Vision Zero - a Swedish contribution to the global community

In October 1997, Vision Zero was passed by a large majority in the Swedish parliament.

The Vision is an expression of the ethical imperative that it can never be ethically acceptable that people are killed or seriously injured when moving within the transport system.
## Vision Zero a policy innovation

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Vision Zero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents /Crashes</td>
<td>Fatalities and serious injuries</td>
</tr>
<tr>
<td>Human errors</td>
<td>Humans make mistakes Humans are fragile</td>
</tr>
<tr>
<td>Individual road users</td>
<td>System designers</td>
</tr>
<tr>
<td>People don’t want safety</td>
<td>People want safety</td>
</tr>
<tr>
<td>Optimum number of fatalities and serious injuries</td>
<td>Eliminate fatalities and serious injuries</td>
</tr>
</tbody>
</table>

**What is the problem?**
- Human errors

**What causes the problem?**
- Individual road users

**Responsibility?**
- People don’t want safety

**Peoples demand for road safety?**
- Optimum number of fatalities and serious injuries

**What is the appropriate goal?**
- Eliminate fatalities and serious injuries
Figure 2: Probability of Pedestrian Fatality by Impact Speed.
Derived from the Interdisciplinary Working Group for Accident Mechanics (1986) and Walz, Hoeflinger and Fehlmann (1983)
Urban safety
Rural safety
Rural Safety

The graph illustrates the growth of rural safety over the years from 2000 to 2019. It shows two lines: one for 2+1-road and another for ATC. The y-axis represents kilometers, while the x-axis represents years from 2000 to 2019.

The red line for ATC shows a steady increase, indicating growth in rural safety, while the blue line for 2+1-road also shows growth but at a slower rate compared to ATC.
Number of deaths in road traffic accidents per 100,000 population in Sweden (1997-2019)
Vision Zero, Safe System, Road to Zero…. "We Have Many Names for the Things We Love!"
Model for safe traffic
Model for safe traffic
Matteo Rizzi, STA
Vision Zero

- Humans have biomechanical limits
- **Nobody is perfect** - we all make errors or mistakes sometimes
- All crashes should be survivable
- The road transport system needs to absorb such errors/mistakes, and to handle the impact energy in an crash
Chain of events leading to a crash

- Normal driving
- Deviation from normal driving
- Emerging situation
- Critical situation
- Crash unavoidable

Time to crash

∞ 10 s 1 s 0
Chain of events leading to a crash

- Normal driving
- Deviation from normal driving
- Emerging situation
- Critical situation
- Crash unavoidable

Time to crash:
- $\infty$
- 10 s
- 1 s
- 0

Preventing the crash

Preventing injuries in the crash
Question: what is the difference?

Energy to handle in a crash
Impact energy can **not** be handled.
Impact energy can be handled.
In simple words

• The main goal is not to totally eliminate the number of crashes

• The main goal is to make sure that speed (energy) is always aligned with the ability to protect road users when a crash occurs

• The challenge is, we (humans) do not a very good perception of the dangers related to speed
Speed is energy – and energy is the key factor

- **Design speed**: maximum speed to avoid serious injuries and fatalities
- **Posted speed**: speed limit
- **Operation speed**: actual driving speed

Design speed = posted speed = operation speed → SAFE SPEED
A tragic example
STA’s in-depth studies of fatal crashes

• 90 km/h speed limit

• Road width 13 m

• AADT 5500
  Annual Average Daily Traffic

• Head-on collision between two passenger cars
Car nr 1, BMW 320 - model year 2007
5 stars EuroNCAP (2005)
Car nr 2, Volvo V70 - model year 2010
5 stars EuroNCAP (2007)
Design speeds for modern cars

- 80 km/h: Head-on
- 40 km/h: Pedestrians
- 70 km/h: Side
- 40 km/h: Rear-end
- 110 km/h: Large animals
The posted speed limit is higher than the design speed
Speed is energy – and energy is the key factor

- **Design speed**
  - maximum speed to avoid serious injuries and fatalities
- **Posted speed**
  - speed limit
- **Operation speed**
  - actual driving speed
Speed is energy – and energy is the key factor

- **Design speed**: maximum speed to avoid serious injuries and fatalities
- **Posted speed**: speed limit
- **Operation speed**: actual driving speed
Summary

• Humans have biomechanical limits

• Nobody is perfect - we all make errors or mistakes sometimes

• The road transport system needs to absorb such errors/mistakes, and to handle the impact energy in a crash

• Speed is energy - and energy is the key factor

• Safe speed can only be achieved with a combination of countermeasures that support and complete each other
Vehicle safety and emerging technologies

Rikard Fredriksson
Senior Advisor, Swedish Transport Administration
Associate Professor, Chalmers University of Technology
Vision Zero

- Safe roads
- Safe use
- Safe vehicles

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EuroNCAP partners 2020
Test labs
Development in crash safety

Kullgren et al 2019
NCAP’s around the world
A Market for Safety

Safety innovation

Consumer information

Market competition
EuroNCAP tests & assessment

- Adult occupant
- Child occupant
- Vulnerable Road User
- Safety assist
EuroNCAP 2019

- 55 tested cars
  - 75% 5 stars
  - 16% 4 stars
  - 9% 3 stars
Market Coverage

70% sold

14% sold

9% sold

7% sold

Unrated

EU-28 passenger car and SUV sales, 2018. Total 15.3 million units.
Correlation to Euro NCAP - injury risk for star bands

Kullgren et al 2019
What is new 2020?
Far-side Crash Protection

8 out of 11

2020 Toyota Yaris with double center airbags
AEB Car-to-car

Turn-across-path

2020
AEB Pedestrian

turning

reversing
Rescue sheet - 2020
First two cars tested 2021

https://www.euroncap.com/en
What is next?
Bicyclist

WAD 2500
WAD 1500
WAD 1000

New pedestrian

2023 Pedestrian Leg Impact Tests

Upper Legform Impactor
Pelvis Sum of Forces
55(Nm - 65N)

Max. femur bending moment
(394 Nm - 459 Nm)

4.5 pts

Lowest scoring parameter from:
- Max. ligament elongation MCL
(21 mm - 35 mm)
- Max. (tibia) bending moment
(287 Nm - 390 Nm)

4.5 pts

9 pts
AEB Car-to-car Next Steps

Crossing traffic

Head-on

2023

2023
AEB Bicyclist

door opening
Child Presence Detection 2023

Euro NCAP Child Presence Detection General Requirements

**Initial Warning**
- Targets the driver
- Directly after locking <10s
- Visual and audible warning for ≥3s
- Temporary delay or cancellation

**Escalation Warning** (direct sensing systems only)
- After initial warning, warn driver and others
- Repeats every 60s for 20 min period
- Vehicle and/or mobile phone warning

**Intervention** (direct sensing systems only)
- Supersedes or replaces escalation warning, 10 min from locking
- Open to possibilities - must actively reduce the threat of hyperthermia

---

In-Vehicle Heatstroke Fatalities in the US

- Period: 2000 - 2018
- Average: 38 cases per year
- Best: 25 (2015)

http://noheatstroke.org

Age of In-Vehicle Heatstroke Victims

- 4 years old
- 5 years old and over
- < 1 year old
- 1 year old
- 2 years old
- 3 years old
AEB Powered Two-wheeler (motorcycle)
Virtual testing and Human Modelling

A paradigm shift ... enables

- large number of
  - crash speeds
  - occupant sizes
  - impact angles

- "real" (i.e. human) injury criteria
  - e.g. fracture or brain injury
  - (compared to acceleration and force in dummy)

© Elemance
Virtual testing avoidance
Driver attention
Occupant State Monitoring

Impaired Driving
- Fatigue
- Distraction
- Driving Under Influence
- Sudden Sickness

© Seeing Machines
Occupant State Monitoring

- **2020**: Indirect
- **2023**: Indirect + Direct
- **2025**: Direct only
Thanks!
Questions?

rikard.fredriksson@trafikverket.se
Road Design
Identify the safe system
the safe system
Pedestrians crossing roads and streets

Separation

Calming
Separation
Division of Responsibilities/Boundary Conditions

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>Contribution passive safety</th>
<th>Contribution active safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>70</td>
<td>55</td>
<td>15</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>80</td>
<td>30</td>
</tr>
</tbody>
</table>

- Head-on: 60, 20
- Pedestrians: 10, 30
- Side: 55, 15
- Rear-end: 20, 20
- Large animals: 80, 30
Speed as the regulator for interactions in urban areas

- Mixed traffic
- Divided but with interactions
- High speed bicycle
Övergångsställe
Signalreglerad korsning
Utan markering

Pedestrian risk

<16 år
16-60 år
>60 år
Thanks

Dr Lars Ekman
Lars.Ekman@trafikverket.se
Results – Safety Benefits of implemented measures
Results – Safety Benefits of Implemented Measures
Matteo Rizzi, STA

with the contribution of
Anna Vadeby, Senior Researcher in Traffic Safety at VTI
Associate Professor at Chalmers University of Technology
Content

Overview of road safety work in Sweden

• 2+1 roads and speed management

• Overall analysis of car fatalities reduction 2000-2010
The problem

- 1990's: 25% of fatalities and 20% of severely injured occurred on 3.5% of national roads
  (3,500 km of total 100,000 km national roads)

- 13 m wide roads

- Main problem **head-on** and **run-off** crashes causing more than 70% of all fatalities
The solution: 2+1 roads

- Redesign the same road to a 2+1 road with medium barrier
- First 2+1 road in 1998
Speed on 2+1

• Mean speed (cars) increased ~2 km/h at speed limit 90 km/h

• Floating car studies confirm a good level-of-service at high traffic flows, up to 1300-1400 veh/h in one direction

• Capacity estimated to be 1600 - 1700 veh/h in one direction during a 15 minute period
Traffic safety effects (2009)

- Fatalities decreased by 77 %
- Fatalities and seriously injured decreased by 51 % (110 km/h) and 63 % (90 km/h)
- All injury crashes – no major changes
Share of fatally and severely injured car occupants in injury crashes in Sweden
The proportion of traffic flow on roads with median barrier increased from 26% to 41%

Road side barriers have been installed and the road side area has been cleared from fixed objects
Audio Tactile Lane Markings (ATLM) have been milled in the middle of the road on 4 000 km of rural roads.

In urban areas roundabouts have replaced intersection with transversally moving vehicles.
Percentage of vehicle mileage with Electronic Stability Control, Seat Belt Reminders and 5 stars NCAP (crashworthiness)
Road traffic fatalities in Sweden

- Car drivers
- Car passengers
- Motorcyclists
- Mopedists
- Cyclists
- Pedestrians
- Other
Fatality addressed by median barrier

2000

2010
Fatality addressed by roundabout

2000

2010
Not addressed: local intervention by removing one single tree
Most effective interventions between 2000 and 2010

<table>
<thead>
<tr>
<th>Number of saved lives</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median barrier</td>
<td>65</td>
</tr>
<tr>
<td>Car crashworthiness</td>
<td>39</td>
</tr>
<tr>
<td>Electronic Stability Control</td>
<td>22</td>
</tr>
<tr>
<td>Side barrier</td>
<td>18</td>
</tr>
<tr>
<td>Seat Belt Reminders</td>
<td>6</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>7</td>
</tr>
<tr>
<td>Roadside</td>
<td>2</td>
</tr>
<tr>
<td>Rumble strips</td>
<td>3</td>
</tr>
<tr>
<td>Total calculated reduction</td>
<td>162</td>
</tr>
<tr>
<td>Actual reduction</td>
<td>176</td>
</tr>
</tbody>
</table>
Summary

• 2+1 roads are a successful measure to increase safety on rural roads

• Fatalities were reduced by approximately 50% between 2000 and 2010 with road, vehicle and speed interventions

• It takes time to achieve the full benefits of vehicle safety technologies
Matts-Åke Belin PhD
Director Vision Zero Academy
Adj. Professor Royal Institute of Technology (KTH)
matts-ake.belin@trafikverket.se
Vision Zero a policy innovation

- Ethical imperative that it can never be ethically acceptable that people are killed or seriously injured when moving within the road transport system
- A safe philosophy based on the overall aim to control for harmful energy
- System perspective where humans (biological, psychological and social capabilities) are put at the center (People will make mistakes. Plan, design and maintain a system for people rather than the other way around)
- Working methods and processes which includes the whole society, research, business, industry, public stakeholders and non-governmental organizations. (Not only a matter for public authorities)
- A chain of responsibility which starts and ends with all professional organizations which have a stake in the function, design and the use of the road transport system
Vision Zero change also the way we do things
Vision Zero - strong focus on changing organizations behavior

- Governance strategies
- System Designers Organizations behavior
- Road Transport System
Governance strategies to influence different stakeholders
Management by objectives

- Safe System
- Intermediate targets: Fatalities and serious injuries by 2030
- Performance indicators
Road traffic fatalities in Sweden and target for 2030
<table>
<thead>
<tr>
<th>Road Safety Performance Indicator</th>
<th>Starting point</th>
<th>2019</th>
<th>National target 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a. Speed, state road network</td>
<td>43 %</td>
<td>• 47 %</td>
<td>80 %</td>
</tr>
<tr>
<td>1 b. Speed, state road network, average travel speed</td>
<td>82 km/h</td>
<td>• 78,1 km/h</td>
<td>77 km/h</td>
</tr>
<tr>
<td>2. Speed, municipal road network</td>
<td>64 % (2012)</td>
<td>• 65 %</td>
<td>80 %</td>
</tr>
<tr>
<td>3. Sober traffic</td>
<td>99,71 %</td>
<td>• 99,75 %</td>
<td>99,90 %</td>
</tr>
<tr>
<td>4. Use of seatbelt</td>
<td>96 %</td>
<td>■ 98,4 %</td>
<td>99 %</td>
</tr>
<tr>
<td>5 a. Use of cycle helmets</td>
<td>27 %</td>
<td>• 47 %</td>
<td>70 %</td>
</tr>
<tr>
<td>5 b. Use of moped helmets</td>
<td>96 %</td>
<td>• 93 %</td>
<td>99 %</td>
</tr>
<tr>
<td>6. Safe passengers cars</td>
<td>20 %</td>
<td>■ 79 %</td>
<td>80 %</td>
</tr>
<tr>
<td>7. Increase in regulatory compliance motorcycle</td>
<td>–</td>
<td>–</td>
<td>Target not set</td>
</tr>
<tr>
<td>8. Safe state roads</td>
<td>50 %</td>
<td>• 80 %</td>
<td>90 %</td>
</tr>
<tr>
<td>9. Safe pedestrian &amp; bicycle crossings</td>
<td>19 %</td>
<td>• 28 %</td>
<td>35 %</td>
</tr>
<tr>
<td>10. Maintenance of cycle paths</td>
<td>18 %</td>
<td>• 19 %</td>
<td>70 %</td>
</tr>
<tr>
<td>11. Systematic road safety work, ISO 39001</td>
<td>–</td>
<td>–</td>
<td>Target not set</td>
</tr>
<tr>
<td>Number of fatalities</td>
<td>440</td>
<td>■ 221</td>
<td>220</td>
</tr>
<tr>
<td>Number of severe injuries</td>
<td>5 400</td>
<td>■ 3 800</td>
<td>4 100</td>
</tr>
</tbody>
</table>

- In line
- Not in line
Alco lock (%) Regulation vs Public Procurement in fleets

- Drink and driving offenders
- Swedish Government fleet
- Buses

Regulations vs Carrot

0
20
40
60
80
100
120

Regulations

Carrot
Speed compliance professional transport (%)
Network collaboration

Volvo Cars and the Swedish National Road Administration in joint offensive against traffic accidents

Volvo Car Corporation and the Swedish National Road Administration will work together to avoid or lessen the effects of road accidents. This is the thrust of the declaration of intent that Volvo Cars’ President and CEO Fredrik Asp and the Swedish National Road Administration’s Director General Ingerman Skogö signed at the start of the traffic safety seminar today in Tråsfjärd.

The Swedish National Road Administration has worked on its Vision Zero approach since 1997, while Volvo Car Corporation presented a vision in 2007 whose aim is to design cars that do not crash. In the shorter term, this means that by the year 2020, nobody should be injured or killed in a Volvo.
Dissemination of scientific results and consumer information

Scientific study of effects → Dissemination of findings through media → Important buyers change their demands on new vehicles → Importers and producers offers ESC as standard
ESC new cars fitment rate 2009
Research program on policy and implementation – how to make things happen and get organizations to contribute to a safe system
Evidence based approach - the need of data
Evidence based approach - the need of data

Kenneth Svensson
Special adviser traffic safety
Swedish Transport Administration
STRADA

Swedish Traffic Accident Data Acquisition

STRADA
Coordinated database for accidents

Traffic safety analyses

Statistics
Road authorities
NGO’s
Police
Insurance companies
Researchers
Police report

Hospital report
Coverage, from Police and Hospital

- Police: 18800
- Hospital: 28000
- Pedestrian fall: 12800

7500
Police, severe injuries 2016

- Pedestrian: 238
- Bicycle: 215
- Moped: 123
- MC: 243
- Car: 1,369
- Other: 194

Hospital Seriously injured 2016

- Pedestrian (single excluded): 204.1
- Bicycle: 1,879.5
- Moped: 220.0
- In a Car: 1,358.2
- Other: 384.1
- MC: 235.2
- Car: 1,369
- Other: 194
In-deepth studies of fatal accidents

In Sweden all fatalities in road traffic undergo an in-depth study by accident investigators at the Swedish Transport Administration.
What is an in-depth study?

Detailed investigation into each fatal road accident with the main objective to identify what caused the fatal injuries.

Routine since 1997 and is regulated in the government’s instruction to the Transport administration.

Accident investigators gather information on each fatal accident.
Three questions to be answered

• What happened?
• Why did it happen?
• What can be done to ensure that it does not happen again?
Road Safety Performance Indicators

**Input**
- Legislation
- Finance/budgets
- Structure/culture
- Etc.

**Output**
- Measures
  - Alcohol interlocks in fleet
  - Median barriers
  - ...

**Outcome**
- Road safety performance indicators
  - Drink driving: proportion of sober drivers in traffic
  - Safe roads: proportion of traffic volume on roads with median barriers
  - Seat belt use: proportion of occupants using seat belt
  - ...

**Consequences**
- Number of fatalities and serious injuries
Long-term goal
Zero deaths and serious injuries by 2050

Interim targets
50% fewer deaths and serious injuries between 2020 and 2030

Intermediate outcome targets
based on Key Performance Indicators directly linked to reducing deaths and injuries
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Proposed definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Speed</td>
<td>Percentage of vehicles traveling within the speed limit.</td>
</tr>
<tr>
<td>2. Safety belt</td>
<td>Percentage of occupants using the safety belt and percentage of children using a child restraint system</td>
</tr>
<tr>
<td>3. Helmet</td>
<td>Percentage of motorcyclists, moped riders and cyclists wearing a protective helmet.</td>
</tr>
<tr>
<td>4. Alcohol and drugs</td>
<td>Percentage of drivers, riders and cyclists without alcohol or drugs impairing driving.</td>
</tr>
<tr>
<td>5. Distraction</td>
<td>Driver distraction indicator.</td>
</tr>
<tr>
<td>7. Infrastructure</td>
<td>Road infrastructure safety indicator.</td>
</tr>
</tbody>
</table>
Controlling of harmful energy
When data is missing

Even if there is a lack of data it is possible to work proactively with traffic safety if the work is based on the principles of Vision Zero
Thank you for listening!

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Table 1: Leading causes of death, all ages, 2016

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause</th>
<th>% of total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart disease</td>
<td>16.6</td>
</tr>
<tr>
<td>2</td>
<td>Stroke</td>
<td>10.2</td>
</tr>
<tr>
<td>3</td>
<td>Chronic obstructive pulmonary disease</td>
<td>5.4</td>
</tr>
<tr>
<td>4</td>
<td>Lower respiratory infections</td>
<td>5.2</td>
</tr>
<tr>
<td>5</td>
<td>Alzheimer’s disease and other dementias</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>Trachea, bronchus, lung cancers</td>
<td>3.0</td>
</tr>
<tr>
<td>7</td>
<td>Diabetes mellitus</td>
<td>2.8</td>
</tr>
<tr>
<td>8</td>
<td>Road traffic injuries</td>
<td>2.5</td>
</tr>
<tr>
<td>9</td>
<td>Diarrhoeal diseases</td>
<td>2.4</td>
</tr>
<tr>
<td>10</td>
<td>Tuberculosis</td>
<td>2.3</td>
</tr>
</tbody>
</table>

8th leading cause of death for people of all ages

#1 cause of death for children and young adults aged 5-29 years

Global Status Report on Road Safety 2018, World Health Organization

2016 WHO Global Health Estimates
There are signs of progress

The rate of death per 100,000 has stabilized but the number of people and motor vehicles has increased.

18.2

Global Status Report on Road Safety 2018, World Health Organization
Number of deaths per 100 000 inhabitants

Global Status Report on Road Safety 2018, World Health Organization
Year 2004 – Road Traffic Injuries on the UN Agenda
About the UN Road Safety Collaboration

In April 2004, the UN General Assembly resolution A/RES/58/99 on “Improving global road safety” invited WHO, working in close cooperation with the UN regional commissions, to act as coordinator on road safety issues across the UN system. The World Health Assembly accepted this invitation in May 2004, and WHO subsequently set up the UN Road Safety Collaboration (UNRSC) which holds biennial meetings to discuss global road safety issues.

The Collaboration is an informal consultative mechanism whose members are committed to road safety efforts and in particular to the implementation of the recommendations of the Global Plan of Action against Road Traffic Injury Prevention. The goal of the Collaboration is to facilitate international cooperation and to promote global and regional coordination among UN agencies and other international partners to implement UN General Assembly resolutions and the recommendations of the World Health Assembly supporting country programmes.

Vision Zero Academy
Russia 2009

Brazil 2015

Sweden 2020
need to promote an integrated approach to road safety such as a safe system approach and Vision Zero...strengthen national intersectoral collaboration, including engagement with non-governmental organizations and civil society and academia, as well as businesses and industry

- Proclaims the period 2021–2030 as the Second Decade of Action for Road Safety, with a goal of reducing road traffic deaths and injuries by at least 50 per cent from 2021 to 2030
- Calls upon businesses and industries of all sizes and sectors to contribute to the attainment of the road safety-related Sustainable Development Goals, including by applying safe system principles to their entire value chain...
- Encourages Member States and private sector entities that have not yet done so to establish an effective mechanism to reduce the number of crashes, road traffic fatalities and injuries caused by professional drivers, including drivers of commercial vehicles, owing to job-specific hazards...
- Decides to convene a high-level meeting of the General Assembly, no later than the end of 2022, on improving global road safety with a view to addressing gaps and challenges as well as mobilizing political leadership and promoting multisectoral and multi-stakeholder collaboration in this regard
14 SDG goals (17 goals) are definitely interrelated by sound road safety work – Vision Zero approach

Goals which focus on equality

Goals which focus on effective and accountable institutions and collaborations

Goals which focus on sound processes in our societies

Goals which focus on consequences for humans and society

Basic requirement

Need to be consider

Will have impact on

Should have impact on

Need to be consider

Will have impact on

Should have impact on

Basic requirement

Need to be consider

Will have impact on

Should have impact on