Safer Speeds: Considerations for Speed Limits and Management

Presented by:
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Berkeley SafeTREC

Presented to:
CA Zero Fatalities Task Force
June 25, 2019

(Image: Photo by David Lofink)
<table>
<thead>
<tr>
<th>Outline</th>
<th>Background</th>
<th>Speed and Safety</th>
<th>US &amp; California</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Safe System</td>
<td>• Speeding</td>
<td>• 85\textsuperscript{th} Percentile</td>
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<td></td>
<td>• Informing Speeds</td>
<td>• Risks of speeding</td>
<td>• National efforts</td>
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<td>• International Practices</td>
<td>• Modal vulnerability</td>
<td>• California MUTCD</td>
</tr>
</tbody>
</table>
Goal of the transportation system?

Provide mobility.
Goal of the transportation system?

Provide mobility.

Provide efficient, cost-effective, equitable, sustainable, ..., and safe mobility.
So, is our transportation system \textit{safe}?
So, is our transportation system **safe**?

The fatality rate has demonstrated a downward trend for decades.
We’re on the right track towards safety.

**FIGURE 1-3**: Fatality Rate and Vehicle Miles Traveled, 1966-2013 (Source: NHTSA FARS)
So, is our transportation system safe?

No. It is not safe.

2017 Fatalities:
- California: 3,602
- USA: 37,133
- Globally: Over 1,300,000
So, is our transportation system **safe**?

No. It is **not** safe.

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### 10 Leading Causes of Injury Deaths by Age Group Highlighting Unintentional Injury Deaths, United States - 2017

<table>
<thead>
<tr>
<th>Rank</th>
<th>Age Groups</th>
<th>Unintentional Suffocation</th>
<th>Unintentional Drowning</th>
<th>Unintentional MV Traffic</th>
<th>Unintentional Fire/Burn</th>
<th>Suicide Suffocation</th>
<th>Suicide Firearm</th>
<th>Unintentional Poisoning</th>
<th>Unintentional Fall</th>
<th>Unintentional Poisoning</th>
<th>Total</th>
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<td>327</td>
<td>428</td>
<td>5,058</td>
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<td>15,129</td>
<td>54,916</td>
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<td>66,322</td>
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<td>2</td>
<td>1-4</td>
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**Data Source:** National Center for Health Statistics (NCHS), National Vital Statistics System.

**Produced by:** National Center for Injury Prevention and Control, CDC using WISQARS™.
So, is our transportation system safe?

No. It is not safe.

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<th>Unintentional Drowning</th>
<th>Unintentional MV Traffic</th>
<th>Unintentional Fire/Smoke</th>
<th>Unintentional Poisoning</th>
<th>Unintentional Other Spec., Cliff, or Fall</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
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<td>125</td>
<td>280</td>
<td>8,409</td>
<td>31,590</td>
<td>38,659</td>
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<tr>
<td></td>
<td>4</td>
<td>10-14</td>
<td>90</td>
<td>125</td>
<td>280</td>
<td>8,409</td>
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<td>280</td>
<td>8,409</td>
<td>31,590</td>
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First, or Second; Age > 1yr

So, is our transportation system safe?

A system in which people cannot die despite human error.

Job, and Sakashita. 2016a
So, is our transportation system dangerous?
So, is our transportation system dangerous?

dangerous

system

a system in which people can die with no human error (e.g., mine field, avalanche area).

Job, and Sakashita. 2016a
Our system is not safe and also not dangerous
Our system is not safe and also not dangerous.

A system in which people can die through human error.

FIGURE 1-3: Fatality Rate and Vehicle Miles Traveled, 1966-2013 (Source: NHTSA FARS)
Our transportation system is **unsafe**

A system in which people can die through human error

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**FIGURE 1-3**: Fatality Rate and Vehicle Miles Traveled, 1966-2013 (Source: NHTSA FARS)

Job, and Sakashita. 2016a
Policy innovation to move the needle
Policy innovation to move the needle

Vision Zero & Safe System challenge our ability to reach zero without a major change.

V1.0

V2.0

dangerous system
unsafe system
safe system
Multi-layered systems approach

Mooren et al., 2011

Figure 3 – The Safe System model reproduced from Howard, 2004 [25]
System core: human tolerance to force

Mooren et al., 2011

Figure 3 – The Safe System model reproduced from Howard, 2004 [25]
Safe System: safer roads, vehicles, speeds

Mooren et al., 2011

Figure 3 – The Safe System model reproduced from Howard, 2004 [25]
Safer Roads, Safer Vehicles, Safer Speeds

Danny Bagwell Flips Violently At Daytona 1999
https://www.youtube.com/watch?v=llotGXqBH0Y
Safe System: safer roads, vehicles, speeds

Mooren et al., 2011

Figure 3 – The Safe System model reproduced from Howard, 2004 [25]
Safe System: alert and compliant users

Mooren et al., 2011

Figure 3 – The Safe System model reproduced from Howard, 2004 [25]
Dichotomy between behavior and belief

- 50.3% have driven 15 mph over the speed limit on the freeway
- 47.6% have driven 10 mph over the speed limit on residential streets
- 2.0x as many people speed on the freeway than think it's acceptable
- 3.4x as many people speed on residential streets than think it's acceptable

- 23.9% believe driving 15 mph over the speed limit on the freeway is acceptable
- 14.0% believe driving 10 mph over the speed limit on residential streets is acceptable

72.6% have driven 10 mph over the speed limit on the freeway

30.0% have driven 10 mph over the speed limit on residential streets

4.0x as many people speed on the freeway than think it’s acceptable

1.6x as many people speed on residential streets than think it’s acceptable

18.0% believe speeding on the freeway is a small problem or not a problem

19.0% believe speeding on residential streets is a small problem or not a problem

How does this affect speed management?

• Vehicle speed is the most important regulating factor for safe road traffic since it is subject to road-user behavior.

• The kinetic energy that the human body can tolerate, forms the basic parameter in the design of a safe transport system.
Fatality risk for collision speed, by crash type

Speed limits for a safe system in Sweden

- **45 mph**: A safe car can protect occupants up to **45 mph** in a head-on collision.
- **30 mph**: A safe car can protect occupants up to **30 mph** in a side collision.
- **20 mph**: Most unprotected road users survive if a car travelling **20 mph** hits them.

Source: Vision Zero and New Speed Limits in Sweden, Anna Vadeby, VTI. Original values have been converted from kph to mph and rounded.
Rural speed limits for safe system, Sweden

- **45 mph** (70 km/h): default limit on rural roads
- **50 mph** (80-90 km/h): 2-lane roads (milled rumble strips in middle of road)
- **65 mph** (100 km/h): 2+1 roads with median barrier
- **70 mph** (110 km/h): motorways
- **75 mph** (120 km/h): motorways with high standard and low traffic flow

Source: Vision Zero and New Speed Limits in Sweden, Anna Vadeby, VTI Original Values have been converted from kph to mph and rounded.
Urban speed limits for a safe system, Sweden

Guidelines consider:
- City's character
- Accessibility
- Security
- Traffic Safety
- Health and Environment

<table>
<thead>
<tr>
<th>Safety Level</th>
<th>Conflicts VRU-car</th>
<th>Conflicts car-car (intersections)</th>
<th>Conflicts car-obstacle</th>
<th>Conflicts car-car (oncoming traffic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>≤ 20 mph</td>
<td>≤ 30 mph</td>
<td>≤ 40 mph</td>
<td>45 mph</td>
</tr>
</tbody>
</table>

Based on: Vision Zero and New Speed Limits in Sweden, Anna Vadeby, VTI. Original Values have been converted from kph to mph and rounded.
Speed and Safety

https://youtu.be/6Xm9kp5PIB4
Speed and Safety

How do we set speed limits to provide the best mobility for a safety constraint of zero traffic fatalities?
History of Setting Speed Limits in the US

- Speed limits are established by computing the 85th percentile speed during free-flow travel.
- This approach was developed based on a 1964 USDOT report labeled “Accidents on Main Rural Highways Related to Speed”. The report’s findings have not been successfully replicated since.
- Another stated rationale is that speed limits below the 85th percentile discourage drivers’ compliance with the posted speed limit.
The Solomon Curve

Conclusion was that traveling near or slightly above the average speed (approximately the 85th percentile speed) would result in the lowest crash risk.
Evolution of Speed

FIGURE 1   Median and 85th percentile speeds on rural Interstates in Montana. (Source: R. Retting of the Insurance Institute for Highway Safety.)

Types of Speed Limits

• Basic Speed Law (CVC 22350) states that a driver may never drive faster than is reasonable or prudent for current conditions.

• Two types of speed limits
  • Statutory speed limit
  • Posted speed limit
Statutory and Posted Speed Limits

• Statutory speed limit (maximum speed limit)
  • Set by the State Legislature and enforceable even if speed limit sign is not posted

• Posted speed limit (regulatory speed)
  • Set by a local jurisdiction (city or county)
  • Must have an up-to-date Engineering and Traffic Survey to be enforceable when radar or LiDAR is used
  • Takes priority over the established statutory speed limit
Engineering & Traffic Survey

• Defined by CVC 627 as a survey of “highway and traffic conditions in accordance with methods determined by the Department of Transportation for use by state and local authorities” and considers:
  • Prevailing speeds as determined by traffic engineering measurements
  • Traffic crash records
  • Highway, traffic, and roadside conditions not readily apparent to the driver.

• 85th percentile speed of free flowing traffic is often considered a safe and reasonable speed limit.¹

• Valid for five years, but may be extended to seven or ten years if a registered engineer determines conditions are met

¹ FHWA-RD-92-084 and FHWA-RD-98-154
² CVC 40802
Speed Limits – Special Conditions

- **School Zone** local authorities can reduce the maximum speed limit allowable to 25 mph, or lower if the E&TS indicates that 25 mph is too fast for prudent and safe operations\(^1\)

- **Work Zone** authorized to “restrict the use and regulate the movement of traffic”\(^2\) and can be set as low as 25 mph\(^3\)

- **Other** 15 mph in alleys, at blind intersections, blind railroad xing, and more\(^4\)

- **Variable** displayed on CMS due to specific conditions such as weather, congestion, and more.

\(^1\) CVC 22358.4
\(^2\) CVC 21370
\(^3\) CVC 22362
\(^4\) CVC 22352
NTSB Safety Study Recommended

• (H-17-27) Revise Section 2B.13 of the MUTCD:
  • Factors currently listed as optional for all engineering studies are required
  • Require that an expert system such as USLIMITS2 be used as a validation tool
  • Remove the guidance that speed limits in speed zones be within 5 mph of the 85th percentile speed.

• (H-17-28) Revise Section 2B.13 of the MUTCD:
  • to (at a minimum) incorporate the safe system approach for urban roads to strengthen protection for vulnerable road users.
Practitioner Survey

• Spring 2018
• 13 questions
• Distributed to numerous transportation professionals
• Number of respondents: 740
• Over 80% use MUTCD regularly
• Average experience: 20 years
Factors most utilized in setting speed Limits?

<table>
<thead>
<tr>
<th>Utilization criteria (top 10 with always utilized)</th>
<th>Overall Rank</th>
<th>10 years or less (rank)</th>
<th>11-20 years (rank)</th>
<th>Over 20 years (rank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of vehicles</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Crash history</td>
<td>2</td>
<td>2</td>
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<td>3</td>
</tr>
<tr>
<td>Context - location</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Statutory requirements</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Geometrics (curve)</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Facility classification type</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Context - land use</td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>10</td>
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<tr>
<td>Geometrics (sight distance)</td>
<td>8</td>
<td>--</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Geometrics (lane width, CS)</td>
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<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>% vehicles above PSL / speed distribution curve / % veh in pace</td>
<td>10</td>
<td>--</td>
<td>7</td>
<td>8</td>
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Slide by Randy McCourt, Chair NCU TCD Task Force on Speed Limit
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Slide by Randy McCourt, Chair NCUTCD Task Force on Speed Limit
NCUTCD Recommendations

Factors that should be considered

- **Speed distribution** of free-flowing vehicles (such as current 85th percentile, the pace, review of past speed studies).
- **Crash experience** for at least a 12-month period relative to similar roadways.
- **Road characteristics** (such as lane widths, curb/shoulder condition, grade, alignment, median type, sight distance).
- **Road context** (such as roadside development and environment including number of driveways, land use, functional classification, parking practices, presence of sidewalks/bicycle facilities).
- **Road users** (such as pedestrian activity, bicycle activity).

Source: National Committee on Uniform Traffic Control Devices Item 18B-RW-03, April 2019
Review of Current Practices for Setting Posted Speed Limits

Figure 1. Prevalence of factors that traffic professionals consider the most when setting speed limits

CA MUTCD is a living document
Timeline of recent speed limit updates

2003
CA Supplemental. Posted speed limit should be established at the nearest 5 mph increment of the 85th percentile speed with the option for further 5 mph reduction.

2006
MUTCD updated. Posted speed limit should be established at the nearest 5 mph increment of the 85th percentile speed with the option for further 5 mph reduction per E&TS.

2010
MUTCD updated. Posted speed may be reduced by 5 mph from the nearest 5 mph increment of the 85th percentile speed, in compliance with CVC Sections 627 and 22358.5

2012
MUTCD updated. Where the posted speed would be required to be rounded up, Caltrans or local authority may round down to the nearest 5 mph of the 85th percentile speed, if no further reductions can be used per CVC Section 21400(f).

2014
Caltrans releases an updated CA MUTCD

2019
Zero Traffic Fatalities Task Force convenes to develop recommendations related to determining speed limits
Progress is always at the mercy of the relationship between the practitioners and the visionaries.

Thank you!

Offer Grembek, grembek@berkeley.edu
Katherine Chen, kchen@berkeley.edu
Dave Amos, daveamos@berkeley.edu