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Will the "New Urbanism" Reduce Traffic or Increase It?

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ABSTRACT
A major attraction of the popular and influential planning movements known as 'the new urbanism', 'transit-oriented development', and 'neotraditional planning' are their presumed transportation benefits. Though the architects and planners promoting these ideas are usually careful to emphasize the many ingredients necessary to obtain desired results — the straightening of streets to open the local network, the 'calming' of traffic, the better integration of land uses and densities, and so on — a growing literature and number of plans feature virtually any combination of these elements as axiomatic improvements.

The potential problem is that the traffic impacts of the new plans are generally indeterminate, and it is unclear designers understand the reasons well enough to avoid unintended results. This paper proposes a simple behavioral model to identify and assess the tradeoffs these ideas impose on transportation and subdivision planners.

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■ Introduction

Transportation problems seem to offer no end of interesting policy wrinkles and engineering challenges, but despite the promise of each new technological innovation, financial windfall, and dazzling social science breakthrough, planners have not fared well. Even as air pollution, fuel, and traffic congestion costs mount to the point where the benefits of making any headway appear substantial, more freeway lanes are dedicated to carpoolers and toll-ways, and new transit systems continue to soak up many billion of dollars, getting people to 'improve' their driving behavior remains the ultimate planning brick wall. Increasing evidence suggests that transportation management schemes have extremely limited effectiveness, in the sense that only marginal and perhaps even cost-ineffective changes can be expected from most of the tools applied thus far (e.g., Giuliano, Hwang and Wachs 1993; Wachs 1993a; Deakin and Harvey, et al. 1994).

While one view is that the planner's arsenal of transportation management tools has proven largely ineffective in dealing with traffic congestion especially, the somewhat more optimistic account of some planners and architects is that attention has been focused on symptoms rather than the disease itself. The vanguard of such urban design schools as 'the new urbanism', 'neotraditional planning', and 'transit-oriented development' have collectively argued that the way we organize space has profound implications not only for traffic patterns but perhaps for our sense of self and modern civilization as a whole. Such prominent urban designers as Andres Duany and Elizabeth Plater-Zyberk (1991, 1992), best known for their work on the neotraditional community of Seaside, Florida, and Peter Calthorpe (1993), the author of the transit-oriented 'pedestrian pocket' concept, forcefully claim their planning strategies will, among other things, improve traffic conditions, reduce home prices and generally increase the quality of residential life.[1]

Of course, this is just talk. As bold and stirring as these claims may be, they are mainly meant to get us thinking afresh about where and how improvements can be made — not as cold hard facts. Most transportation planners probably recognize that blanket statements of this nature are overly simplistic. (See for example the questions raised concerning the scope for transportation policy to influence land use, or vice-versa, in Boarnet and Crane (1995), Gómez-Ibáñez (1985), Giuliano (1989), and Wachs (1993a, 1993b).) Even the architects and planners promoting these ideas are usually careful to emphasize the many ingredients necessary to obtain desired results: The straightening of streets to open the local network, the 'calming' of traffic, the better integration of land uses and densities, and so on. The new designs have many elements, and while their purported transportation benefits are often featured, it is by no means the primary component.

Still, these ideas appear to have had made a great impact on modern city planning thought and practice. Perhaps in their frustration to find policy tools that can make a difference in the struggle with automobiles in the city, a good many planners and communities have taken the transportation themes of the new urbanism to heart as among the most feasible and promising. Within a few short years, the new urbanism has become perhaps the most visible intellectual paradigm in urban design theory circles and has steadily increased its influence among subdivision and transportation planners as well. A growing number of general and specific plans feature various combinations of these elements as self-evident improvements (e.g., see Calavita 1994; Los Angeles 1993; San Bernardino 1993; San Diego 1992), and the claim that virtually any one such element has transportation benefits has rarely been challenged in either the practitioner or scholarly literatures.

It is somewhat surprising, then, to find the empirical support for these transportation benefits to be meager and their behavioral foundations obscure (Crane 1995; Gordon and Richardson 1995). Only a few studies — discussed below — have examined these issues head on, and interpreting their mixed and contrary results is difficult owing to the lack of a consistent analytical framework.

The purpose of this paper is to suggest an organizing scheme, and to then explore the behavioral implications of the new plans for travel. It presents a simple model of travel demand identifying the interaction of the main factors under debate. Under very general circumstances, we find the net effect of the new plans can either increase or decrease the number of car trips as well as overall vehicle miles traveled. The result in any instance depends in part on how sensitive the demand for each mode is to changes in the time required for each trip, how well one mode substitutes for another, and the particular manner in which the plan is implemented. There is no theoretical basis for stating that the new urbanism will unambiguously reduce car travel.

However well intentioned, the new designs can thus cause problems when naively applied. A second purpose of this paper is to suggest how such problems can be avoided. The behavioral framework can be used as the basis for comparing the impacts of different plan elements on traffic and pedestrian travel. The new urbanism is a hopeful school of thought, brimming with promise, and should be encouraged in those respects in which it succeeds. The purpose of this work is to make that task easier.

■ Linking Neighborhood Design to Travel

As essentially architecture, the new urbanism is part philosophy, part art, part economics, and part social engineering. Still, a key to its popular acceptance is the open embrace of conventional and even conservative standards of neighborhood form, scale and creed. Neotraditional planning in particular self-consciously recalls small town settings where your neighbors walk to get a haircut, and stop on the way to chat as you sit on the front porch watching the kids play. The attraction of these ideas is subjective, personal, yet pervasive: surveys indicate their appeal among suburban residents is especially solid (Inman 1993). After all, in principle, what's not to like about pretty homes in quiet, friendly and functional neighborhoods?

But will they improve the traffic?

Available evidence on the transportation benefits of any feature of these plans is mixed at best and often contrary. Most studies are grounded in either dubious assumptions, poorly framed questions, or comparisons of dissimilar communities. Studies of actual neotraditional developments have not been published, as virtually none are fully built out at this time. Hence, even careful quantitative evaluations tend to be based on hypothetical situations, as in the case of engineering simulations, or data obtained from older 'traditional' communities sharing some characteristics with proposed 'neotraditional' communities. Those studies supportive of automobile-suppressing properties of either grid street patterns or pedestrian friendly characteristics tend assume trip frequencies do not vary from one design to another, or fail to isolate the independent influence of each feature on travel behavior:

Simulation studies, such as Kulash, Anglin and Marks (1990), McNally and Ryan (1993), Rabiega and Howe (1994), and Stone, Foster and Johnson (1992), have tended to focus on whether a more grid-like street pattern reduces vehicle miles traveled (VMT). They model the new plans as essentially moving trip origins and destinations closer together, but most hold the number of trips fixed. (Stone, Foster and Johnson (1992) let trip generation rates change based on assumed differences in the land use mix in each scenario, and then apply fixed trip rates for each use based on published engineering standards.) Thus the studies tend to ask "If a trip becomes shorter, will people drive as far?" The answer is "no", but what we learn from the exercise about the expected impact of these schemes is unclear. The pivotal question is whether there will be a behavioral response, such as a change of modes or a change in trip frequency. These studies typically assume away such responses — apart from what engineering standards divine — though they would seem to be key to predicting what will happen in practice.

(Figures 1, 2 and 3 about here.)

Empirical studies can't assume away behavior; rather they must explain it. The research strategy in most analyses has been to simply search for correlations among neighborhood features and observed travel — in some cases controlling for other relevant factors and in others not. For example, studies such as Cervero and Gorham (1995), Friedman, Gordon and Peers (1992), Hanson and Schwab (1987), Guy and Wrigley (1987), Handy (1992b, 1994), Holtzclaw (1994), Kitamura, Mokhtarian and Laidet (1994), and 1000 Friends (1993), have collectively reported that more 'traditional' neighborhoods are associated either fewer or more automobile trips than 'non-traditional' environments, with the result that overall VMT can either fall or rise. Again, however, interpreting this range of results in any one case is problematic since the causal theory is not clearly established outside the design rhetoric. What is generalizable about the factors in one environment that generate more car trips, and in another less? While some studies based on observed behavior do attempt to control for different trip purposes (e.g., shopping versus commuting), trip lengths (neighborhood versus regional), and demographic variables likely associated with trip demand (income, age, etc.), the approach is typically *ad hoc*. Further, there is the question of what the range of outcomes found in this work suggests about the ability of the new urbanism to deliver the transportation benefits it promises.

The point of departure for this paper is the argument that the literature on the transportation impacts of neotraditional or other new urbanism designs has yet to employ a strong conceptual framework when investigating these issues, making both supportive and contrary empirical results difficult to compare or 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 planning and 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.

The demand approach assumes that individuals make choices, either alone or as part of a family or other group, based on their *preferences* over the goods in question, the *relative costs* of those goods, and *available resources* (e.g., Kreps 1990). Preferences include attitudes and tastes, for example regarding the experience of driving versus walking, and are likely correlated with demographic and other personal idiosyncratic characteristics. But the decision to take a trip to the coffee shop by car or by foot depends not only on how one feels about those options, but also on external factors over which one has no or only limited control; i.e., on the cost of one mode versus the other. I may prefer to drive, but if the gasoline or parking expenses of doing so are high enough, walking may appear to be the better choice. Thus the demand for walking trips is explained not only by one's preferences across modes but also on the cost of walking relative to the cost of driving, etc.

That, simply put, is the economic theory of demand. The role of accounting for available resources is mainly to fix the importance of costs; the impact of a $5 parking charge on your decision to drive to the coffee shop depends on what funds you'll have left for that double expresso needed to get you through the afternoon. Note the framework applies just as well to any situation where decisions are made concerning the allocation of scarce resources, whether they involve actual money or not. In the model presented below, for example, the scarce resource is time, and each mode is compared in terms of the time consumed rather than the cash. Note also that this framework does not explain preferences, it only explains how one makes informed decisions given those tastes together with costs.

While this approach can appear artificially abstract and vexing at times, depending on the problem at hand, it does have the substantial advantage of laying out the tradeoffs of interest in a relatively clear-cut fashion once the fundamentals are understood. What would we expect if the cost of one mode rises while the other falls, for example? It is not necessary to follow the model or the derivation of the results to understand the argument they support, but the details do determine the credibility of the argument. The usefulness of the analysis is another matter. Modeling design features in this framework requires some simplification and standardization. That naturally depends on the appropriateness of the model to the problem under study, and oversimplification can obviously be fatal in that respect. This is no less true in the present instance, and some care has been taken to capture the main elements of the neighborhood travel environment. The results are summarized in the last paragraph of this section and the conclusion.

A Model of the Influence of Neighborhood Design on Trip Demand

To focus on the behavior of interest, consider the problem of individuals making choices over five uses of time: the number of trips they complete by car, those they complete by foot, those by transit, those by some other transportation mode, and a composite good representing all other uses of time. (That is, the model abstracts from other decisions, which is different from assuming they don't happen but does imply they aren't a central feature of the story.) For most purposes, a trip is a 'derived' demand, meaning that people typically travel as a means to an end, not as an end in itself. A 'trip' is thus defined as a hedonic index of the quantity and kinds of goods one obtains during each sort of trip. We ignore non-time constraints to emphasize the restriction imposed by the time required for a trip in each mode on the choice of the number of trips in each mode. (These simplifications substantially streamline the exposition while not affecting the qualitative results.)

In this case, the decision process behind the choice of the number of trips may be formalized as the constrained maximization problem of choosing the number of trips by each mode to maximize the benefit of travel by mode, subject to a budget constraint reflecting travel costs and available time. In the standard functional notation of this modeling approach, the problem statement is to assume that individuals choose their desired number of trips by each mode to maximize

$$U(\mathbf{a}, \mathbf{w}, \mathbf{b}, x)$$

subject to

$$y = x + \mathbf{a}\mathbf{p}_a + \mathbf{w}\mathbf{p}_w + \mathbf{b}\mathbf{p}_b ,$$

where U is an index of the benefits of using time for each purpose, $\mathbf{a}$ is a vector of the number of trips by automobile for each purpose, $\mathbf{w}$ is a vector of the number of trips by walking for each purpose, $\mathbf{b}$ is a vector of the number of trips by bus or other transit for each purpose, x is a composite of the time spent on other activities, the $\mathbf{p}_i$ are the respective vectors of times for each trip type in each mode ($i = a,w,b$), and y is total available time. For example, say there are 10 different trip purposes which we index by $j = 1,2,3,\ldots,10$. Perhaps the first purpose is grocery shopping, the second trips to school, etc. Then $\mathbf{a} \equiv (a^1, a^2, a^3, \ldots, a^{10})$ = *(number of car trips to grocery store, number of car trips to school,....)*. The total number of car trips taken for all purposes during the reference time period (a week say) is $\sum_{j=1}^{10} a^j$, and the total time spent traveling by car was $\mathbf{a}\mathbf{p}_a = \sum_{j=1}^{10} a^j p_a^j$. Note further the time per trip is the quotient of trip length m_i and speed t_i; i.e., where $p_i \equiv m_i / t_i$ for $i = a,w,b$, for any particular trip purpose (i.e., with superscripts suppressed for simplicity).[2]

The solution to the choice problem is summarized by the trip demand functions $\mathbf{a}(\mathbf{p}_a, \mathbf{p}_w, \mathbf{p}_b, y)$, $\mathbf{w}(\mathbf{p}_a, \mathbf{p}_w, \mathbf{p}_b, y)$ and $\mathbf{b}(\mathbf{p}_a, \mathbf{p}_w, \mathbf{p}_b, y)$. These functions have many useful properties, but their practical value for the problem at hand is that for any given set of travel preferences, they transparently relate changes in trip costs to the number of trips desired, by trip purpose. For example, they can be used to estimate the impact of an urban design change that lowered the time (or other cost) of a trip by foot on the number of trips by foot, the number of trips by car, and the number of transit trips — for each trip purpose. This information could thus be used to calculate how vehicle miles traveled respond to increased pedestrian, transit, or auto access due to a change in street patterns. Estimable forms of these demand functions for empirical application to specific data may be obtained by specifying a particular form for U (e.g., Small 1992; Crane and Crepeau 1995).

However, the basic theoretical implications of the behavioral model can be explored without data. The potential inconsistency regarding the transportation benefits of the new urbanism is *internal* to these design principles. To show this most clearly, the paper is restricted to deriving some basic implications of the behavioral model via the method of comparative statics.[3]

In the context of the model presented above, how can the pivotal features of the new plans be represented? Rather than attempt a comprehensive review, the analysis is restricted to the three most common design elements with assumed transportation benefits: a grid-like street pattern intended to reduce the distance between local trip origins and destinations, traffic 'calming' measures intended to slow cars down, and integrated land uses at higher densities intended to combine more trip destinations at single locations.

The role of the grid in these plans is multifaceted, ranging from increasing the 'legibility' of the neighborhood to improving the connection of people and places. Among the ideas that have been reborn in the new urbanism, the renewed popularity of the grid is both the most frequently mentioned by traffic analysts and perhaps the most compatible with modern street and subdivision codes. For transportation purposes, its major function seems to shorten local trips. The relationship between the time required for each trip in each mode and land use is assumed to be captured by way of a 'grid' shift parameter γ, where an increase in γ (more grid-like) decreases trip lengths. That is, the derivative $\frac{dm_i}{d\gamma} < 0$ for $i = a,w,b$. Notice this parameter could represent the effect of any land use change that made a trip shorter. It is also compatible with a specification assuming transit or pedestrian trips are shortened more than car trips, where $\frac{dm_a}{d\gamma} > \frac{dm_w}{d\gamma}$, or other possibilities.

Traffic calming refers to the narrowing of streets and intersections, and other means as well, that slow cars down (e.g., Untermann 1984; Ben-Joseph 1995). We model this effect with a 'calming' parameter χ, where an increase in χ slows car speeds down; i.e., $\frac{dt_a}{d\chi} < 0$. Finally, mixing, combining and intensifying the density of land uses to make any one trip potentially serve more than one purpose might affect trip demand in at least three ways: It can essentially increase the consumption associated with a trip directly and it can also lower the cost of any 'chained' trip. Defining an increase in the shift parameter μ to symbolize an increase in land use mixing or more intense use of a destination site, the former effect can be represented by $\frac{\partial a}{\partial \mu} < 0$ and the latter by $\frac{dp_i}{d\mu} < 0$ for $i = a,w,b$. More intensive use can also increase congestion, such that $\frac{dt_a}{d\mu} < 0$.

The Grid

With these design features so defined, we can investigate their individual and collective theoretical impacts on travel behavior via comparative statics. Note first that total VMT for all trips is $\mathbf{am}_a = \sum_{j=1}^{10} a^j m_a^j$. Hence, an approximate measure of the effect on VMT for one particular purpose due to a move toward a grid street pattern is simply,

$$\frac{dVMT}{d\gamma} = \frac{a}{t_a}\frac{dm_a}{d\gamma} + p_a \frac{da}{d\gamma} \tag{1}$$

(This approach treats trips as approximately continuous. They are not, of course, and the modifications necessary to account for the discrete nature of the trip decision are described in Ben-Akiva and Lerman (1985) and Small (1992).) This equation succinctly summarizes the automobile travel behavior of an individual benefiting from a more grid-like street network that in turn leads to shorter trips. The first term on the right-hand side of (1) measures the effect of shorter trips for the number of car trips prior to the street network change. It enters (1) negatively by assumption, and summarizes the results of the studies which have held trip frequency fixed. The latter term is the induced effect on the number of car trips. Do we expect trips to increase or fall?

To see this note the number of car trips responds to a small change in trip length according to the total derivative,

$$\frac{da}{d\gamma} = \frac{\partial a}{\partial m_a}\frac{dm_a}{d\gamma}\frac{1}{t_a} + \frac{\partial a}{\partial m_w}\frac{dm_w}{d\gamma}\frac{1}{t_w} + \frac{\partial a}{\partial m_b}\frac{dm_b}{d\gamma}\frac{1}{t_b} \tag{2}$$

The first term on the right-hand side is the change in the desired number of car trips induced by the time savings per trip. This is likely positive, as can be seen from the Slutksy decomposition for $\partial a/\partial p_a$, which breaks down the price change impact into two parts: the impact due to a change in relative prices, and the impact due to a change in overall costs:

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

where $\frac{\partial a^c}{\partial p_a} \equiv \frac{\partial a(p_a, p_w, U)}{\partial p_a} < 0$ is the change in demand due to the change in relative prices (the 'compensated' effect) and $\partial a/\partial y$ is the impact of having time freed up by the shorter trips. If automobile trips are a normal good (i.e., the demand for auto trips increases with resources), then $\partial a / \partial y > 0$ and $\partial a / \partial p_a$ must be negative. Thus, the demand curve for automobile trips is typically downward sloping and the first term in (2) is positive: All things considered as the time per trip falls, due in this case to a shorter trip, people will tend to want to take more trips.

The number of car trips can fall with a decrease in trip length, however, if the sum of the second and third terms in (2) is sufficiently negative. These represent the cross-price or substitution effects of shorter walking and transit trips on car trips. As walking trip lengths fall, owing to a better system of walkways or more direct street patterns, etc., we might expect people to substitute walking trips for car trips. Indeed, pedestrian trips are more influenced by trip length (and purpose) than by trip time, especially when compared to motorized transport. Evidence that walking trips fall off dramatically after trip distance of a half-mile suggests that the second term in (2) is highly elastic near that figure, and zero for longer distances (e.g., Untermann 1984). Shorter transit trips have a less clear effect, again depending on the trip purpose and other particulars not explicitly modeled here — though the time of the trip is probably a more important single indicator that the trip length.

Hence, if automobile trips are a normal good then $\frac{\partial a}{\partial m_w}$ is negative and the sign of (2) is indeterminate. If the new street network is such that people tend to substitute walking or transit for car trips compared to an alternative plan, and the demand for car trips is relatively insensitive to the length of the trip, the number of car trips can fall. But if these conditions are not met, car trips can rise. Whether VMT rises or falls is a separate matter. VMT is the product of the number of trips and their length. If trip lengths fall, as implied by a move to a grid, (2) shows that the number of trips could rise — especially where few transit or walking trips are substituted for car trips and if car trips are sensitive to their length. If the number of car trips rise enough, then VMT could rise as well.

To see this, look at how VMT for a given trip purpose changes with an increase in the grid parameter:

$$\begin{aligned}\frac{d(VMT)}{d\gamma} &= a\frac{dm_a}{d\gamma} + m_a\frac{da}{d\gamma} \\ &= \left(1 + t_a\varepsilon_{ap_a}\right)a\frac{dm_a}{d\gamma} + m_a\left(\frac{\partial a}{\partial m_w}\frac{dm_w}{d\gamma}\frac{1}{t_w} + \frac{\partial a}{\partial m_b}\frac{dm_b}{d\gamma}\frac{1}{t_b}\right)\end{aligned} \tag{3}$$

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 (3) to be negative, and hence for VMT to be lower in more grid-like neighborhoods, is that trip demand be sufficiently price-inelastic (i.e., $\varepsilon_{ap_a} > -1/t_a$) and the cross-price elasticities be negative. In that case, the number of desired car trips does not increase enough to offset the shorter trip distances, and total travel falls. (This is more likely the slower the trip.) If the price-elasticity of trip demand is sufficiently elastic or the cross-price elasticities are sufficiently small, however, VMT will rise.

More simply, a move to a grid shortens trips lengths for all modes. The demand for trips in each mode will then likely rise. In part, however, this depends on how well one mode substitutes for another for a given trip purpose and how the resulting trip lengths suggest for the feasibility of either walking or transit. Even with more car trips, VMT may fall — or it may rise.

Traffic Calming

The remaining results can be obtained with much less work. The effect of slowing car speeds can be assumed to unambiguously to lower the demand for car trips. That is, $\frac{da}{d\chi} < 0$ and VMT must fall:

$$\frac{d(VMT)}{d\gamma} = m_a\frac{\partial a}{\partial t_a}\frac{dt_a}{d\gamma} < 0$$

While this feature is an important part of many new plans (e.g., Seaside, Florida), it is also among the most difficult to put into practice. Lower capacity streets and narrower intersections conflict with most transportation and subdivision trends and standards (see, e.g., Reps 1965; Kaplan 1990; Bookout 1992a; Southworth and Ben-Joseph 1995).

Mixed and Intensified Uses

These design elements refer to practices that try to encourage residents to accomplish more with each trip, perhaps by bundling more trip destinations at a given node, apart from reducing trip lengths or slowing traffic. Many mixed use strategies effectively do all three, but in this section we want to isolate the impacts of these plans that are different from those discussed above. Afterward we'll consider their cumulative effect.

As discussed above, mixing and intensifying uses has two clear consequences for the travel environment: It essentially increases the potential yield of any one trip and it reduces the effective cost of additional trips. In the first view, a given trip can accomplish more. Therefore, you don't need to travel as often to obtain a given set of goods. An increase in the mixed-use parameter thus reduces the demand for car trips: $\frac{\partial a}{\partial \mu} < 0$. In the second view, the marginal cost of all trips beyond the first are lower if they can be 'piggy-backed' onto the first. This effect on car trip demand is positive: $\frac{\partial a}{\partial p_a}\frac{\partial p_a}{\partial \mu} > 0$. These two effects overlap somewhat, but both seem to capture part of what would happen and the net influence is again indeterminate, as:

$$\frac{da}{d\mu} = \frac{\partial a}{\partial \mu} + \frac{\partial a}{\partial p_a}\frac{\partial p_a}{\partial \mu} \gtrless 0$$

A third potential effect is that higher densities could increase congestion, thus increasing trip times. Wachs (1993a, 1993b), for example, has pointed out that while the per capita VMT is lower in such densely developed and populated places as New York, Hong Kong and Singapore, congestion is climbing and VMT per square mile is very high. Congestion in turn might depress the demand for car trips relative to walking and transit, depending on how well transit fared with the new densities.

One could argue that the first factor dominates the second; i.e., that since a given quantity of goods can be obtained with fewer trips, the stimulative impact of the lower cost of chained trips is only secondary. That seems likely in many situations, but it is not axiomatic. The impact of the third potential effect is impossible to generalize without more structure and detail, but congestion may well reduce the number of car trips demanded. Again, the net effect on trip frequency and mode choice is uncertain. The effect on VMT is also unclear, in part because there is the added possibility that walking trips would substitute for car trips — but this seems unlikely for most trip purposes, especially where goods are to be carried back home.

Table 1 summarizes these individual results. A move toward a street grid increases the number of car trips demanded, with an uncertain net affect on VMT. Traffic calming measures reduce car trips and VMT. Mixing and intensifying uses probably reduces trip demand and thus VMT, but it may not depending on the manner in which it is implemented, the congestion induced, and the purpose of the trips. Table 1 also lists the effects of each element on automobile mode split, and the cumulative effects of all three features on each behavior: While the details of any one plan would provide a more precise outcome, in general a combination of these features may either increase or decrease both automobile trips and VMT.

■ Closing Remarks

A major attraction of many influential and popular planning movements is their presumed transportation benefits. Among other features, these designs assert that more 'legible' and transit- or pedestrian-oriented residential patterns reduce vehicle miles traveled and automobile mode share when compared to modern cul-de-sac subdivisions — chiefly by reducing trip lengths, integrating and intensifying land uses, and facilitating walking and transit by generally increasing the quality of the built environment. Will the new plans live up to their promises? This study suggests that while some may, others may not, and that even in the best case the benefits might not be as great as expected. In particular, the transportation merits of any particular design attribute are rarely self-evident.

This point may be well understood in some circles, but planning research addressing these issues has for the most part failed to separate hype from hypothesis. This paper has proposed a more precise statement of the new urbanism transportation argument, and explored the implications of that argument in preliminary fashion by explicitly connecting various design elements to travel behavior. This framework is neither a complete statement nor a complete analysis. However it is constructive and opens the door for further work by identifying several empirical questions at issue.

Specifically, the behavioral parameters that would be useful in an examination of a given design include the elasticities of trip demand by mode and purpose with respect to that trip's (a) speed and (b) distance. For example, how do trip generation rates for cars, transit and walking vary with trip length and time? In addition, the cross-elasticities among modes are an important indicator of how variation in trip length and time in one mode affect the attractiveness of travel by others. If car speeds are reduced in a grid setting that also reduces car trip lengths, how will the walking mode split be affected at the margin? The need to distinguish among trip purposes is already well understood in these literatures, as is the importance of analyzing neighborhood and longer trips separately (e.g., Cervero and Gorham 1995; Handy 1992b, 1994). Further, many such price elasticities have been estimated for a variety of communities by mode (Small 1992).

The missing step seems to be the explicit linkage of the design features discussed in this paper with economic concepts of price, cost and quality. Though comparisons of grid-like and cul-de-sac type neighborhood street patterns are the basis of many studies, there exists no systematic discussion of how to translate the grid or any street pattern for that matter into a reliable quantitative measure of trip length or quality (though see Southworth and Owens (1993) for a related discussion including a proposed categorization scheme for suburban street patterns.) Thus, essentially four further steps are required to implement the considerations of this paper in empirical work: (1) determining a workable and meaningful means for mapping street network and other land use measures map into the price parameters ($\mathbf{p}_i$, $\mathbf{m}_i$, $\mathbf{t}_i$) for each mode, (2) determining how the specification of these parameters varies with trip purpose, (3) locating corresponding data, and (4) specifying a functional form for the demand functions and estimating by mode.

Until then it is worth repeating that the urban design proposals examined here are generally attractive and thoughtful exercises, and have justifiably received considerable attention and praise. Moreover, even their transportation claims certainly have merit in some circumstances, though each and every component of these strategies may not always be a good thing — a possibility that has largely escaped the review literature. What is important is that more information be developed and carefully applied to the questions raised here, in order to avoid a situation where a 'new urbanism' style development unintentionally causes more traffic problems than it solves.

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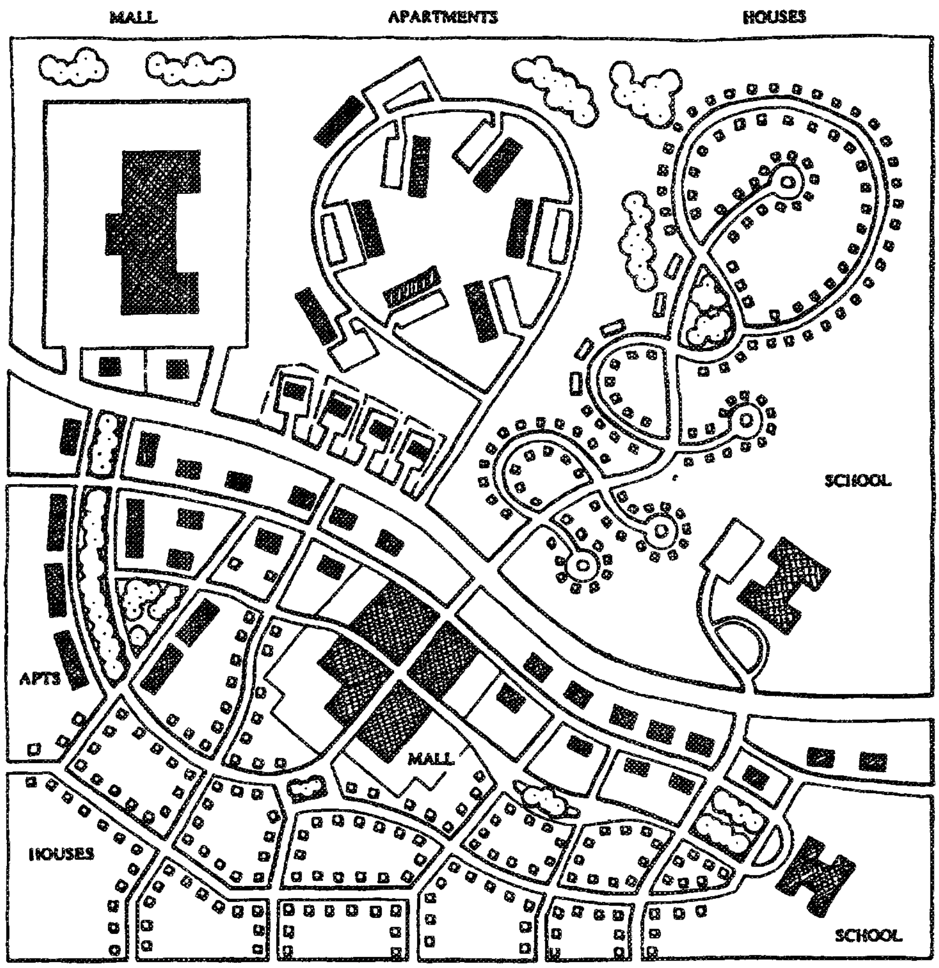
Figure 1: A Comparison by Duany and Plater-Zyberk (1992) of 'Suburban Sprawl' and 'Traditional' Neighborhood Development.

SUBURBAN SPRAWL



TRADITIONAL NEIGHBORHOOD

Figure 2: A Comparison of 'Preferred' and 'Discouraged' Street and Circulation Patterns in the 'Transit-Oriented' Development Guidelines prepared for the City of San Diego by Calthorpe Associates (San Diego 1992).

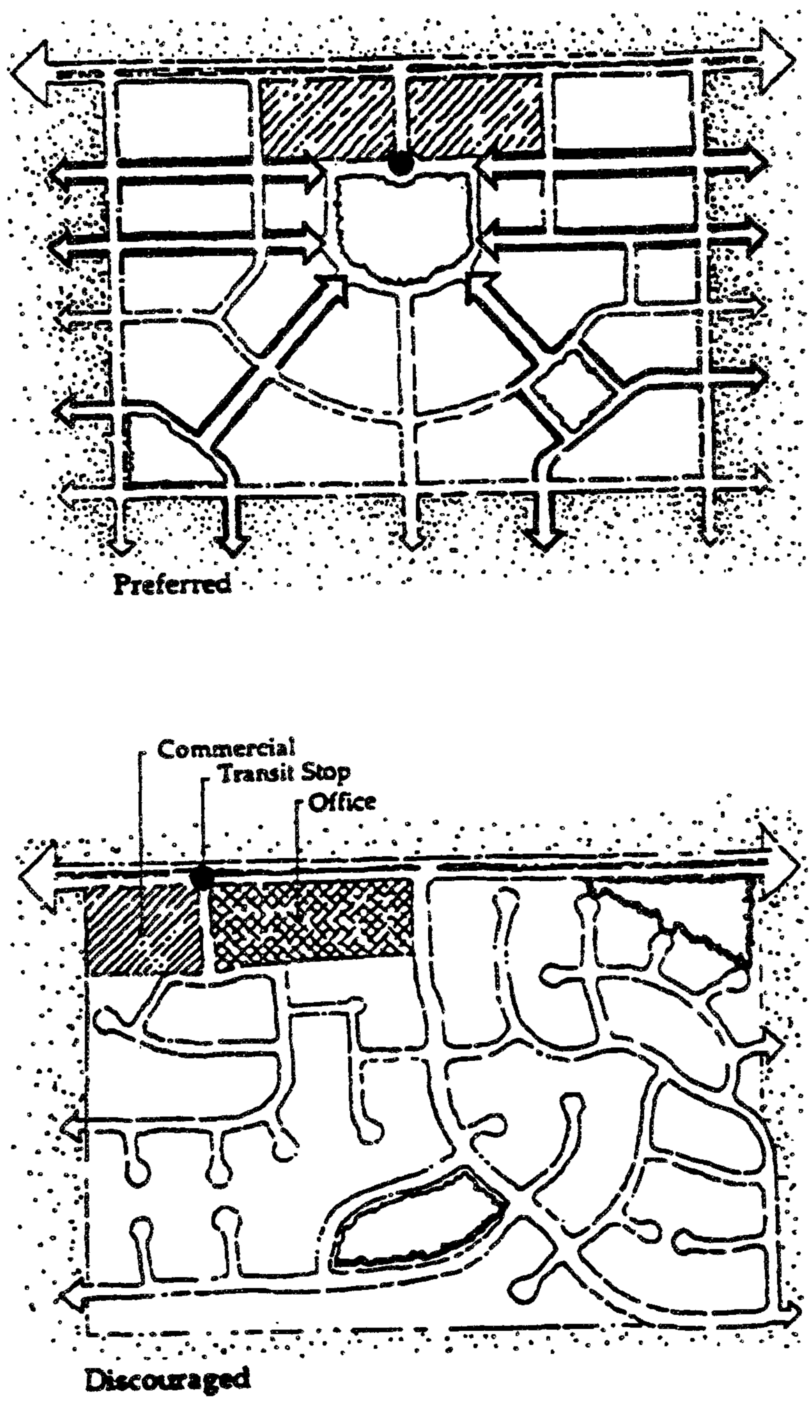
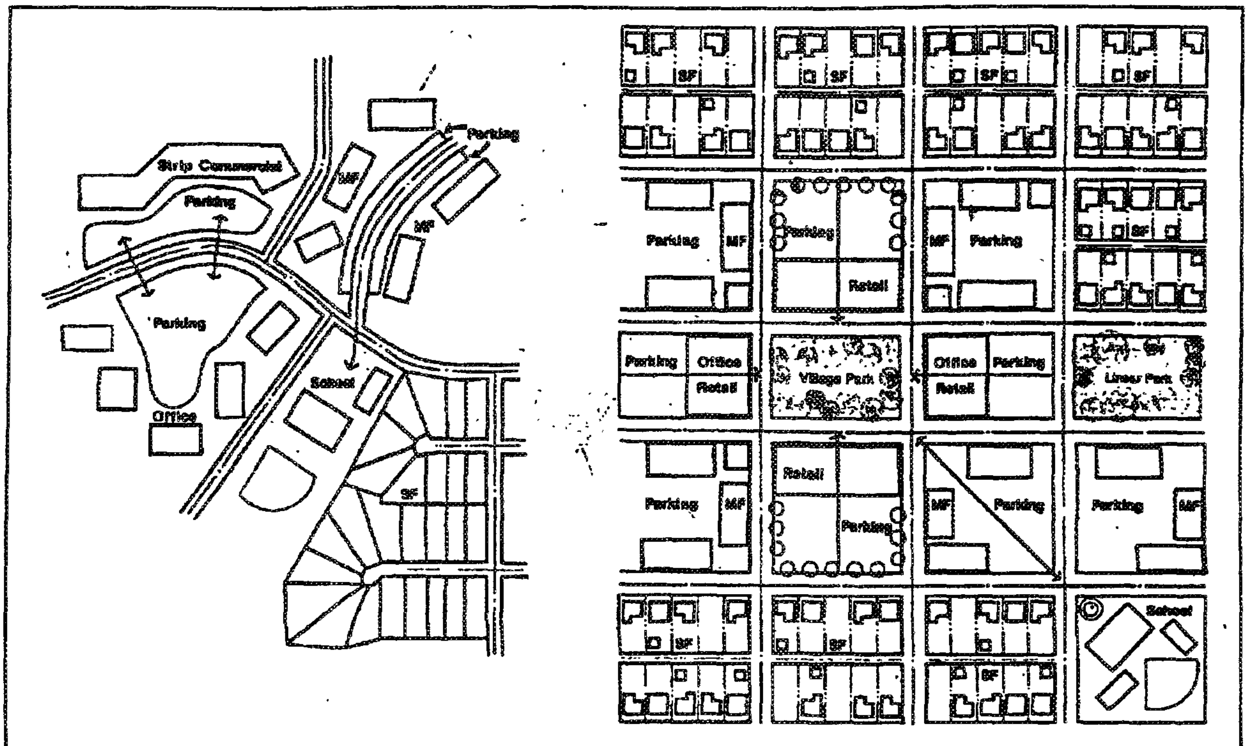


Figure 3: A Comparison by Kulash, Anglin and Marks (1990) of 'Conventional' Suburban Development and 'Traditional' Neighborhood Development.



A. Conventional Suburban Development B. Traditional Neighborhood Development

Table 1:
Qualitative Effects of Different Neighborhood Design Features On Car Travel

Traffic Measure	Design Element			
	Grid (Shorter trips)	Traffic Calming (Slower trips)	Mixing Uses and Land Use Intensification	All Three
Car trips:	*Increase*	*Decrease*	*Increase* *or* *Decrease* (depending on trip purpose, trip length, and induced congestion)	*Increase* *or* *Decrease* (depending on relative mix of elements)
VMT:	*Increase* *or* *Decrease* (depending on how sensitive trips by each mode are to trip length)	*Decrease*	*Increase* *or* *Decrease*	*Increase* *or* *Decrease*
Car mode split:	*Increase* *or* *Decrease*	*Decrease*	*Increase* *or* *Decrease*	*Increase* *or* *Decrease*

Endnotes

[1]Useful presentations and discussions of these ideas include Abrams (1986), Audirac and Shermyen (1994), Beimborn, et al. (1991), Boles (1989), Bookout (1992a, 1992b), Dunlop (1989), Gordon and Richardson (1995), Handy (1991), Katz (1994), Kelbaugh (1989), Knack (1989), Langdon (1994), Leccese (1990), Lerner-Lam, et al. (1991), Mahoney and Easterling (1991), Rowe (1993), and Ryan and McNally (1995).

[2] The formal statement of the maximization problem should properly include certain conditions on the form of preferences, price-taking behavior, and optimization over other consumption; e.g., see Kreps (1990). It is assumed the standard and necessary conditions hold.

[3] Comparative statics is perhaps the most powerful and certainly the most popular tool in microeconomics. It permits the analyst to ask various "what if?" questions, and derive the qualitative answers in some detail. Moreover, the basis for those answers follow transparently from the structure of the model. Though I have glossed over many details in this summary of the method, a fuller treatment would show this is not a 'black box' approach to explaining outcomes.