tool kit

Connectivity

Connectivity is a measure of how well a roadway or pedestrian network provides route alternatives between origins and destinations. In terms of the Regional Thoroughfare Network (RTN), communities and municipalities that are well-connected within their own boundaries make better use of thoroughfares for through-travel by offering parallel, alternate routes for local trips.

Benefits of Connectivity

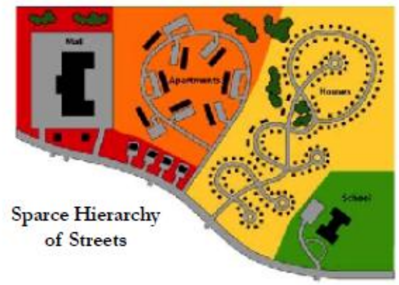
The American Planning Association (APA) states that transportation efficiency is "enhanced when there are consistent and adequate street connections that allow people and goods to move with as few impediments as possible." In addition, "proper street connectivity reduces miles travelled, increases non-motorized trips, and supports transit use[1]."

Decreased Traffic Congestion

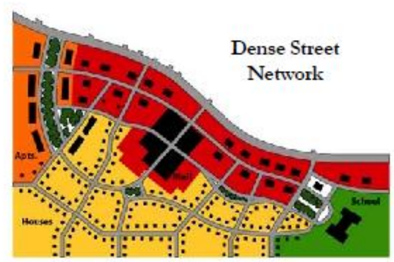
Conventional suburban development is disconnected with single-use pods of development. The road system is typically comprised of a hierarchy of private, local, collector, arterial, and principal arterial roads, as shown in the figure to the right of the page.

This disjointed road system and development pattern forces local traffic onto arterial streets for local trips that should be served by local streets. The result is severe traffic congestion on arterial roadways that should maintain high travel speeds to effectively serve primarily regional trips. The Institute of Transportation Engineers (ITE) stresses that improved connectivity helps keep short, local trips off arterials by providing an alternate, local route[2].

With increasing connectivity, the roadway network becomes more grid-like. A gridded network contains more capacity, spreads traffic out across multiple routes, and so reduces congestion. A grid also provides shorter routes from point A to point B, and so reduces travel times between points.

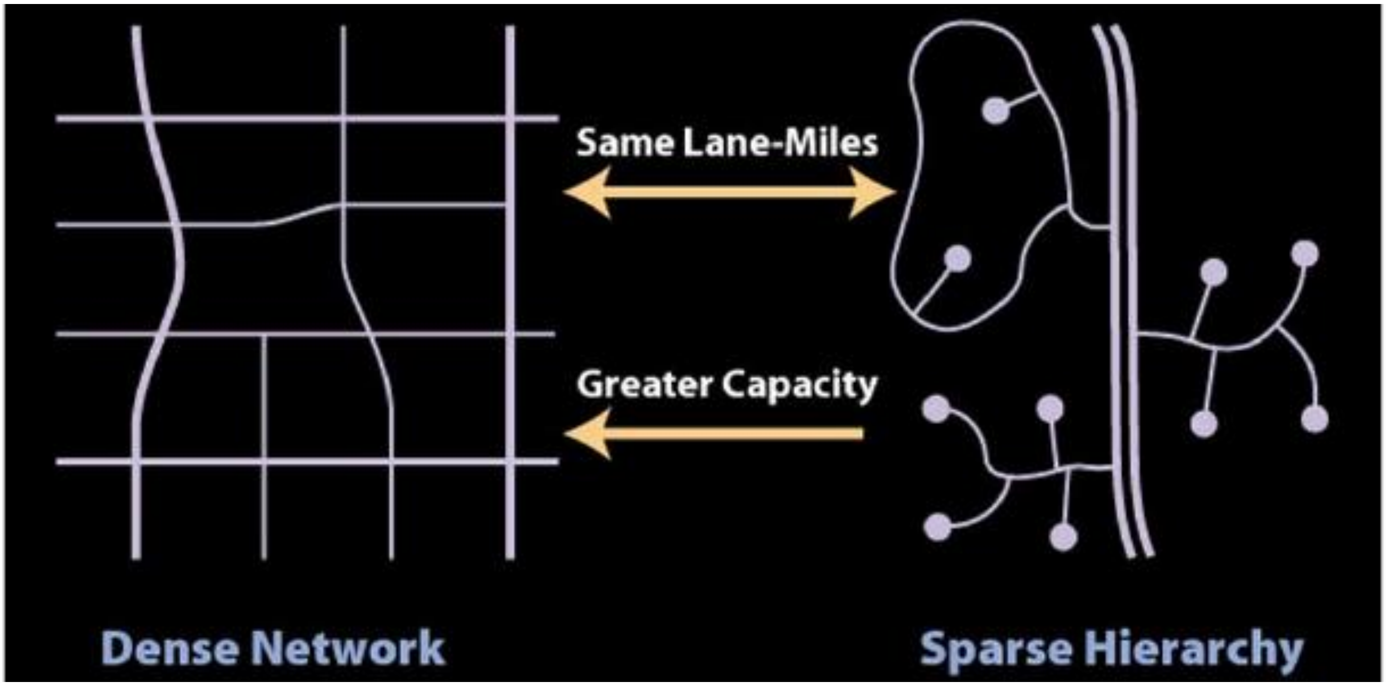


A typical suburban tract at four housing units per acre on cul de sacs forms a rough grid of through streets spaced at about 3,000 feet apart, resulting in traffic volumes of 9,000 vehicles per day on the arterial grid – too much for neighborhood interaction.



Placing the same houses on an interconnected grid size of 750 feet reduces the traffic on each street to less than 2,000 vehicles per day, which is satisfactory for neighborhood interaction. A smaller grid size would reduce traffic even more.[2]

ITE states that "networks should provide a high level of connectivity so that drivers, pedestrians and transit users can choose the most direct routes and access urban properties."



Studies have confirmed that a more connected roadway network reduces travel times and overall vehicle miles travelled (VMT). Well-connected traditional neighborhood networks have been found to reduce VMT by 57% compared to less-connected conventional suburban networks[3]. Reduced VMT also has the added benefit of improving air quality in a community. **Figure 2** above shows the increased capacity benefits and the ability to provide more direct routes of grid systems as opposed to suburban systems.

Pedestrian & Bicycle Safety

A well-connected network provides more direct routes. This creates opportunities for pedestrians and bicyclists to reach destinations within comfortable walking (1/4 mile) or bicycling (2 miles) distances, making a more pedestrian and bicycle friendly environment. Studies have shown that pedestrian volumes are significantly higher in areas with more street/ sidewalk connections and smaller block sizes. In comparison of two similar areas in Seattle, WA, with similar population sizes, population densities, and mixed-use neighborhoods, pedestrian volumes were found to be four times higher in the area with smaller block size and greater number of street and sidewalk connections[4].

Improved connectivity also enhances pedestrian safety. Traffic speed has the tendency to increase in open expanses of roadway with few interruptions. Added road intersections calm traffic speeds, which makes it safer for pedestrians and bicyclists to cross roadways. Motorists also adjust their driving behavior in the presence of increased numbers of pedestrians and bicyclists, as witnessed by inverse relationship between the likelihood of a pedestrian or bicycle accident and number of pedestrians and bicyclists in an area[5]. Well-connected places that exhibit higher levels of pedestrian travel are also safer environments for pedestrians.

Planning for Pedestrians at the Parcel Level

Pedestrian and vehicular connectivity often coincide through the provision of sidewalks adjacent to roadways. However, a complete network of pedestrian-ways through a community is required to achieve pedestrian connectivity. This network can take the form of sidewalks or pathways through developments, multi-use trail systems through urban or natural areas, hiking trails, and pedestrian crossings and bridges.

Pedestrian Planning in Urban, Suburban and Rural Areas

Urban

Wide Sidewalks

Suburban

Safe Routes to Schools

Rural

Multi-Use and Hiking Trails

Pedestrian connectivity can be required at the parcel level through regulations requiring inter-parcel pedestrian access to neighboring non-residential parcels. Typical zoning regulations do not require this and the result is a community with fences, shrubbery, and landscaped buffers where pedestrian connections should be. Requiring stub streets to adjacent undeveloped parcels that must be connected when new development is built, greatly increases pedestrian connectivity in residential and non-residential areas.

Pedestrian Connectivity in Urban, Suburban, and Rural Areas

Pedestrian connectivity varies in urban, suburban and rural areas. Different facilities are appropriate in different areas. In urban areas, a continuous sidewalk network is needed along all roadways to provide safe access between destinations. These sidewalks should be wide (10-20 feet) to permit outdoor dining and street furniture such as benches. In suburban areas, the primary importance of the network is for safe pedestrian routes from residential neighborhoods to the schools that serve them. In rural areas continuous sidewalk networks are not practical to serve the wide-spread population. In these areas a network of hiking and multi-use trails through natural areas would benefit rural residents, as well as the urban/suburban recreationalist. **Figure 3** below illustrates appropriate pedestrian facilities for each area.

Regulation and Zoning Standards Used to Increase Connectivity

A number of communities around the country have incorporated connectivity standards into their subdivision and development regulations. The most common ways of regulating connectivity are through block length and area limits and connectivity indices.

Block sizes can be regulated through block area limits or through block length limits. They can be also determined by the spacing of intersections to ensure streets in a community are uniformly arranged. Block lengths between 330 feet and 550 feet have been shown to support connectivity. Imposing block length standards can be an easy way to enforce connectivity, but these standards are inflexible; they do not permit for situations in which site conditions such as topography or hydrology make this infeasible or undesirable. Cul-de-sacs are typically restricted or limited in length in communities with block length requirements. Permitting limited cul-de-sacs of 200' or 300' in situations where block length requirements are infeasible is one way to ensure requirements provide for flexibility and are not too onerous for the development community.

Connectivity Indices

The second commonly used technique to ensure connectivity is through connectivity indices. These are measured by the ratio of links to nodes (i.e. street segments to intersections/cul-de-sac heads): the higher the ratio the greater the connectivity of the street system, with 1.7 being a traditional grid and 1.2 being a typical suburban network. Using these indices as opposed to block length requirements allows for greater flexibility in accommodating unique site features. It can also serve as a performance measure in a performance based development approval process. The result of using these standards is more four way intersections and fewer cul-de-sacs. Other less common techniques to calculate connectivity are calculating the number of intersections per road mile and the ratio of travel distance to straight-line distance.

National Experience with Connectivity Standards

Municipalities around the country have been adopting connectivity standards and ordinances to improve connectivity in their communities. From the multitude of national experiences the following commonalties stand out:

- Fire Departments are strongly in favor of connectivity.
- The typical impetuses for ordinances have been to improve subdivision design, emergency response time, alleviate traffic on arterials, and encourage walkability and alternative modes of transportation.
- A wide variety of regulated items and maximum limits have been used to enforce connectivity (maximum block length, maximum block area, maximum distance between street connections, maximum cul-de-sac length, prohibiting cul-de-sacs, prohibiting gated and private streets, requiring stub streets, requiring minimum connectivity index).
- Regulations have been successful in previously undeveloped areas, as well as in infill sites.

Overcoming Resistance to Connectivity

In some cases, local governments have encountered developer resistance, and have dealt with it by including developers in the process, permitting narrower streets, and giving them opportunities to provide alternatives to the regulations that still meet the spirit of the ordinance. In particular, developers may fear that if more connections are required more land will be needed to produce the same number of units – reducing profitability. This resistance can be improved by allowing narrower streets (20') in connected developments. There is also the fear that standards decrease profitability by reducing premium priced cul-de-sac lots and increasing larger corner lots. In situations where it can be shown that the regulations result in a lower-lot yield for a developer, communities may permit a reduction in minimum lot sizes or other variance to allow the same amount of units.

References

[1]American Planning Association. 2002. *Policy Guide on Smart Growth*

[2]Institute of Transportation Engineers. 2006. Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities

[3]Kulash, Anglin, and Marks. 1990. Traditional Neighborhood Development: Will Traffic Work?

[4]Moudon, Hess, Snyder, Stanilov. 1997. Effects of site design on pedestrian travel in mixed-use, medium-density environments

[5]PL Jacobsen. 2003. Safety in numbers: More walkers and bicyclists, safer walking and bicycling.