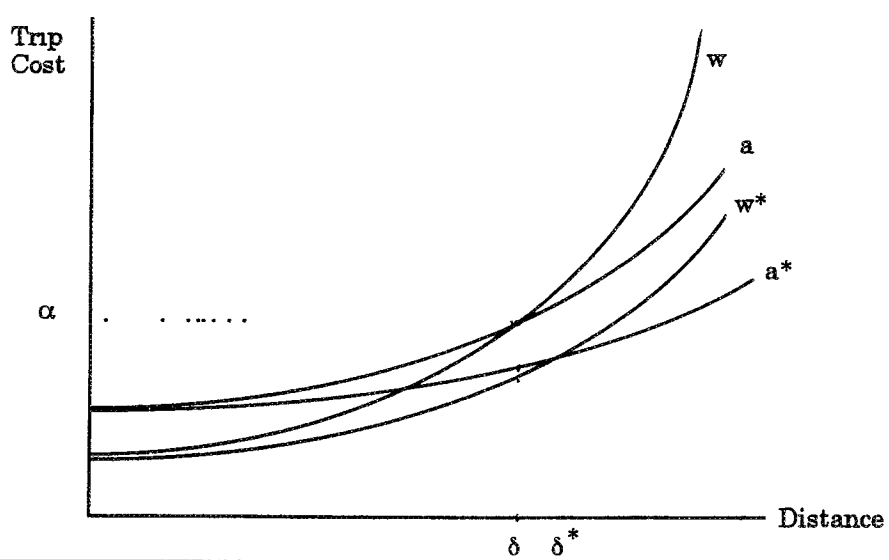


CHART 2: THE NEW SUBURB — TRIP COSTS FALL FOR BOTH MODES.
An example where auto travel costs fall less than walking costs,
so maximum walking trip length rises from δ to δ^*



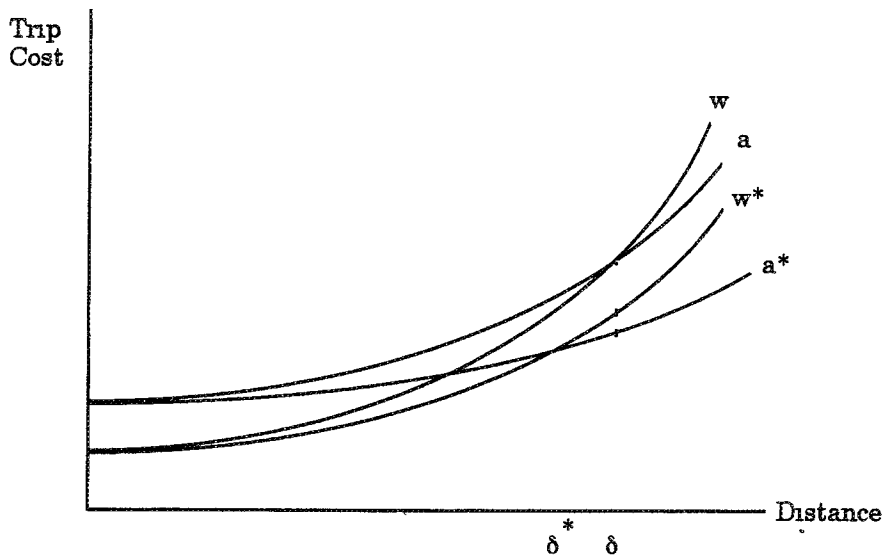
This is not the only possible outcome, however New suburban designs also promise to improve circulation and reduce congestion for automobile travel, and designers have rarely if ever explicitly compared how these improvements compare with the value of pedestrian-oriented features of the community It is possible that the grid-like circulation pattern characteristic of many neotraditional designs could generate the result shown in Chart 3, where a reduction in street congestion and other changes lower per-mile auto travel costs the most In some instances the change in automobile circulation is the focus of the design.

The other implication of new suburban design which can be suggested in these simple diagrams is that the length of a particular trip — e g , to the bookstore or the park — will decrease, regardless of which mode is used and however trip length is measured. Better access leads to shorter trips in each mode

While many of the travel-oriented components of neotraditional neighborhood designs are aimed at encouraging pedestrian and transit travel, they often also include changes in street patterns which will reduce the distances required to drive between locations. Will this lead to more walking and less driving, as promised? The charts above suggest the net impact on mode choice is ambiguous, except where the (time and money) cost of non-auto modes are reduced the most. What cannot be easily answered with these figures is the impact of improved access on total trip generation, and thus on the total amount of travel by mode. Depending on how relative access changes, more trips are likely generated in some modes, including possibly car travel. Even in those cases where better access translates into a shift from cars to pedestrian travel for preexisting trips, new trips by car may result in response to the lower cost per trip. Whether the total level of driving — trip frequency times trip length — rises or falls therefore depends on how these two components compare. If the number of automobile trips increases by more than average trip length declines, a result opposite to the neotraditional promise is obtained

The Appendix presents a formal argument identifying the basic tradeoffs that make the impact of neotraditional street patterns on auto use ambiguous. That analysis examines the effect of a decrease in

CHART 3. An example where per-mile auto costs decrease more than walking costs, so maximum walking trip length falls from δ to δ^*.



trip cost on automobile trips, on walking trips, on miles traveled by automobile, on miles traveled walking, and on aggregate travel However, the main idea can be presented somewhat more plainly as follows A change in the time required for a trip by any particular mode may affect the number of trips desired in all modes. It does this in two ways By affecting the relative cost of a trip in each mode (in economic terms, the 'substitution' effect), and by affecting the remaining time and money available for travel (the 'income' effect) A reduction in the time and convenience required for a trip by foot will both increase the attraction of walking versus other modes, while it also increases the amount of time available for travel by all modes (Handy, 1991). As it becomes easier to walk, owing to a better system of walkways, shorter distances, better landscaping, etc , we thus expect people to substitute walking trips for car trips. Put another way, we usually expect the substitution effect to dominate, so the demand curve for travel by any given mode is downward sloping Indeed, this possibility is often mentioned as the predicted outcome of the grid-like land use patterns associated with neotraditional neighborhood design.

The conventional assessment ignores a critical part of the story, however. Perhaps the main point of this paper is that this same argument applies to travel by car The increase in access associated with neotraditional neighborhood design typically reduces the cost of travel for <u>all</u> modes. A move to a grid-like street pattern will shorten the driving distances between any two locations, thus reducing the time and effort required for each trip by car. As neotraditional planners have pointed out, this will reduce the length of each trip. However, it follows from our characterization of travel demand that people, in the aggregate, will also take <u>more trips by car</u> This part of the result is unambiguous. The indeterminate part of the story is whether they take enough new trips to more than offset the shorter trip length, resulting in more travel overall. This outcome depends on how individuals assess the importance of trip length, and overall access, on trip frequency. Not only will this evaluation differ from one individual to another, it will critically depend on other characteristics of the land use and circulation environment Hence, a change in land use that improves community access overall <u>may or may not reduce auto travel</u>.

Within the evaluative framework of neotraditional planning, the impact of a time savings on car trip demand is thus theoretically indeterminate. An increase in accessibility both encourages and discourages automobile travel in part, leaving the net effect impossible to determine *a priori*. As shown in the Appendix, the number of trips by car is more likely to rise with a decrease in the time per trip the larger is the magnitude of the substitution effect relative to the income effect. In the special case where

the compensated cross-price elasticity of demand for car trips is zero, which involves unlikely restrictions on travel preferences, the number of desired auto trips will unambiguously rise with an increase in access. It will also rise so long as the substitution effect remains sufficiently small If trip demand is sufficiently price-elastic or the cross-price elasticity is sufficiently positive, however, automobile travel will fall. The substantive point of this paper is that the magnitude of these elasticities will depend on local circumstances, such as the availability of close substitutes for car travel, and cannot be stated generally

4. Closing Remarks

The increase in access associated with neotraditional neighborhood design typically reduces the cost of travel for all modes All things considered, people will likely take more trips They could take enough new trips to more than offset the shorter trip length, resulting in more travel overall A direct consequence is that a change in land use and street configuration improving community access, even if transit- and pedestrian-oriented access are improved the most, may or may not reduce auto travel. It may well increase it, particularly if the demand for auto travel is relatively price-elastic and/or income-elastic Even if car travel falls with access, ignoring the higher trip frequency associated with more open circulation patterns is misleading, and thus overstates the potential transportation benefits of the design

Careful empirical study of these issues is surprisingly rare It is tempting to conclude that many urban designers and transportation planners have taken the neotraditional argument at face value, at least with respect to travel impacts. If true, the assessment is premature, as available analyses offer little conclusive evidence that 'new suburban' planning influences travel behavior in any way other than shortening the average trip. In some instances behavior toward trip frequencies and mode split appears to be relatively inelastic with respect to access, although these relationships have been analyzed for statistical significance in only a few cases. In the most thorough study done to date, Handy (1992b) presents evidence that trip frequencies usually increase with access, while the net effect on total travel is much less clear

In fairness, though neotraditional designers have likely been overly enthusiastic in their arguments that such designs have auto travel benefits, they are generally careful to emphasize the many needed complementary elements of such strategies It is mainly traffic engineers and land use planners who have focused on the traffic advantages of the grid without considering its impact on trip frequency, and without emphasizing the attendant need to make pedestrian travel more pleasant and social (e.g ,

Kulash , Anglin and Marks, 1990; Friedman, Gordon and Peers, 1992, McNally and Ryan, 1993) Though most neotraditional developments probably have traffic benefits, these are likely due to features that 'calm traffic' and cluster destinations within walking distance than the collateral benefits of a grid-like subdivision form. These benefits are also less likely to affect commuting and major shopping than other kinds of trips In the end it seems evident that the relationship between a 'legible' street pattern and car vs pedestrian travel is simply one that has not been deeply examined.

In the face of incomplete knowledge, planners have begun to experiment with 'contingency standards', which are themselves dependent on the actual behavior generated by a development rather than design promises San Diego County has designed a contingency transportation plan for the 23,000 acre 'neotraditional' Otay Ranch development, eventually to contain as many as 80,000 residents If the development does generate fewer than the standard number of auto trips per household, as its designers intend but cannot guarantee, traffic engineers have agreed to convert some of the lanes on arterials to open space (Calavita, 1993) In the interim, however, streets must conform to existing codes

It is worth repeating that the purpose of this paper is not to disagree with what neotraditional and pedestrian-oriented planners have in mind Their approach to the modern suburb is substantially more thoughtful and functional than that characterizing the typical suburban development In most respects, moreover, the new suburban model appears to satisfy its design objectives. At the same time, the results developed here suggest that the transportation benefits of neotraditional design are likely overstated. The main problem with these benefits is that in nearly all instances, they are expected to follow from each and every feature of a neotraditional traffic plan. Thus much attention has been devoted to what is perhaps the easiest element to implement, a rectilinear grid street plan, often to the exclusion of other, more promising features. The fact that a grid, by itself, may cause more traffic problems than it solves has slipped between the cracks

Appendix An Illustrative Model of the Impact of Trip Length on Mode Split and Trip Frequency

To focus on the behavior of interest within a standard microeconomic model of behavior (e g , Kreps (1990)), say that individuals have tastes over only three commodities the number of trips they complete by car, those they complete by foot, and a composite good representing all other consumption. A 'trip' is thus defined as a hedonic index of the quantity and kinds of goods one obtains during each sort of trip, measured in the units of time required to complete each trip. This simplification substantially streamlines the exposition while not affecting the qualitative results We ignore non-time constraints to emphasize the influence of the time required for a trip in each mode on the choice of the number of trips in each mode, and we assume that trip time is closely related to trip length In this case, the decision process behind the choice of the number of trips may be written as the constrained maximization problem of choosing the number of trips by each mode and other consumption to,

$$\max U(a,w,x)$$

$$\text{s t} \quad y = x + ap_a + wp_w$$

where U is a strictly quasi-concave utility function, a is the number of trips by automobile, w is the number of trips by walking, x is a composite of the time spent on other activities, p_a is the time per trip for travel by automobile, p_w is the time per trip for walking, and y is the total time available for travel (which we take as fixed) The solution to this problem is then summarized by the trip demand functions $a(p_a,p_w,y)$ and $w(p_a,p_w,y)$. Estimable forms of these demand functions may be obtained by specifying a particular form for U (e g., see Domencich and McFadden, 1975, and Small, 1992, for discussions and alternative approaches)

The main lessons of this paper can be derived for general preferences via some simple comparative statics. The relationship between the time required for each trip in each mode and land use is captured by a shift parameter τ, where an increase in τ decreases the time per trip [14] Hence, for small changes in τ, the derivative $\frac{dp_i}{d\tau} < 0$ for $i = a,w$. Treating trips as a continuous variable for convenience, and denoting total travel by $T = ap_a + wp_w$, an approximate measure of the change in time spent traveling is simply the total derivative,

$$\frac{dT}{d\tau} = a\frac{dp_a}{d\tau} + w\frac{dp_w}{d\tau} + p_a\frac{da}{d\tau} + p_w\frac{dw}{d\tau} \qquad (1)$$

This equation summarizes the mode split and travel behavior of an individual benefiting from increased access, as measured by a reduction in the time necessary to complete a trip of any given length The first two terms on the right-hand side of (1) measure the effect of decreased distances for the given number of trips in each mode. These enter (1) negatively by assumption. The latter two terms are the induced effect on the number of trips in each mode One might expect each of these to be positive, as argued in Section 3, but a closer look reveals the potential for substantial ambiguity.

For example, the number of car trips responds to a small change in the time per trip in both modes

according to the total derivative,

$$\frac{da}{d\tau} = \frac{\partial a}{\partial p_a}\frac{dp_a}{d\tau} + \frac{\partial a}{\partial p_w}\frac{dp_w}{d\tau} \qquad (2)$$

The first term on the right-hand side is the change in the desired number of trips by car induced by the time savings per trip. This is likely positive, as can be seen from the Slutksy decomposition for $\frac{\partial a}{\partial p_a}$,

$$\frac{\partial a}{\partial p_a} = \frac{\partial a^c}{\partial p_a} - a\frac{\partial a}{\partial y}$$

where $\frac{\partial a^c}{\partial p_a} = \frac{\partial a(p_a, p_w, U)}{\partial p_a} < 0$ is the change in the compensated demand for auto trips and $\frac{\partial a}{\partial y}$ is the income effect of the price change. If automobile trips are a normal good, then $\frac{\partial a}{\partial y} > 0$ and $\frac{\partial a}{\partial p_a}$ must be negative. This is just another way of saying that the demand curve for automobile trips is downward sloping. Hence, the first term in (2) is positive.

The number of car trips can fall with a decrease in trip length, however, if the second term in (2) is sufficiently negative. This term represents the effect of a decrease in walking time on car trips. As it becomes easier to walk, owing to a better system of walkways, shorter distances, better landscaping, etc., we might expect people to substitute walking trips for car trips. Indeed, this possibility is often mentioned as the predicted outcome of the grid-like land use patterns associated with neotraditional neighborhood design. What is often neglected is the first term in (2). The Slutsky equation for the second term in (2) is

$$\frac{\partial a}{\partial p_w} = \frac{\partial a^c}{\partial p_w} - w\frac{\partial a}{\partial y} \qquad (3)$$

where $\frac{\partial a^c}{\partial p_w} = \frac{\partial a(p_a, p_w, U)}{\partial p_w} > 0$. If automobile trips are a normal good, then $\frac{\partial a}{\partial p_w}$ is positive. Hence the sign of (3) is indeterminate. The cross-price effect is more likely to be positive the larger the substitution effect and the smaller the income effect.

Substituting, the total change in the desired number of trips by car may be written as,

$$\frac{da}{d\tau} = \frac{\partial a^c}{\partial p_a}\frac{dp_a}{d\tau} + \frac{\partial a^c}{\partial p_w}\frac{dp_w}{d\tau} - \left(a\frac{dp_a}{d\tau} + w\frac{dp_w}{d\tau}\right)\frac{\partial a}{\partial y}$$

The second term on the right-hand side of this expression is negative. The other terms enter positively, leaving the impact of a time savings on car trip demand theoretically indeterminate. The number of trips by car is more likely to rise with a decrease in the time per trip the larger is the magnitude of the own-price effect (the first term) relative to the cross-price effect (the second term) and the income effect (the

third term) In the special case where the compensated cross-price elasticity of demand for car trips is zero, which involves unlikely restrictions on travel preferences, the number of desired auto trips will unambiguously rise with an increase in access. It will also rise so long as the substitution effect remains sufficiently small

The effect on only automobile travel of an increase in access is

$$\frac{d(ap_a)}{d\tau} = a\frac{dp_a}{d\tau} + p_a\frac{da}{d\tau}$$

$$= \left(1 + \varepsilon_{ap_a}\right)a\frac{dp_a}{d\tau} + \frac{\partial a}{\partial p_w}\frac{dp_w}{d\tau} \qquad (4)$$

where $\varepsilon_{ap_a} < 0$ is the own-price elasticity of demand for trips by car A sufficient condition for the right-hand side of (4) to be negative, and hence for auto travel to decrease as access rises, is that $\varepsilon_{ap_a} > -1$ and $\frac{\partial a}{\partial p_w} < 0$. In that case, the number of desired trips by car does not increase enough to offset the shorter trip distances, and total travel falls. If the price-elasticity of trip demand is sufficiently elastic or the cross-price elasticity is sufficiently positive, however, the right-hand side of (4) will be positive The magnitude of these elasticities will depend on local circumstances, such as the available of close substitutes for car travel, and cannot be stated generally

The change in the share of all trips that take place by car is,

$$\frac{d\left(\frac{a}{a+w}\right)}{d\tau} = \frac{1}{a+w}\left(w\frac{da}{d\tau} - \frac{a}{a+w}\frac{dw}{d\tau}\right)$$

A sufficient condition for this to fall is that walking trips increase and auto trips fall However, it can rise if either walking trips fall a sufficient amount or if auto trips rise sufficiently This would depend on the behavioral parameters identified above.

NOTES

[1]Other recent discussions of their work are found in Abrams (1986), Boles (1989), Bookout (1992b), Dunlop (1989, 1991), Kelbaugh (1989), Knack (1989), Leccese (1990), Mahoney and Easterling (1991), Rowe (1991), and Ryan and McNally (1994)

[2]The mixed views the architectural profession has held toward the suburbs is perhaps part of the story, ranging from disdain to merely aesthetic See the discussion in Boles (1989)

[3]Except, as Calthorpe (1993) emphases, traditional small towns tend to lack the densities required to support transit Fink also (1993) argues that the neotraditional model, based in many ways on the prototypical 'Eastern' small town, does not apply well to the more decentralized character of the western U S

[4]Interestingly, Duany (1989) emphasizes that these communities are not typically permitted under standard building and planning codes A central feature of his firm's town plans have been their codes, which both provide for more flexibility in some respects, such as allowing narrower streets, and less in others, such as prescribing design guidelines for individual structures Clear descriptions of how a neighborhood and a planning department might change street codes to benefit existing neighborhoods are found, respectively, in Appleyard (1981) and Fernandez (1994)

[5]Alternative views of the street 'grid' as a design element representing spatial 'attitudes' as well as form, in theory and historical practice, are found in Nitschke (1966), Groth (1981) and Kostof (1991)

[6]A sampling includes Calthorpe (1993), Bookout (1992a), Duany and Plater-Zyberk (1992), Kulash, Anglin and Marks (1990), Beimborn, et al (1991), Lerner-Lam, et al (1991), and Ryan and McNally (1994) More doubtful assessments are found in Kaplan (1990), Leccese (1990), and Handy (1991)

[7]Many of the broader issues concerning the linkages between land uses and transportation behavior are discussed in, for example, Cervero (1989), Deakin (1991), Giuliano (1989) and Handy (1992a)

[8]See Middlesex Somerset Mercer Regional Council (1992) for a survey and new evidence that increasing densities and mixing uses can significantly decrease both VMT and auto trips

[9]Holtzclaw defines 'pedestrian access' as (fraction of through streets)x(fraction of roadway below 5 percent grade)x(0 33)/(fraction of blocks with walks) + (building entry setback) + (fraction of streets with controlled traffic)

[10]Access has been measured in many ways, but is often used to capture scale as well as distance (Handy, 1992b, 1992c) The number and diversity of potential destinations within some specified distance, such as the number of grocery stores and restaurants, is a typical measure (Hanson and Schwab, 1987) In practice, node composition as well as the spatial distribution of nodes thus both matter To keep the basic story straightforward, this paper abstracts from all aspects of access but linear

distance Increasing the diversity of destinations clearly affects the attractiveness of any travel mode for any given travel distance, however, but it does not qualitatively affect the logic of the argument

[11]Handy (1992b) is the only source I am aware of which explicitly notes this consequence of reducing trip length

[12]Extending the story to allow for more travel modes, such as transit and bicycling, would complicate the narrative and analytics without changing the qualitative nature of the results

[13]I employ the term 'demand curve' somewhat differently than its usual usage, as it gives the preferred mode corresponding to the total cost of an entire trip, not the number of trips or the trip length per unit cost

[14]As suggested by a referee, a fuller treatment would decompose the time per trip into the product of trip length in miles m_i and time per mile t_i, i e, letting $p_i \equiv m_i \times t_i$ for $i = a, w$ We could then examine the independent effects of land use and street patterns on the miles per trip and the time per mile, and in turn the impact of each on the time per trip This is especially important for examining pedestrian trips, which are perhaps as dependent on the length of a trip as on the time it requires

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