A CYCLE OF DEPENDENCE: Automobiles, Accessibility, and the Evolution of the Transportation and Retail Hierarchies

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Abstract

This paper explores how the automobile has indirectly led to dramatic changes in patterns of accessibility to retail and service activity within metropolitan regions. The automobile instigated a greater articulation of the hierarchy of transportation facilities, as reflected in a greater differentiation between the local and the regional systems. At the same time, the automobile instigated a collapse in the retail hierarchy, by encouraging the growth of community and regional centers at the expense of local shops and the central business district. The result has been a cycle of dependence, in which suburban communities are designed for the automobile, leaving residents little choice but to drive. Access to retail activity is now dependent on the automobile but vulnerable to increasing levels of congestion that are driven by dependence on the automobile.

Accessibility has been defined as the "intensity of possibility of interaction" (Hansen 1959). The accessibility of a particular location is determined by the distribution of potential destinations around that location and reflects both the ease with which each destination can be reached and the magnitude, quality, and character of the activity found there. Choice is central to this definition: the greater the number and variety of potential destinations, the greater the choice that residents have and the higher the level of accessibility. Travel cost is also central to this definition: the lower the travel costs, both time and monetary costs, the greater the number of destinations that can be reached within a set fiscal or time constraint and the higher the level of accessibility. The most dramatic change in accessibility in metropolitan regions in this century can be attributed to the automobile, which directly expanded accessibility by reducing the travel time to all destinations and providing residents with unprecedented freedom to choose when and to where they traveled.

Less obviously but perhaps more importantly, the automobile indirectly led to dramatic changes in patterns of accessibility to retail and service activity within metropolitan regions by instigating significant changes in the transportation and retailing systems. In general, the articulation of the hierarchy of transportation facilities has increased, with greater differentiation between the local and the regional systems. At the same time, the retailing hierarchy has collapsed, due to the

growing importance of medium-sized and specialized centers. As a result, access to regional centers of activity has improved, through the development of urban expressway and freeway systems and the rise of regional shopping centers. On the other hand, access to activity in the local area has declined, because of planning and design practices that separate land uses and emphasize automobile travel, coupled with an increase in the scale of "neighborhood" centers and establishments.

These changes have very direct implications for travel, as well as for quality of life. Prior to the wide-spread adoption of the automobile, a suburban resident would walk to local stores to buy the sorts of goods and services she needed on a regular basis. For less frequently purchased goods, she would ride the streetcar to downtown to shop in department stores and specialty shops. Now residents drive to one of the nearby strip malls to do their grocery shopping or pick up a prescription, or drive to one of several regional malls in the area to buy clothes and household goods. Today's typical suburban resident does not have the option of walking to a local store, either because there is no store within walking distance, or the walk is too dangerous and unpleasant. The resident has no reason to shop in the central business district, because the mall is much closer, has convenient parking, and offers all of the same goods and services.

Whether the new accessibility patterns are an improvement is to some extent a matter of preference: for those who like to walk, it might be worse; for those who like shopping malls, it is undoubtedly better. The problem is that these accessibility patterns are not sustainable. Because they were designed for automobile use—solely designed for automobile use, in most cases—and are dependent on high-speed travel, not proximity, these patterns generate levels of automobile travel that often exceed the capacity of the transportation system, creating congestion. As congestion increases, accessibility declines, all else being equal, since accessibility is partly determined by travel time: if congestion increases, then speeds decrease, and destinations are farther away from the perspective of travel time. The accessibility patterns that have emerged are particularly vulnerable to increasing congestion, because they are dependent on access by automobile, but for the same reason the patterns have led to increasing congestion. In other words, it is a self-destructive cycle of dependence.

This paper traces the role of the automobile in instigating these changes, describing first the emergence of the concept of a hierarchy of streets and highways, and then the upheaval in the retail hierarchy. In both cases it is clear that, as a result of these changes, accessibility to commercial areas has become dependent on the automobile. This paper concludes by discussing how this dependence has both increased congestion and left accessibility vulnerable to increasing levels of congestion. The question that remains to be answered is whether

this cycle of dependence will continue indefinitely or be broken before accessibility declines significantly.

The Transportation Hierarchy

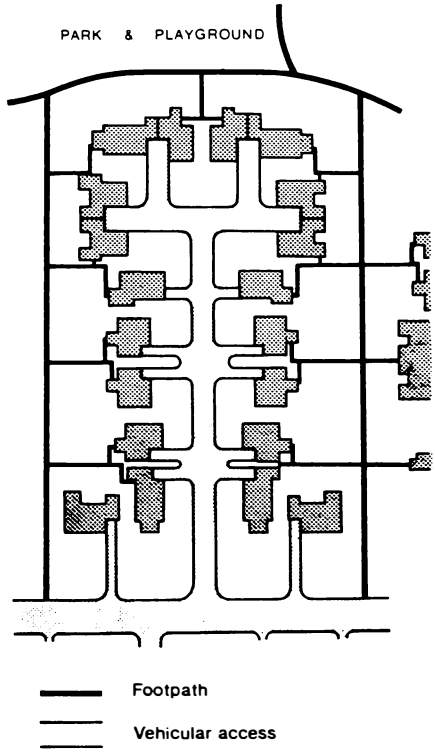
Although the basic rectilinear grid found in suburban communities remained generally unchanged until after World War II, the ideals that initiated the change emerged many decades earlier. The Garden City movement at the end of the 19th Century led to a "rediscovery" of the street system as a crucial design element and instigated a movement away from the grid toward a new pattern and scale of streets that would improve safety and increase light, air, and the sense of nature in suburban communities (Wolfe 1987). However, it was the increase in automobile traffic in the 1920s that eventually resulted in the emergence of the curvilinear streets concept and cul-de-sacs structured into a hierarchy of streets scaled according to their use.

The hierarchy concept was popularized by Raymond Unwin, Frederick Law Olmsted Jr., and Clarence Perry, among others. It achieved its fullest definition in Clarence Stein and Henry Wright's "landmark" design for Radburn, N.J., in 1928, in which the rectilinear grid "was unequivocally rejected" (Kostof 1991: 80). In their plan, houses were clustered on cul-de-sacs that linked to distributor streets that, in turn, linked to the arterial streets that bounded the development. In addition, pedestrian traffic was almost completely segregated from automobile traffic. A central open space contained "serpentine pedestrian and bicycle paths diving under rusticated over-bridges" (Hall 1988: 127) so that residents could walk from one end of the community to the other without having to cross a single street (Figure 1). The combination of the clustering of housing, the shift away from the grid, and the creation of a "superblock" meant that "not only through traffic, but all traffic, was excluded" from much of the development (Hall 1988: 127). Stein called their plan for Radburn "a town for the motor age" (Kostof 1991: 80): it guaranteed residents the benefits of the automobile but minimized its negative impacts, particularly with respect to pedestrian safety.

Concerns over safety due to rapidly increasing automobile traffic soon led to the establishment of formal guidelines and policies on the creation of hierarchies of streets. In 1938, the Federal Housing Administration published two pamphlets, "Planning Profitable Neighborhoods" and "Successful Subdivisions," which defined construction standards and desirable street patterns and were intended to keep the risk of real estate investment down and ensure marketability of new developments (Kostof 1991). The desired street patterns heavily favored curvilinear layouts with three-way T-intersections. After World War II, real-estate developers increasingly adopted the curvilinear form, partly due to the increasing volume and speed of traffic,

Figure 1

Typical Radburn Layout



Source: Harry Dupree, Urban Transportation: The New Town Solution (Brookfield, Vt.: Gower, 1987).

> . . . which made it necessary to choose street patterns that would differentiate between one kind of traffic and another, and eliminate points of conflict. So the planning profession came to accept the notion that there should be roads for fast traffic, and others for local use laid out as loops and cul-de-sacs; long blocks, if not superblocks; and three legged T-intersections that reduce traffic conflict points (Kostof 1991: 80).

The element of the Radburn plan that was omitted from policy and practice, however, was the separation of pedestrian from vehicle traffic. By the 1950s, the focus of suburban design had shifted entirely to the accommodation of the automobile.

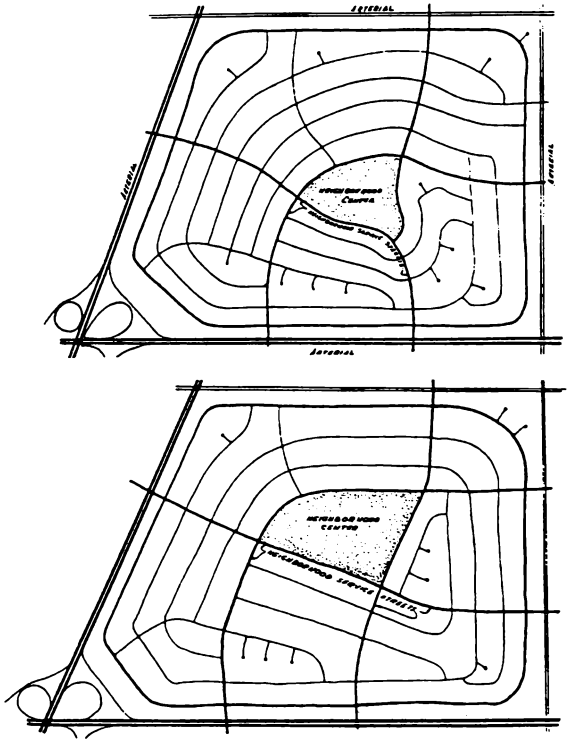
This shift in design philosophy became entrenched in transportation planning practice during the 1950s and is still evident today. Sunnyvale, California's, 1957 General Plan, for example, described neighborhood units bounded by arterials as a vision of the way in which the city was intended to grow (Figure 2). A 1958 example of the hierarchical philosophy, shown in Figure 3, proposed a one-mile spacing of arterials with a three-mile spacing of expressways to create a patchwork of one-mile-square residential developments (National Committee on Urban Transportation 1958). By the 1980s, this vision had not changed considerably.

The Institute of Transportation Engineers' 1984 (ITE 1984) guidelines on suburban development called for a hierarchical design (Figure 4), as did the guidelines for the American Society of Civil Engineers in 1990 (ASCE 1990) (Figure 5).

The guiding philosophy of the hierarchy is that facilities differ in the degree to which they serve access and/or movement functions (National Committee on Urban Transportation 1958). Local streets or subcollectors are designed to provide access to residences and carry very low volumes of traffic at relatively low speeds. Collectors provide for some access but also for movement between sub-collectors and arterials and carry somewhat higher volumes. Arterials principally serve a movement function, carrying even higher volumes at even higher speeds. Expressways and freeways represent successively higher steps in the hierarchy, with very limited access and significantly higher speed limits. In theory, the width, curbs, sidewalks, speed limits, parking provision, and similar factors of each facility are designed to match its projected level of use.

Figure 2

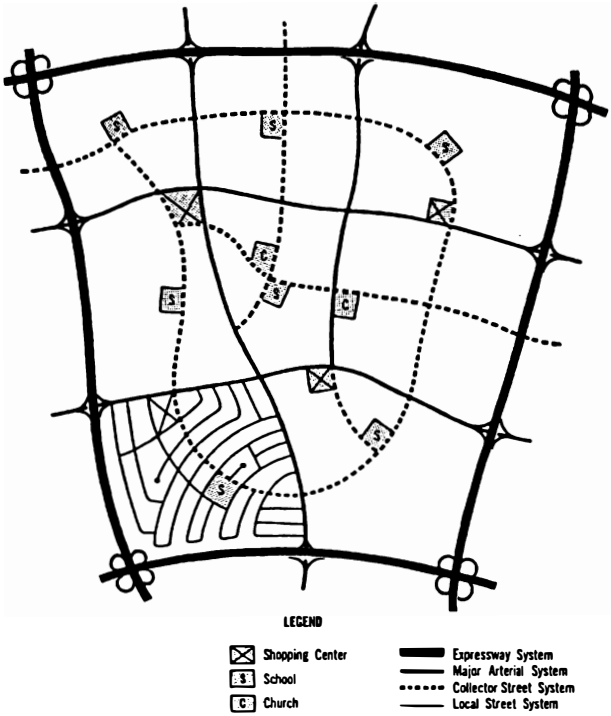
Example of Hierarchical Vision:
"The Neighborhood—General View"



Source: City of Sunnyvale, California, *Preliminary Studies for a General Plan* (Sunnyvale, California: City of Sunnyvale Planning Department, 1957).

Figure 3

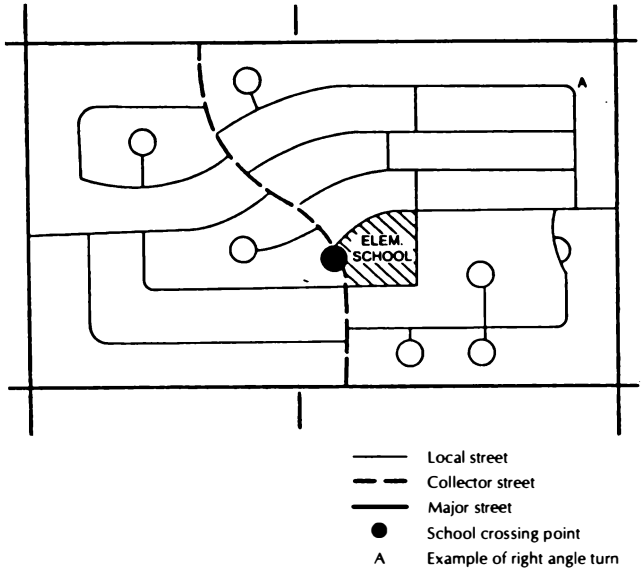
Example of Hierarchical Vision:
"Diagrammatic Layout for a Residential Area"



Source: National Committee on Urban Transportation, *Better Transportation For Your City: A Guide to the Factual Development of Urban Transportation Plans* (Chicago: Public Administration Service, 1958).

Figure 4

Example of Hierarchical Vision:
"Illustration of Layout Principles," Inst. of Transportation Engineers



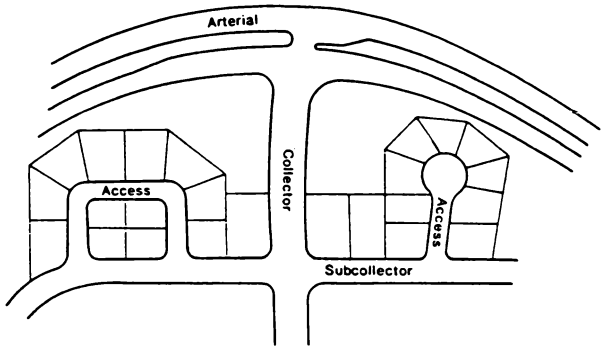
Source: Institute of Transportation Engineers, *Recommended Guidelines for Subdivision Streets* (Washington, D.C.: ITE, 1984).

A primary goal of this hierarchy is to minimize the volume of through traffic on residential streets in the interests of both safety and the quality of the living environment. Most versions of a hierarchy create residential areas bounded by high-speed arterials, with limited entrances from those arterials, an idea that clearly has its roots in the Radburn design. The American Society of Civil Engineers' 1990 guidelines (ASCE 1990), for example, discuss the pros and cons of having one or several entrances from arterial streets, noting that entrances must be designed for "convenient access" but not so that through traffic will be encouraged. The intentional exclusion of commercial land uses from residential areas that is associated with these designs is also justified on safety grounds. One report about pre-hierarchy, gridiron layouts claims: "Many residential area problems are caused by location

of land use activities which encourages or requires traffic to pass through residential neighborhoods" (Smith and Appleyard 1980: 12).

Figure 5

Example of Hierarchical Vision:
American Society of Civil Engineers, 1990



Source: American Society of Civil Engineers, National Association of Home Builders, Urban Land Institute, *Residential Streets*, Second Edition (Washington, DC: ASCE, 1990.)

In most cases, the hierarchical system has been implemented using curvilinear streets, although a hierarchy can be created using other street designs as well. Existing rectilinear grids, for example, frequently were altered beginning in the 1920s. A hierarchy was created by closing off local streets at arterials and by adding features that would slow traffic, such as speed bumps or landscaped "chokers." These changes were designed to prevent traffic from diffusing in all directions through the grid (Smith and Appleyard 1980) and were supposed to provide "existing gridiron subdivisions with some of the desirable characteristics of the limited-access subdivision" (Stover and Koepke 1988: 88). Nevertheless, the hierarchical system is associated primarily with a curvilinear design.

The hierarchical/curvilinear system as it has generally been implemented has had a number of implications for travel. One implication is that routes between any two points within a residential area can be both limited and indirect. Traffic is by necessity channeled to the one or two connections to arterials, thus generating high volumes on collectors and at a few major intersections, in contrast to a rectilinear grid, which tends to disperse traffic evenly throughout the network. The internal street system is often discontinuous, with three-way rather than

four-way intersections, to further discourage through trips (Stover and Koepke 1988). The result is that trips necessarily involve zig-zags and turns, in contrast to the straight-line trips possible in a grid layout. Although a purported advantage of the hierarchical approach is that it makes the street system "comprehensible" (ASCE et al. 1990), the layouts with which it has been implemented can be quite confusing to outsiders; one study claims that these "complex and confining streets patterns" help to reduce the incidence of crime for precisely this reason (Smith and Appleyard 1980: 15).

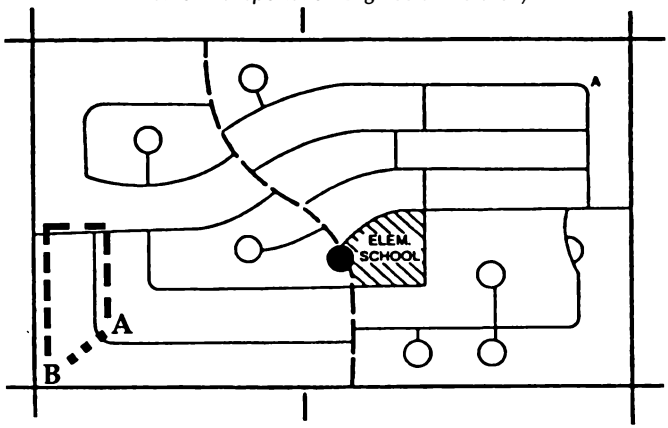
A second implication is that residential areas are separated from surrounding development. Wolfe (1987: 121) decries the effect of this situation: "densely trafficked, the new high-speed arterials that surround neighborhoods in effect separate one from the other, transforming them into no-man's-lands in between." This separation means that the relationship of each residential subdivision to its neighboring subdivisions and to the city as a whole is largely ignored (Wolfe 1987, Homburger et al. 1989). Thus, through their impact on travel distance, hierarchical subdivisions further strengthen the separation between residential and commercial areas. For example, a commercial center may be located on an arterial just over the back fence of a particular house, but its residents may be forced to travel a significant distance by street to reach it. Figure 6 shows how the straight-line distance can be several times greater than the street distance Mr. A must travel to get to store B. As a result of these changes, local travel, has become more cumbersome.

Pedestrian activity also has been affected by these design practices. Local streets have become safer environments for pedestrians because traffic is minimized. Most guidelines suggest that sidewalks may not even be needed on these streets, as it is deemed safe for pedestrians to walk in the street, and the costs of providing a sidewalk are judged to exceed the benefits (ASCE et al. 1990, Homburger et al. 1989). While local streets are in theory designed for slower speeds, they have in practice generally been designed with excessive widths that encourage fast driving (Institute of Transportation Engineers 1984) and may not always provide safe environments for pedestrians. On higher-volume streets, wider sidewalks with landscaped buffers are recommended, but these design changes may not be enough to overcome the perceived danger and very real discomfort of walking along a high-volume, high-speed street. This consideration is particularly important for children, elderly and others who depend on walking as their primary means of transportation. Although local streets may be safer environments for children in the hierarchical design (it is not clear that they always are), it becomes dangerous for them to walk or bike to the local store, since they are forced onto the arterial that carries high volumes of traffic at high speeds. In addition, the separation between residential and commercial areas that is associated with the hierarchy means that

the local store might not be within convenient walking distance. Thus, the hierarchy has the potential to increase pedestrian activity on local streets, but almost certainly discourages pedestrian trips to areas outside the arterial-bounded superblock.

Figure 6

Straightline vs. Network Distance,
Inst. of Transportation Engineers' Hierarchy



Source: Institute of Transportation Engineers, *Recommended Guidelines for Subdivision Streets* (Washington, D.C.: ITE, 1984).

On the other hand, the hierarchy means that once a resident reaches the arterial, the expressway and freeway system facilitate travel to other parts of the region (at least during off-peak hours). The first urban expressways and freeways tended to be radially oriented, providing a link between suburban communities and the central city. Later, "beltways" were constructed around most metropolitan regions, linking one suburban area to another. By 1985, the urban federal-aid highway system contained over ten times the mileage of the 1950 system (Federal Highway Administration 1985). The facilities at the high end of the hierarchy allow for relatively direct trips at relatively high speeds to re-

gional centers, conveniently located at interchanges. Trips to regional centers of activity have become easier, at the same time that trips to local commercial areas have become more difficult. In fact, the accessibility that these higher-level roadways provide has enabled the development of suburban shopping centers and has led to an upheaval in the traditional retail hierarchy.

The Retail Hierarchy

Historically, the retail hierarchy emerged because of differences in the nature of goods being sold. Frequently purchased "convenience" goods require a relatively small market area. A grocery store can thrive on a population of less than 10,000. In contrast, infrequently purchased "comparison" goods require a much larger market area, on the order of 100,000 people or more for department stores. The hierarchy reflects not only the type of good, but the size of the establishment in which it is sold; e.g., supermarkets require a larger market area than grocery stores. In addition, establishments are sorted by the size of the center in which they are located, with large establishments selling comparison goods found in "higher order" regional centers and small establishments selling convenience goods found in "lower order" neighborhood or convenience centers. Berry (1967: 20) defined the hierarchy of retail trade, which was first articulated in Christaller's central place theory, as consisting of a "distinct step of centers providing distinct groups of goods and services to distinct market areas." The Urban Land Institute's (1985) definition of the hierarchy of retail centers is shown in Table 1.

Table 1

Urban Land Institute's Retail Hierarchy Definition

Type of Center	Minimum Population Needed	Radius (miles)	Driving Time (minutes)
Super-Regional	300,000 or more	12	30
Regional	150,000 or more	8	20
Community	40,000 to 150,000	3 to 5	10 to 20
Neighborhood	2,500 to 40,000	1.5	5 to 10

Source: Urban Land Institute, *Shopping Center Development Handbook*, Second Edition (Washington, D.C.: Urban Land Institute, 1985).

Although the actual pattern of retail centers within metropolitan regions has never completely fit this neat description, today's retail sys-

tem bears even less resemblance to the theoretical hierarchy than before. Rapid suburbanization and increased automobile use beginning after World War II instigated significant changes in the retail hierarchy in metropolitan regions. In particular, developers began to design shopping areas specifically for customers who would be arriving by automobile, instead of by foot or streetcar. The result was a dramatic change in accessibility patterns within metropolitan regions.

Before World War II, retail activity was concentrated largely in central business districts. Hoyt (1968) observed that in 1920, 90 percent of general merchandise sales were made in the central business district (CBD). When Proudfoot (1937: 1,3) looked at 37 cities in the U.S., "the retail structure of which [were] characterized by a high degree of decentralization," the CBD was still the "retail heart of the city" for both convenience and comparison shopping. Philadelphia's CBD accounted for over 37 percent of total sales, and the average sales per store was over three times higher than outside of the CBD. Thirty-two "outlying" centers, or "miniature" CBDs, were also identified, but accounted for less than 20 percent of sales. This left an important role for neighborhood businesses: over 40 percent of sales were made in the two-thirds of the stores that were located outside of centers. Customers of these establishments, located along neighborhood business streets or in isolated store clusters, came from within "easy walking distance." Residents walked to local stores or rode the streetcar to the central shopping district.

But the growing importance of the automobile was already having an impact well before World War II. The U.S. Bureau of Foreign and Domestic Commerce in 1924 recognized the importance of automobile access, though the focus was still on the streetcar. This report advised store owners that "bus lines and automobile traffic to surrounding points may be large factors drawing trade" (p.4), and suggested that store owners might not want to select a store location on a street with a streetcar line, if prospective customers were likely to drive. Proudfoot's Philadelphia study identified 16 "principal business thoroughfares," which were "both a business street and a traffic artery," carrying traffic into the CBD or to an outlying center (p.4). Along these strips were "large, widely-spaced" convenience and comparison stores with "ample" curb-side parking. These strips or "string streets" did not fit easily into the concept of a retail hierarchy (Garrison et al. 1959), and the hierarchy began to unravel.

In the 1950s, the hierarchy of unplanned clusters of establishments began a transformation to a hierarchy of planned centers, as retail technology adapted to the use of the automobile (Berry 1967). Once residents had switched to the automobile in large numbers, traffic in downtown shopping areas came to a standstill. Retailers quickly realized the potential in decentralization and located branch stores in less

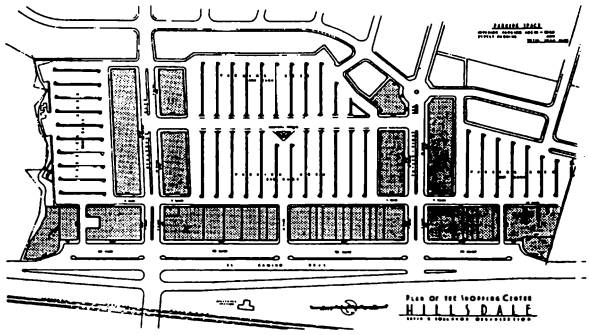
congested suburban areas that were more accessible to their customers, a trend well documented for Los Angeles by Bottles (1987). These freestanding department stores located on large lots with ample parking provided the first seeds for growth of regional shopping centers (Urban Land Institute 1985).

Several reports by the Urban Land Institute (ULI) illustrate the rapid change in retailing beginning after Word War II. In 1945, a ULI Technical Bulletin was already reviewing "mistakes [in location and design] we have made in developing shopping centers" (Nichols 1945: 1), although most of the centers included in the study were more like shopping districts, integrated into the local street grid, rather than shopping centers as they have come to be known. By 1949, the ULI claimed that "the shopping center is becoming a familiar and integral part of the American neighborhood scene" (Mott and Wehrly 1949: 3). In 1953, a mall consisted of "a pedestrian street with two strips of stores face to face," and some centers had been developed with "parking on all four sides to reduce walking distances" (McKeever 1953: 24, 62). The dramatic evolution in shopping center design during this period is demonstrated by the 1947 and 1953 plans for Hillsdale Shopping Center in San Mateo, California (Figure 7). By 1957, the ULI was publishing extensive guidelines on the development of shopping centers, many of which contained two department stores (McKeever 1957). The number of planned centers grew from under 1,000 in 1950 to over 25,000 (of all sizes) in 1984 and accounted for over 40 percent of all retail sales (ULI 1985).

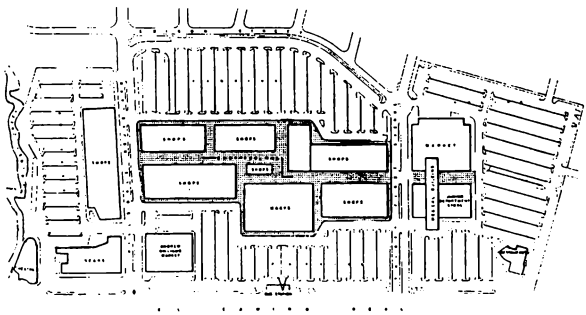
Clearly, the automobile had much to do with this trend in shopping mall design. McKeever (1957: 12) claimed that shopping centers represented "the first established commercial building type which really takes into account the Americans' use of their automobiles as part of their everyday living habits." Garrison also identified the importance of the automobile: "the location of centers with respect to the [highway] system plays a vital role in the success of centers. . . centrality implies accessibility to residences via the highway system" (Garrison et al. 1959: 136). Similarly, the greater ease of movement provided by the automobile meant that "the purchase of high order goods in specialized centers is substituted for purchase of these goods in lower order centers." These centers drew business from both the CBD and local commercial areas, since they offered a mix of comparison and convenience shopping and the possibility of one-stop shopping.

Figure 7

Evolution of Suburban Shopping Center Design:
Plans for Hillsdale Shopping Center, San Mateo, CA, 1947 & 1953



12a. PLAN ONE—HILLSDALE SHOPPING CENTER. Strip Building Plan with Parking Lumped in Rear of Stores. Plan as Proposed in 1947.



12c. PLAN THREE. Plan as Being Constructed 1952. Better Use of Mall Frontages. More Careful Store Grouping. Better Arrangement of Parking Areas and Improved Circulation. Bus Stop Incorporated for Mass Transportation.

Source: J. Ross McKeever, "Shopping Centers: Planning Principles and Tested Policies" (*Technical Bulletin No. 20*, Urban Land Institute, July 1953).

By the 1970s, "super-regional" malls, with four or more department stores and two levels of shops, were the fastest growing category of shopping centers. The implications of this trend are well recognized in the ULI's Shopping Center Development Handbook:

> Perhaps the most significant innovation of the 1970s was that regional centers grew in stature from being simply locations for retail sales to becoming the focus of community activity, offering retail shopping, entertainment, food, theaters, and other forms of recreation or leisure time activity . . . the mall of the regional shopping center became downtown Main Street a place to meet people, a place to see people (ULI 1985: 14).

Regional malls, in other words, have become the center of public activity for many suburban communities, replacing the traditional downtown or town square of early suburban communities and shifting the focus of public life away from the neighborhood level and toward the regional level. That this was the goal of shopping center developers can be seen as early as 1960:

> . . . By affording opportunities for social life and recreation in a protected pedestrian environment, by incorporating civic and educational facilities, shopping centers can fill an existing void. They can provide the needed place and opportunity for participation in modern community life that . . . our own Town Squares provided in the past . . . if the shopping center becomes a place that not only provides suburbanites with their physical living requirements, but simultaneously serves their civic, cultural and social community needs, it will make a most significant contribution to the enrichment of our lives (Gruen and Smith 1960: 23-24).

Neighborhood centers also underwent a transformation during this period. In 1959, a typical neighborhood center included a supermarket, a drug store, a dry-cleaner or laundry, and other convenience establishments (Garrison et al. 1959). Although new types of establishments, such as video rental stores, appeared in these centers over time, their basic function did not change significantly. One trend was toward greater specialization, as centers tailored their products and services to match the demographics of local residents (ULI 1985). However, the scale of these centers increased as supermarkets themselves grew in size and in the diversity of products and services they provided. "Super drugstores" were also increasingly found in neighborhood centers. As the scale of the centers and their establishments increased, they needed a greater population to support them; as long as population densities were constant or decreasing, the increasing scale implied that the distance between centers grew over time. Today's neighborhood centers may have more to offer to local residents, but they are farther away on average than before. The result is longer automobile trips and fewer pedestrian trips to commercial areas.

In addition, only superficial consideration was given to integrating these centers into residential development. Whereas in Proudfoot's (1937) survey, neighborhood retail activity was located throughout residential areas and integrated into the residential fabric, post-World

War II zoning and design practices meant that residential and commercial areas were strictly segregated. Developers themselves favored locations within sight of freeways and expressways. Now, efforts to integrate commercial activity are limited to considerations of the "compatibility of design" of the neighborhood center with surrounding residential development and the use of higher-density residential development, as a transition between centers and low-density residential areas (ULI 1985). This separation has further contributed to an increase in minimum distances from residences to commercial areas and has often made walking to these areas undesirable even where the distances are reasonable.

Community centers, larger than neighborhood centers but much smaller than regional centers, emerged to serve intermediate functions. New forms of retailing, such as discount department stores, off-priced clothing outlets, or "super-super drug stores" often located in these centers, as did previously free-standing stores such as hardware and furniture stores. Indeed, the emergence of a full spectrum of retail center sizes reflects the advantage that centers have over free-standing establishments; the center's "ability to provide one-stop convenience and to combine trips gave it obvious advantages over scattered retail locations" (ULI 1985: 17). These centers represent concrete evidence of the benefits of agglomeration economies. Combined with easy access from major arterials or even freeways and ample parking, this advantage has made such centers a dominant retailing form in automobile-dependent suburbs.

In addition to neighborhood, community, regional, and super-regional centers, a number of other retailing forms have emerged: outlet centers, "power" centers, discount centers, and other specialty centers. Strip commercial developments, consisting of a string of independently developed commercial lots (ULI 1985), are still ubiquitous. Clusters of community centers may function like a single regional center (Martin 1990). Most of these newer forms are on the scale of community centers, thus bringing more commercial activity within short driving distances of residential areas.

Hierarchies of particular types of *establishments* have also changed, further complicating the picture. As noted above, the size of supermarkets has been growing over time: in 1953, the median size of a new supermarket was 13,600 square feet, while in 1987, the median size was 46,892 square feet (Food Marketing Institute 1990). The range of products and services has also grown. In 1980, 37 percent of supermarkets had a deli, 28 percent had a bakery, and 19 percent had a floral shop. By 1989, these numbers had grown to 72 percent, 62 percent, and 51 percent of supermarkets, respectively (Food Marketing Institute 1990). As the size and complexity of supermarkets increased, their numbers decreased. For example, in Seattle in 1940, there were

1,144 persons per supermarket, versus 11,028 persons per supermarket in 1990 (Yim 1990). This change resulted in an increase in average travel distance, from 0.46 miles to 0.79 miles, from just under to considerably over the maximum acceptable walking distance commonly assumed by designers and planners.

A number of other types of food stores have emerged, however, to fill specific needs. Quick-stop convenience stores have replaced mom-and-pop grocery stores to some degree. These convenience stores are a fraction of the size of supermarkets, at an average size of 2,377 square feet (National Association of Convenience Stores 1990), but offer a wide range of products and services, including prepared food, and are often open 24 hours a day. They differ from the mom-and-pops, however, in that they are almost always designed and located for automobile access. For example, AM/PM Mini-Markets are found at ARCO gas stations. At the upper end of the hierarchy, discount warehouses, such as Price Club and CostCo, are growing in popularity. These establishments sell food and a full range of other products, in bulk quantities and at discount prices. The Food Marketing Institute has forecast the discount warehouse share of the grocery business will double within 10 years to between 13 and 20 percent (*San Francisco Examiner* 8/2/92). Discount warehouses, generally located at freeway and expressway interchanges, are also designed for automobile access.

The result of these changes is that the retailing system fits the concept of a hierarchy of well-defined centers less well than ever. A recent survey concluded that while planners hold to the ideal of a hierarchy of nucleated centers, the reality that they face is a commercial system much more complex than the ideal (Howe and Rabiega 1992). Martin (1990: 15) observes that developers are going to build wherever there is a market to serve, including areas previously ignored; "in the process, the distinctions between types of centers will become blurrier than ever." He echoes Howe and Rabiega in predicting that "more new terms will be invented to describe the new mix" (p. 15).

More importantly, these changes have had significant implications for accessibility and travel. While residents are generally farther away from convenience shopping than before, they are much closer, at least by automobile, to a full range of comparison shopping and personal services. A wide variety of needs can be met within a single center or even within a single store, increasing the possibility of multi-purpose trips and potentially reducing the total number of trips. This structure encourages trips by automobile, even if the distances are short or the transit service is exceptional, because of the volume of goods that customers may buy in any single trip. The new pattern of retail accessibility is highly dependent on the automobile.

The Cycle of Dependence

The net impact on accessibility of all of these changes is difficult to assess. On one hand, community and regional centers have brought specialized goods and services closer to suburban residents, to the point where the CBD has little extra to offer the shopper, except inconvenience. On the other hand, convenience shopping has become less convenient from a travel standpoint. The scale of neighborhood centers has increased and planning and development practices have pushed commercial activity outside the boundaries of residential areas and have made walking unappealing. Whatever the net impact, however, current levels of accessibility are not sustainable, unless these trends change.

The dependency of today's accessibility on the automobile means that it is vulnerable to increasing congestion. Regional centers are now reached almost exclusively by automobile by way of expressways and freeways. As congestion increases and speed decreases, these centers will drift farther away from residential areas with respect to travel time. But residents usually have no alternative to driving: transit is rarely a viable option. Accessibility to neighborhood and regional centers will also be impacted by congestion, because it too is dependent on the automobile and the level of service on arterial streets. Congestion results in increasing delays at the major intersections where most of the neighborhood and community centers are now located. Again, residents have no choice but to drive: walking to a neighborhood center is no longer an option in many suburban communities. The shopping opportunities and the available services may be growing and improving, but they are more and more costly to reach.

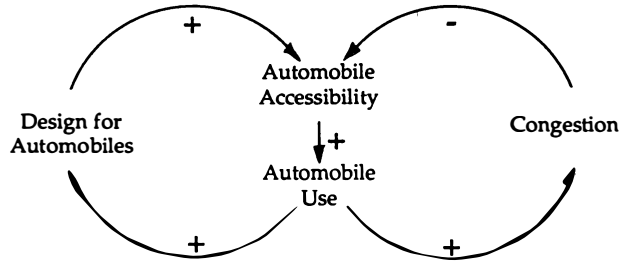
The automobile dependency that is associated with today's accessibility patterns is also a large contributor to the increasing levels of congestion that are threatening that accessibility. By 1990, automobile ownership had increased to more than one vehicle per licensed driver nationwide. The average number of trips and the average miles traveled by motorized vehicle per household per year both increased by 22 percent from 1969 to 1990, at the same time that household size decreased by 19 percent (FHWA 1992). Most of the growth has been in shopping and other family or personal business travel, rather than work travel. Vehicle-miles traveled have thus increased dramatically, while increases in the capacity of the road system have slowed. The result is that congestion in urban areas has also grown: less than 25 percent of urban interstate freeway miles were at congested conditions (defined as a volume-to-capacity ratio of greater than 80 percent) during peak hours in 1975, versus 45 percent at congested conditions in 1990 (FHWA 1990).

Historically, we have seen a cycle of dependence: the use of automobiles encouraged design for automobiles which encouraged the use

of automobiles (Figure 8). The cycle continues today. Places are designed for the automobile because that is what the vast majority of residents use to get to those places. But because of the design, they have no choice but to drive, even if some might want to walk or take public transit: today's accessibility patterns are dependent on the automobile. We are now seeing a cycle of destruction: automobile-dependent accessibility necessitates automobile use which increases congestion which, in turn, decreases levels of accessibility. The perpetual design of transportation and retailing systems for the automobile will ultimately contribute, and may already be contributing, to a decline in accessibility in metropolitan areas.

Figure 8

The Cycle of Dependence —The Cycle of Destruction



Breaking the Cycle

Is there any way to break this cycle? Proposals have emerged to do just that, by returning to less automobile-dependent forms of suburban development, ones that are designed for other modes of travel as well. Proponents of "neo-traditional development" suggest that by returning to the traditional rectilinear grid, by integrating commercial activity with residential areas so that residents are within a reasonable walking distance, and by paying more attention to the design of suburban environments from the perspective of walkers and bicyclists, the cycle of automobile dependence can be broken. Whether these designs will have any significant impact remains to be seen (Handy 1992). We may, in fact, be beyond redemption.

Clearly any effective solution will require changes in both the transportation system and the retail system. Distances between residential and commercial areas can be reduced by both developing smaller cen-

ters that require smaller market areas and creating more direct links between residential and commercial areas. This would bring potential destinations within reasonable walking distances, and reduce driving distances for those who continue to rely on the automobile. The appeal of walking can be improved by paying attention to the design and location of pedestrian ways, as well as the design of commercial areas with respect to pedestrians. This would provide pedestrians with an alternative to walking along high-speed, high-volume arterials and crossing vast parking lots to reach the store. But such change is resisted by the risk aversion of developers, the realities of retail economics, and the entrenched practices of planners.

The important thing to remember is that this dependency is or at least was a matter of choice. Residents adopted the automobile because they preferred it to public transit: it was more comfortable, more convenient, and got them where they wanted to go when they wanted to go. In short, it vastly increased their access to all parts of the metropolitan region. But the choice quickly became necessity, as already inferior alternatives largely disappeared. The question now is whether we will or can once again make automobile use a matter of choice. Whether or not neo-traditional design principles ultimately reduce automobile travel, they at least will give people the choice to continue to rely solely on automobile accessibility or to take advantage of the walking and transit accessibility that these communities may offer. The automobile vastly expanded our choice of potential destinations, but we can expand our choice even further by providing alternatives to automobile dependence.

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REFERENCES

American Society of Civil Engineers, National Association of Home Builders, Urban Land Institute. 1990. *Residential Streets.* Second Edition.

Berry, Brian. 1967. *Geography of Market Centers and Retail Distribution.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Bottles, Scott L. 1987. *Los Angeles and the Automobile: The Making of the Modern City.* Berkeley: University of California Press.

Federal Highway Administration. 1990. *Highway Statistics*. Washington, D.C.: U.S. Dept. of Transportation.

_____. 1992. *Summary of Travel Trends: 1990 Nationwide Personal Transportation Survey*. Washington, D.C.: U.S. Department of Transportation.

_____. 1985. *Highway Statistics*. Washington, D.C.: U.S. Department of Transportation.

Food Marketing Institute. 1990. "Facts About Store Development, 1989." Washington, D.C.

Garrison, W. L., et al. 1959. *Studies of Highway Development and Geographic Change*. Seattle: University of Washington Press.

Gruen, Victor, and Larry Smith. 1960. *Shopping Towns USA: The Planning of Shopping Centers*. New York: Reinhold Publishing Co.

Hall, Peter. 1988. *Cities of Tomorrow*. Oxford and New York: Basil Blackwell.

Handy, Susan. 1992. "Regional Versus Local Accessibility: Neo-Traditional Development and its Implications for Non-work Travel." *Built Environment* 18(4): 253-267.

Hansen, Walter. 1959. "How Accessibility Shapes Land Use." *Journal of the American Institute of Planners* 15: 73-76.

Homburger, Wolfgang, et al. 1989. *Residential Street Design and Traffic Control*. Institute of Transportation Engineers. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Howe, Deborah A., and William A. Rabiega. 1992. "Beyond Strips and Centers: The Ideal Commercial Form." *Journal of the American Planning Association* 58(2): 213-219.

Hoyt, Homer. 1968. "The Changing Principles of Land Economics." *Technical Bulletin No. 60*. Washington, D.C.: Urban Land Institute.

Institute of Transportation Engineers. 1984. *Recommended Guidelines for Subdivision Streets*. Washington, D.C.

Kostof, Spiro. 1991. *The City Shaped: Urban Patterns and Meanings Through History*. Boston: Little, Brown, & Co.

Martin, Dan. 1990. "Shopping for Trends." *Planning* 56(12), December: 14-18.

McKeever, J. Ross. 1953. "Shopping Centers: Planning Principles and Tested Policies." *Technical Bulletin No. 20*. Urban Land Institute, July.

_____. 1957. "Shopping Centers Re-Studied: Emerging Patterns and Practical Experiences." *Technical Bulletin No. 30 and No. 31*. Urban Land Institute, February.

Mott, Seward H., and Max S. Wehrly. 1949. "Shopping Centers: An Analysis." *Technical Bulletin No. 11*. Urban Land Institute, July.

National Association of Convenience Stores. 1990. *Convenience Store Industry 1990 Fact Book*. Alexandria, Virginia.

National Committee on Urban Transportation. 1958. *Better Transportation For Your City: A Guide to the Factual Development of Urban Transportation Plans*. Chicago: Public Administration Service.

Nichols, J. C. 1945. "Mistakes We Have Made in Developing Shopping Centers." *Technical Bulletin No. 4*. Urban Land Institute, August.

Proudfoot, Malcolm. 1937. *Intra City Business Census Statistics for Philadelphia, PA*. Washington, D.C.: U.S. Bureau of Foreign and Domestic Commerce, Government Printing Office.

Smith, Daniel T., and Donald Appleyard, et al. 1980. *State of the Art: Residential Traffic Management*. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

Stover, Vergil G., and Frank J. Koepke. 1988. *Transportation and Land Development*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Sunnyvale, City of. 1957. *General Plan for Sunnyvale*. City Planning Commission.

Urban Land Institute. 1985. *Shopping Center Development Handbook*. Washington, D.C., Second Edition.

U.S. Bureau of Foreign and Domestic Commerce. 1924. *Retail Store Location*. Washington, D.C.: Government Printing Office. Prepared under the direction of L. A. Hansen, Domestic Commerce Trade Information Bulletin No. 269.

"Welcome to the Club." 1992. *San Francisco Examiner*. 8/2/92: p. E1.

Wolfe, Charles R. 1987. "Streets Regulating Neighborhood Form: A Selective History," in *Public Streets for Public Use*, Anne Moudon, ed., New York: Columbia University Press.

Yim, Youngbin. 1990. "The Relationship between Transportation Services and Urban Activities: The Food Retail Distribution Case." Unpublished Ph.D. dissertation, Department of Transportation Engineering, University of California at Berkeley, June.