The safe system approach in the Netherlands: adoption, implementation and updates of the vision

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The Netherlands

- Population: < 17 million
- Area: 41,543 km² (18% water)
- Population density: 412 p/km² (3,66 p/km² in Canada)
- Mainly flat country

Decentralised policy:
- 12 provinces
- 388 municipalities (decreasing number)
- 2 metropolitan traffic authorities
Typically Dutch...
Our road network

Length of the road network: ca. 140,000 km

…dense road network…
Our traffic context

- Cars: 8.4 million
- Motorways: avg. 2,268 mv/h (max.: 5,836 mv/h)

- Bicycles: 22.7 million (2015)
  - 1.3 bike/inhabitant
  - 84% of population > 1 bike
  - 16% has an e-bike
We want to ride a bicycle...
...learn it as early as possible....
...cycle whatever the conditions...
...or the party...
Road traffic fatalities

2016: 629
International ranking

Fatalities per 100,000 population

WHO ranking of 180 states (2015)

- The Netherlands: rank 8
- Canada: rank 29

Source: IRTAD/OECD (2014)
Policy developments

- Legislation
- Motorway construction
- Passive safety
- Behavioural change
- Decentralization
- Sustainable safety
- IIS-applications

Timeline from 1950 to 2000.
Serious road injuries

Definition: MAIS 2+
Main causes of unsafety

- Bad luck... (till 1920...)
- Who is to blame? (1920-1950...)

- Human: 63-95%
- Vehicle: 4-25%
- Infrastructure: 12-46%

(1950 and later on)
... and solutions...

- Better motivate road users?
- Or realise safe conditions?
- Better educate road users?
Sustainable Safety
Sustainable Safety

1992 Introduction of the Sustainable Safety vision

1995
Start of demonstration projects

1997-2002
Start-up programme

2005/2006
Launch of the first advanced version

2017
Preparations for second advanced version
Some words on the title

‘Sustainable’ as in UN Brundtland-report (1987) on sustainable development

“...a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”
The human measure

- We are vulnerable
- We are fallible
- We are tempted

Sustainable Safety aims for:
- Prevention of serious crashes
- Where this is not possible: reduce probability of severe injury
How to deal with the ‘human measure’?

**INFRASTRUCTURE**
- Design fits to the human capabilities and limitations

**VEHICLE**
- Support the driving task
- Provide physical protection

**ROAD USER**
- Is well informed and trained
- Behaviour is being checked where needed
Proactive safe system approach

System approach: prevention of latent errors (system gap)
- Intervene as early in chain as possible
- Make unsafe actions less dependent from choices of individual road users

Diagram:
- System design
- Quality control
- Psychological precursors for unsafe actions
- Actions during traffic participation
- Defence mechanisms
- Latent errors
- Unsafe actions

CRASH
Proactive safe system approach

System approach: prevention of latent errors (system gap)

- Intervene as early in chain as possible
- Make unsafe actions less dependent from choices of individual road users
Safety principles

**SAFETY CONSCIOUS PLANNING**

**HUMAN CENTRED ROAD DESIGN**

- **Functionality** of roads
  - **Homogeneity** of masses, speed and driving directions
  - **Predictability** of road course and road user behaviour by recognizable road design
  - **Forgivingness** of the road environment and of road users
  - **State awareness** of road users
Functionaly of roads

Flow function

Access function (exchange)

Ideal: monofunctional roads
Functional road categorisation

<table>
<thead>
<tr>
<th>Road category</th>
<th>Flow</th>
<th>Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through road</td>
<td>all</td>
<td>-</td>
</tr>
<tr>
<td>Distributor road</td>
<td>road</td>
<td>intersection</td>
</tr>
<tr>
<td>Access road</td>
<td>-</td>
<td>all</td>
</tr>
</tbody>
</table>
Homogeneity in mass, speed and driving direction

- Prevention of conflicts at high speed (flow)
  - Separate driving lanes for differences in mass or speed
  - Opposite driving directions: physical separation

- Conflicts unavoidable (exchange)? Reduce speed!
  - Lower speed limit
  - Speed reduction at intersections
What is a ‘safe’ speed?
(adopted from Tingvall & Haworth, 1999)

<table>
<thead>
<tr>
<th>Types of infrastructure and traffic</th>
<th>Maximum safe travel speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations with possible conflicts between cars and pedestrians</td>
<td>30 km/h</td>
</tr>
<tr>
<td>Intersections with possible side collisions between cars</td>
<td>50 km/h</td>
</tr>
<tr>
<td>Roads with possible frontal collisions between cars</td>
<td>70 km/h</td>
</tr>
<tr>
<td>Roads with no possibility of side or frontal collisions (only collision with structures)</td>
<td>&gt;100 km/h</td>
</tr>
</tbody>
</table>
Forgivingness: physical and social

Physical forgivingness:
- Matted shoulders
- Obstacle-free zones
- Shielded obstacles

Social forgivingness:
- Anticipating way of traffic participation
- Giving space to other road users
- Particularly directed at less capable road users
Predictability of road layout and traffic behaviour

- Reduce uncertainty and probability of failure:
  - Recognizable situations: consistency in road design
  - Predictable road course: continuity in road design

‘Essential Recognisability Characteristics ‘(ERC):

<table>
<thead>
<tr>
<th></th>
<th>Trough roads</th>
<th>Distributor roads</th>
<th>Access roads</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rural roads</strong></td>
<td>100 km/h</td>
<td>80 km/h</td>
<td>60/80 km/h</td>
</tr>
<tr>
<td><strong>Urban roads</strong></td>
<td></td>
<td>50 km/h</td>
<td>30 /15 km/h</td>
</tr>
</tbody>
</table>

Self-explaining road elements

High-speed roads
(e.g. Theeuwes, 1994):
- Emergency lane
- Directional separation
- Portals

Low-speed road sections
(e.g. Martens et al. 1997; Davidse et al., 2004 Elvik & Vaa, 2004):
- Narrow road width
- Bendy road
- Built-up area
- Speed humps
- Roundabouts

Presence of other road users
(e.g. Kaptein & Theeuwes, 1996; Davidse et al., 2007):
- Cycle lanes
Credible speed limits

Accelerators:
- Open road environment
- Wide road
- Straight road stretches
- High quality road surface

Decelarators:
- Dense road environment
- Narrow roads
- Short road stretches
- Physical speed reducers
- Low quality road surface
State awareness of the road user

- Being aware of one's own competences
- Situational task capability

Age categories:
- Men
- Women

Risk behaviour/state:
- Alcohol
- Cellular phoning
- Fatigue

Relative risk:
- Severe injured/billion travellers km

Graphs showing the correlation between age categories and severe injuries, as well as the relative risk associated with different factors.
Implementation and results
Demonstration projects

Aim: implementation experience at local level

Main lessons

- Cooperation between parties (road authorities + police)
- Transparency about tasks + budgets
- Communication (public support)
Startup programme

- Covenant
  - central government, provincial, local authorities
  - 24 agreements on implementation and financing

- Implemented measures:
  - Categorisation of roads (approximately 100%)
  - 30 km/h zones: 30 000 km out of 55 000 km
  - 60 km/h zones: 12 500 km out of 25 000 km
  - (Roundabouts: from 1000 to 3000)
  - Mopeds on the carriageway
  - ERC: 75% of rural AR; 40% rural DR
  - Increase in traffic enforcement (regional teams)
  - Permanent traffic education toolkit: traffic education programmes for all age groups
Optimal versus low-cost road design

**Access road**

**Optimal**
- Credible speed limit of the whole road design

**Minimal**
- Credible speed limit with add-ons

**Distributor road**

**Optimal**
- Physical separation between road user types and driving directions

**Minimal**
- Lanes for different road user types and driving directions
Total road safety effects

- 1600 to 1700 lives saved in 1998-2007
- Decrease in risk was stronger than period before (5.8% versus 2.6% per year)
- Benefits about 4x costs of measures
- However: less effective for serious road injuries
Lessons learned in practice

- Low cost implementation: phasing solution but not the final idea!
- Start in the right order:
  1. Good network structure
  2. Well designed and attractive through roads
  3. Safe and credible lower order roads
- Attention for:
  - Communication with the public
  - All elements of the road system
  - Evaluation
- Appropriate timing
- Linkage to other policy domains to get support (integral approach)
New developments
Elements for an update

- Aims
- Desired future
- Expected developments
- Actual problems
- Desired future

Context and conditions

Solutions

Vision
= how to reach the desired future
Trends & developments

Demographic developments

Mobility patterns

Urbanisation

Global warming

Economic development

Information and communication technology
Demographic trends

Trends:
- Increase in population: migration
- Increased share of elderly (75+); decrease of other age groups
- People work longer
- Grow of single households

Effects:
- Mobility: increase
- Risk: increase (elderly, immigrants)
Urbanisations

**Trends:**
- Jobs and population: increase in large cities, decrease in decentral areas
- Increase of single households in suburban zones

**Effects:**
- Mobility: increase of cyclists, pedestrians in urban areas; increase in motorised mobility in rural areas
- Risk: decrease (under conditions)
Information- and communication technology

- Improvements and developments: technology
  - Pessimists: no further growth; problems
  - Optimists: further automation and solutions (e.g. near-eradication of distraction)

- Uncertain developments
  - ADAS versus fully automated driving
  - Changing role of driver
  - Adoption?
  - Transition period

- Other developments: shift in mobility
  - Teleworking
  - Internet shopping
Safe Traffic System and Vision Zero developments

- Vision zero
- Sustainable safety
- Safe System approach Australia
- Safe System approach New Zealand

Map showing vision zero and sustainable safety initiatives around the world, with a focus on Australia and New Zealand.
Vision levels

Context and conditions:
1. Maintain the status quo
2. Only prevent damage to others
3. Inherently safe traffic for all (but realistic)

Aims:
1. Reduce largest risks
2. Prevent serious crashes
3. Limit the long-lasting consequences
1. The human measure

New: broader use of human characteristics

- Humans have their own wisdoms and wishes
- Habitual (unconscious behaviour)
- Negative: fallible, limited attention span, prone to fatigue, selfish motives
- Positive: creative, solving new problems, pattern recognition, emphatic (most of us...)
2. The traffic system

More emphasis on:

- Also environment of driver/rider → social + physical
- Technology → support human characteristics
- Trauma care → reduction of consequences
- Redundancy of elements → fail-safety

*The role of the traffic professional* → responsibility!
Enlarged scope of principles

3 design principles, 2 organisation principles
3.1 Road functionality

- Monofunctional road parts, built up in a hierarchical network

- Advanced ideas:
  - Combination of flow and access function in particular conditions
  - Dynamic functionality?
Traffic in cities, dealing with cycling volumes
3.2 Physical compatibility

**Homogeneity** in mass, speed and driving direction

- Prevention of conflicts at high speed (flow)
  - Separate driving lanes for differences in mass or speed
  - Opposite driving directions: physical separation

- Conflicts unavoidable (exchange)? Reduce speed!
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**Forgiveness:** physical and social

- Physical forgivingness:
  - Matted shoulders
  - Obstacle-free zones
  - Shielded obstacles

**Safe fit of speeds, masses, driving directions and physical protection**

**Advanced ideas:**

- Combination of homogeneity and (physical) forgiveness
- Also applied to vehicles and protective measures
- Specific attention for two-wheelers: also protection at low speeds
Compatibility for two-wheelers

CycleRAP
3.3 Psychological compatibility

The traffic environment offers perceivable, understandable and self-explaining information without overloading the road user.

Advanced ideas:
- Visible, readable, self-explaining
- Reliable, consistent and credible
- In time
- Not overloading the road user
- Relevant and personal to the road user
- Take older driver as starting point (reduce complexity)
Taking human factors into account...
3.4 Responsibility of stakeholders

- Responsibilities are divided between stakeholders and road users in an effective way, and with an institutional context of road safety.

This means:

- Professionals (governments and market): responsible for maximal safety quality of the traffic system (roads, vehicles, information, communication, training, enforcement, ITS).
- The road user: (within limits) responsible to obey the rules, to be aware of his state to participate in traffic and do so only when task capability is sufficient.
- Institutional context of road safety: road safety has a fixed place in policy.
3.5 System oriented learning and innovation

Organisations invest in knowledge on causes and solutions for serious road crashes and educate traffic professionals to improve the system.

This means:

- Organisations continue learning what they can improve in the traffic system by investing in research into remaining causes of crashes.
- Organisations improve (innovate) the safety of the system based on knowledge on problems and effective solutions.
- Organisations invest in education of safety professionals to be maximal informed on the latest insights of a well functioning traffic system, latent errors and solutions.
To conclude

- First steps towards Safe System Approach: a paradigm shift is possible!
- Success depends on understanding the vision behind it
- Connect road safety to other policy domains

- Put the human characteristics at the centre
  - Physical laws are not negotiable
  - Deal with human errors and habits by tuning the system design, don’t rely on people’s good will, skills etc.

- Essential to Safe System Approach
  - Don’t wait for crashes to occur
  - Look at risk factors (SPI’s)
  - Implement a mixture of effective measures
  - Evaluate, learn and improve
To conclude

- Join us in a journey towards a safe road traffic system
- Share your ideas and experiences
- Help others in taking first or further steps...

Thank you for your attention!