Road Design

Susan Handy

TTP Orientation Seminar

October 2015
## Road Design in the U.S.

<table>
<thead>
<tr>
<th>Level</th>
<th>Agencies</th>
<th>Primary concern</th>
<th>Primary role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>FHWA, FTA</td>
<td>National Highway System</td>
<td>Funding Policy</td>
</tr>
<tr>
<td>State</td>
<td>DOT</td>
<td>Highways outside metro areas</td>
<td>Planning Building Operating</td>
</tr>
<tr>
<td>Regional</td>
<td>MPO, Transit</td>
<td>Highways, transit within metro areas</td>
<td>Planning</td>
</tr>
<tr>
<td>Local</td>
<td>Planning Public Works</td>
<td>Local streets</td>
<td>Planning Building Operating</td>
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</tbody>
</table>

### Manuals and Guidelines
- from FHWA and state DOTs, also from:
  - **AASHTO** – American Association of State Highway and Transportation Officials
  - **ITE** – Institute of Transportation Engineers
  - **NACTO** – National Association of City Transportation Officials
Topics

- Network design
- Facility design
- Plus others
Network Design

- What are the two main purposes of streets/roads/highways?
- What’s the main difference between streets vs. roads vs. highways?
The Road Hierarchy

Source: http://ops.fhwa.dot.gov/access_mgmt/what_is_accsmgmt.htm
Fig. 21—Plan of the residential districts, dated November 1929.
preliminary studies for a
GENERAL PLAN for the city of Sunnyvale
PLANNING DEPARTMENT
City of Sunnyvale, 1957
FIGURE 1. Illustration of Layout Principles
Benefits of grid...?

• More direct routes
  – Less distance
    • Less driving (?)
      – Less pollution, energy consumption, noise, etc.
    • More walking/biking
      – More exercise, less weight, better health, etc.
  – Better efficiency
    • Emergency response time
    • City services
• More choice of routes...
## Connectivity Measures

Source: Peter Owens

<table>
<thead>
<tr>
<th>Street Patterns</th>
<th>Gridiron (c. 1900)</th>
<th>Fragmented Parallel (c. 1950)</th>
<th>Warped Parallel (c. 1960)</th>
<th>Loops and Lollipops (c. 1970)</th>
<th>Lollipops on a Stick (c. 1980)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intersections</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lineal Feet of Streets</td>
<td>20,800</td>
<td>19,000</td>
<td>16,500</td>
<td>15,300</td>
<td>15,600</td>
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<tr>
<td># of Blocks</td>
<td>26</td>
<td>19</td>
<td>14</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td># of Intersections</td>
<td>26</td>
<td>22</td>
<td>14</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td># of Access Points</td>
<td>19</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>4</td>
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<tr>
<td># of Loops &amp; Cul-de-Sacs</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>24</td>
</tr>
</tbody>
</table>
Figure 4.1. Eugene’s Block Requirements

Block length is defined as the distance along a street between the centerline of two intersecting through streets, including “T” intersections, but excluding cul-de-sacs. Source: Eugene Local Street Plan, 1996.
The measure of connectivity is the number of street links divided by the number of nodes. Nodes exist at street intersections as well as cul-de-sac heads. Links are the stretches of road that connect nodes. Stub outs shall also be considered as links.

In this example, there are 11 links (circles) and 9 nodes (stars); therefore, the connectivity index is 1.22.

The Suburbs Under Siege

Homeowners Love Cul-de-Sacs, Planners Say They're Perils; Taking Sides in Minnesota

By AMIR EFRATI
June 2, 2006; Page W1

One of the most popular features of suburbia is under attack.

For many families, cul-de-sac living represents the epitome of suburban bliss: a traffic-free play zone for children, a ready roster of neighbors with extra gas for the lawnmower and a communal gathering space for sharing gin and tonics. But thanks to a growing chorus of critics, ranging from city planners and traffic engineers to snowplow drivers, hundreds of local governments from San Luis Obispo, Calif., to Charlotte, N.C., have passed zoning ordinances to limit cul-de-sacs or even ban them in the future.
MODERN LIFE

Planners go 'round and around over cul-de-sacs

Once a homeowner's dream, the dead-end street is falling out of favor everywhere -- except Southern California.
By Dawn Bonker
Special to The Times

March 24, 2007

CITY planners shun them. New urbanists hate them. Boulder, Colo., all but banned them.

Cul-de-sacs — those once-beloved icons of the suburban good life — have become something of a demonized concept. The growing consensus among urban planners is that these lollipop-shaped streets hurt communities by chopping up neighborhoods, isolating children, intensifying traffic woes and discouraging walking.

Then why are so many still being built here?

Leave it to Southern California to defy the new convention. While cities across the country return to streets laid out on a traditional grid system, cul-de-sacs are springing up from Calabasas to Chula Vista. Yes, homeowners often fall in love with the quiet courts and initial sense of built-in neighborliness. But, experts say, just wait.
Reconsidering the Cul-de-sac

BY MICHAEL SOUTHWORTH AND ERAN BEN-JOSEPH

FOR OVER FIVE DECADES developers, homebuyers, and traffic engineers have favored the cul-de-sac, a basic building block of the American suburb. Despite its popular success, the “loops and lollipops” street pattern has been repeatedly criticized by many leading architects and planners, particularly New Urbanists, who strongly advocate the interconnected gridiron pattern. The cul-de-sac has come to symbolize all the problems of suburbia—an isolated, insular enclave, set in a formless sprawl of similar enclaves, separated socially and physically from the larger world, and dependent upon the automobile for its survival. Nevertheless, much can be said in favor of the cul-de-sac street as a pattern for neighborhood space.
The Case for Cul-de-Sacs

People who live in them actually have greater social cohesion, according to one sociologist.

EMILY BADGER | Oct 17, 2013 | 66 Comments

In a weird way, Thomas R. Hochschild Jr. actually first encountered the social cohesion of cul-de-sacs in his latest research when he wandered into one in Connecticut with his clipboard and polo shirt, and someone called the cops.

That never happened on the other types of streets he was studying, places where it would turn out the neighbors didn’t know each other as well, and it was less clear who “belonged.” Repeatedly, though, he found at the end of cul-de-sacs families who watched each others’ children and took in each others’ mail, who barbequed and orchestrated the removal of snow together, and who
Berkeley Diverters
Village Homes, Davis
Davis Greenbelt System

To Woodland, 12 mi/19.3km via frontage road, access Hwy. 113 at Rd. 29, exits 113 at Rd. 27 west to Rd 99, continue north to Woodland
Houten, Netherlands
Let’s see some images from Susan’s visit in September 2012...
## Facility Design

<table>
<thead>
<tr>
<th></th>
<th>Responsibility</th>
<th>Influence</th>
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<tbody>
<tr>
<td><strong>Local Streets</strong></td>
<td>Cities and counties</td>
<td>ITE – Institute of Transportation Engineers</td>
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<tr>
<td><strong>Highways and Freeways</strong></td>
<td>State DOTs</td>
<td>AASHTO – American Association of State Highway Officials</td>
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Guidelines for Residential Subdivision Street Design

A Recommended Practice of the Institute of Transportation Engineers
Right-of Way – Cross-Section

FIGURE 1. Typical Cross Section
1 ft = 0.3 m
<table>
<thead>
<tr>
<th>Reference Number</th>
<th>Terrain Classification</th>
<th>Level</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
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<td>2.04.01</td>
<td>Development Density</td>
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<td></td>
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<td></td>
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<td>2.04.02</td>
<td>Right-of-Way Width (feet)</td>
<td>70</td>
<td>70</td>
<td>80</td>
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<td>Pavement Width (feet)</td>
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<td>24-36</td>
<td>40</td>
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<tr>
<td>2.04.04</td>
<td>Type of Curb</td>
<td>Vertical Face</td>
<td>4-6</td>
<td>4-6</td>
<td>4-6</td>
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<td>2.04.05</td>
<td>Sidewalk Width (feet)</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>2.04.06</td>
<td>Sidewalk Distance from Curb Face (feet)</td>
<td>250</td>
<td>250</td>
<td>250</td>
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<tr>
<td>2.04.07</td>
<td>Minimum Sight Distance (feet)</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
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<td>2.04.08</td>
<td>Maximum Grade</td>
<td>200</td>
<td>200</td>
<td>200</td>
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<td>2.04.09</td>
<td>Minimum Spacing Along Major Traffic Route (feet)</td>
<td>1,300</td>
<td>1,300</td>
<td>1,300</td>
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<td>2.04.10</td>
<td>Design Speed (mph)</td>
<td>35</td>
<td>35</td>
<td>35</td>
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<td>2.04.11</td>
<td>Minimum Centerline Radius (feet)</td>
<td>480</td>
<td>480</td>
<td>480</td>
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<tr>
<td>2.04.12</td>
<td>Minimum Tangent Between Reverse Curves (feet)</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<td>2.04.13</td>
<td>Street Lighting</td>
<td>See Discussion</td>
<td>See Discussion</td>
<td>See Discussion</td>
<td></td>
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</tbody>
</table>
The Green Book

a policy on
Geometric Design of Highways and Streets
2004

American Association of State Highway and Transportation Officials

Wide Streets

All over Davis, and elsewhere
Innovations/Trends

• Skinny Streets
• Traffic Calming
• Road Diets
• Complete Streets
• Green Streets
• Context-Sensitive Design
• Others...
Skinny Streets

Canyon Rim Village, Medford

Traffic Calming

"Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users."

- ITE Subcommittee on Traffic Calming
Types of Traffic Calming

**Speed Control Measures**
- Vertical deflection
  - speed bumps
  - raised crosswalks
- Horizontal deflection
  - traffic circles
  - chicanes
- Horizontal narrowing
  - bulb-outs, neck-downs, curb extensions

**Volume Control Measures**
- Diverters
- Restrictions

[Image: Respect our streets]
- Speed bump
- Raised crosswalk
- Traffic circle
- Chicanes
- Bulb-outs
Woonerfs – Home Zones
Road Diet

BEFORE

AFTER

Source: http://www.buryinc.com/blog/2012/08/10/the-road-diet/
Road Diet

Fifth Street Road
Diet in Davis: Many years in the making!
Complete Streets

STRIP GARDENS: Raised and widened medians with plantings serve as refuge, help “calm” traffic, and give the street a boulevard-like feel.

LOUNGE AREAS: Encouraging cycling will require more bike racks and bike parking; making the streets safer for pedestrians will require more bollards and better lighting for sidewalks; and benches, tables, and other places to watch the world go by will foster community in public spaces.

http://la.streetsblog.org/wp-content/uploads/2008/10_06/10_8_08_complete_streets.jpg
Complete Streets

Green Streets

Anatomy of a Green Street

- Pedestrian friendly
- 1000 cf soil volume for street tree tree boxes
- Landscape areas
- Permeable sidewalks
- Bike Lane
- Permeable pavement in transitway
- Bioretention
- Recycled materials used
- Mature Street Trees
- Compost amended soils
- Permeable pavement in parking lane
- Bike Rack
- Interpretative signs

Shielded, Energy efficient street fixtures

Marcy McInelly, SERA/Urbsworks
Green Streets

Sources:  www.museumofthecity.org; http://www.mwcog.org/transportation/weeklyreport/2013/06-04.asp
Urban
Street
Design
Guide
National Association of City Transportation Officials
Designing Walkable Urban Thoroughfares: A Context Sensitive Approach

Institute of Transportation Engineers
“Context-Sensitive Design”
Main streets through a community that also happen to be state highways provide access to businesses, residential roads and other nearby properties. Main streets serve pedestrians, bicyclists, businesses and public transit, with motorized traffic typically traveling at speeds of 20 to 40 miles per hour. Main streets give communities their identity and character, they promote multi-modal transportation, support economic growth, and may have scenic or historic value.

The California Department of Transportation (Caltrans) recognizes the value of a main street to a community and understands that planners and designers need to address community values when developing highway improvements where state highways also serve as main streets. Caltrans is committed to early and continuous public participation to accommodate a community's values into the planning and design of projects.

This booklet identifies Context Sensitive Solutions and Livable Community concepts that can assist communities and Caltrans in balancing community values with transportation concerns for safe and efficient operations for travelers, pedestrians, bicyclists, transit users, and highway workers.
Texas-Style
Freeway Removal

Road Design Conundrum

Crash risks minimized but high speeds

Crash risks remain but low speeds
Parking!
Parking Problems

- Minimum parking requirements for residential and commercial development, in zoning codes
  - Excess parking and thus pavement and thus heat, run-off, etc.
- Free curbside parking in central business districts
  - Excess driving – “cruising” to find spaces – and thus emissions

See Don Shoup’s work!
Traffic Management

• Approaches:
  – Traffic control devices to regulate behavior
  – Roadway design to shape behavior

• Goals:
  – Safety
  – Efficiency
  – *Plus* livability!
MUTCD Principles

- Purpose is “… to promote highway safety and efficiency by providing for the orderly movement of all road users... throughout the Nation…”
- “The decision to use a particular device at a particular location should be made on the basis of either an engineering study or engineering judgment…”
- *Not a legal requirement*
- *Not a substitute for engineering judgment*
Speed Limits

- MUTCD section 2B-10 (update: 2B-13) requires that the numeric value be determined on basis of an engineering study. The following factors should be considered:

  1. Road surface characteristics, shoulder condition, grade, alignment and sight distance.
  2. The 85-percentile speed and pace speed.
  3. Roadside development and culture, and roadside friction.
  4. Safe speed for curves or hazardous locations within the zone.
  5. Parking practices and pedestrian activity.
  6. Reported accident experience for a recent 12-month period.

For a discussion, see: http://www.motorists.org/speed-limits/safety-setting-limits
Level of Service

TRB’s Highway Capacity Manual

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Control Delay per Vehicle (sec/veh)</th>
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<tbody>
<tr>
<td>A</td>
<td>≤ 10</td>
</tr>
<tr>
<td>B</td>
<td>&gt;10-20</td>
</tr>
<tr>
<td>C</td>
<td>&gt;20-35</td>
</tr>
<tr>
<td>D</td>
<td>&gt;35-55</td>
</tr>
<tr>
<td>E</td>
<td>&gt;55-80</td>
</tr>
<tr>
<td>F</td>
<td>&gt; 80</td>
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</table>


LOS = f (volume/capacity)  ➔  How to increase LOS?
Result: Massive Intersections
Next up: Paul Erickson on vehicle technology