2+1 roads in Sweden
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Swedish Road Administration
SNRA is responsible for 100,000 km roads

All rural roads of public interest
Main streets in urban areas for through traffic
The safety problem

Type of accidents

- Run-off: 31%
- Head on over: 35%
- Junct.: 13%
- Vuln.: 13%
- Wild: 3%
- Oth.: 4%
- 100,000 km state roads
- 8,000 km trunk roads
- 400 killed per year

- 3,600 km “13” m roads
- Nearly 100 killed per year
- Fatality ratio > 6*Freeway
Low budget treatment: the 2+1 design concept
• cable barrier
• intersections in transitions
• access control and separation, if possible
• sometimes 1+1 or 2+2
A lot of critics and hesitation… and discussions:

- would there be severe transition zone safety problems
- hazardous breakdowns and stops on narrow one-lanes 5 m
- what about level-of-service
- overwide and super heavies
- pedestrians, cyclists, slow moving …
- maintenance operations
- driver attitudes
- motorcycles
- and a lot of other concerns, sometimes conservative sometimes relevant
SRA decision in 1998:
• 6 test projects to develop design and maintenance standards

Spring 2000 Minister order:
• some 15 new projects within 2 years
  now time for widening!

June 2001 SRA decision:
• standard cross section
And what happened?

2+1 road network in Sweden
Today: 1300 km

- 450 km “semi-motorway”
- 850 km “normal 2+1”

2007 plan: another 220 km
So far 450 km semi-motorways –

39 projects AADT 4-23 000 – average 10 000:
- mostly 13 m, interchanges, full access control
- no peds and bikes, no slow moving vehicles
- posted speed limits for cars 90 kph (some 15 projects) or 110 kph

Measures undertaken:
- entry lanes, roadside areas, road surface and markings improved
- maintenance standard increased

Costs: 200.000 $/km
850 km “normal 2+1”

Some 70 projects AADT 4 - 15 000 average 8 000:
• mostly 13 m, at-grade intersections, partial access control
• peds, bikes, slow moving vehicles normally allowed
• posted speed limits for cars 90 kph
  110 kph only 15 projects

Measures undertaken
• roadside area, intersections, accesses, separation, surface improved
• maintenance standard increased

Costs: Some 300 000 $/km
At-grade design

- 1+1
- Lane for left-turns
- Sometimes bus-stops and ped crossings
- Sometimes U-turns
"Right-turn accesses"
Safety as yet ..... a tremendous success

- overall fatality rate 0.0019 – down 80 %
- some 100 lives saved from 1998
- rate ”killed and severed injured” – down 50 – 60%
## Accident types

<table>
<thead>
<tr>
<th>Type</th>
<th>Effect</th>
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<tbody>
<tr>
<td>Head-on</td>
<td>almost eliminated</td>
</tr>
<tr>
<td>Overtaking</td>
<td>reduction 40 – 70 %</td>
</tr>
<tr>
<td>Run-off</td>
<td>reduction 12 – 67 %</td>
</tr>
<tr>
<td>Rear end</td>
<td>some  + 150 %</td>
</tr>
<tr>
<td>Access roads</td>
<td>reduction</td>
</tr>
<tr>
<td>Junctions</td>
<td>small changes</td>
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</tbody>
</table>
Motorcycles?

As yet 13 severe accidents:
• 2 fatalities
• 11 severe injuries

Median cable barrier involved in 7:
• 1 fatality
• 6 severe injuries
Level-of-service?
A surprise .... “better up to 1000 veh/hour”

Passenger car speed

Capacity some 1500 veh/h one-way
10 - 20 % loss
And drivers attitudes?

- one month after the first project 1 % satisfied
- after one year 60-70 % satisfied
- improved driving task … “you can plan your overtaking ..”
- scared for one-lane breakdowns …. 
- conspicuity in rain and dark, especially elderly drivers !!
- elderly drivers in general !!
Maintenance and operation

- no unexpected problems – could be handled
- as expected … barrier crashes frequent
  - so far average 0.43 per mill. apkm
    in southern Sweden, 0.56 in northern
- rescue operations in 20-25 % of the crashes
- Workzone safety…
- rutting ... so far no major
  problem in surveys but ...?
- over-wide and
  super-heavies a problem
Thanks for your attention!