OVERVIEW

- Introduction
- Safety and Accident Reduction
  - Engineering
  - Enforcement
  - Education
- National differences
- Examples and study sites
SAFETY AND ACCIDENT REDUCTION

DEFINITION

What is a ‘safe trip’?

- without any accident
- without unsafe feelings

Classification of safety-measures:

- engineering
- education
- enforcement
ROAD SAFETY AUDIT (SAFESTAR)

Identify potential safety problems before a new road is open to traffic

Procedure:

- Collection of all relevant information
- Systematic and detailed check of each element of the design
- Report on the findings
URBAN SAFETY MANAGEMENT
(Dumas)

method to reduce accident casualties in a town or city
developed for ‘scattered accidents’
an area-wide, structured safety approach that integrates
different disciplines

- safety strategy
- other policies influencing safety
SAFETY AND ACCIDENT REDUCTION

SAFETY MANAGEMENT TABLE

**Safety Strategy**

- Measures at high risk sites
- Measures to help pedestrians and cyclists
- Environment
- Road construction and maintenance
- Enforcement
- Education, training and publicity
- Health, welfare and education
- Land use
- Public transport
- Area safety schemes

**Other Policies Influencing Safety**

www.eu-portal.net
Driver behaviour is governed by drivers’ expectations, based on information from the environment.

Three-level hierarchy of driver behaviour:

- Macroperformance (navigation)
- Situational performance (guidance)
- Microperformance (control)
SAFETY STANDARDS FOR DESIGN AND REDESIGN

(Safestar)

Standards in road (re)design help to improve the engineering of roads in terms of road safety

(Re)designing roads requires a.o.:

• Traffic engineering techniques
• Insight into driver behaviour
## EXAMPLES OF (RE)DESIGN CONCEPTS

<table>
<thead>
<tr>
<th>Approach</th>
<th>Origin</th>
<th>Focus</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainable safe transport systems, STSS</strong></td>
<td>Dutch</td>
<td>Human capability, Information Protection</td>
<td>5 Road classes, Interurban/Distributor/access, Rural/Urban, speed, access, roadside design…</td>
</tr>
<tr>
<td><strong>Relation design, RD</strong></td>
<td></td>
<td>Network homogeneity</td>
<td>Design speed, sight distance</td>
</tr>
</tbody>
</table>
SAFESTAR APPROACH

= STTS + RD

Tools:

• Alignment
• Cross section
• Tunnels
• Junctions & interchanges
ROAD DESIGN AND SPEED

Proper road design $\Rightarrow$ voluntary decrease of speed
(Master, 1998)

Self Explaining Roads (SER) (Master, 1998):

- Function and use match (also in user’s head)
SAFETY MEASURES AND PROCEDURES FOR WORK ZONES

• Special safety consideration

• 4 main categories:
  • physical design:
  • traffic control
  • road equipment
  • other
SAFETY MEASURES AND PROCEDURES FOR WORK ZONES

- Information near work zones
- Regulation & enforcement near work zones
- Protection
- Road work zone implementation:
  - involves many actors
  - 5 phases of implementation: planning, design, installation, operation, removal (Arrows 1998)
SAFETY AND ACCIDENT REDUCTION

SAFETY OF NON-MOTORISED MODES

• Basic needs for all modes:
  • a trip needs to be *quick*, *safe* and *comfortable*

• Basic needs for cyclists and pedestrians:
  • avoid restrictive measures
SAFETY AND ACCIDENT REDUCTION

TWO APPROACHES TO ROAD USER DEMANDS

• Cycling and walking as an *activity*

• *Interactions* between non-motorised and motorised traffic: safety versus quickness & comfort
OPTIMISING INFRASTRUCTURE

• Criteria for optimising *efficient* and *safe* cycling / walking on 4 levels of infrastructure:
  • network
  • routes
  • road sections
  • other
<table>
<thead>
<tr>
<th>Demand</th>
<th>Criterion</th>
<th>Network</th>
<th>Route</th>
<th>Road section</th>
<th>Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycling or walking as an activity</td>
<td>Possible/necessary manoeuvre</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Continuity in the cross-section</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Predictability</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuity between the infrastructure levels</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>
# Vital Criteria of Cycling/Walking as an Activity Related to Each of the Infrastructure Levels

<table>
<thead>
<tr>
<th>Demand</th>
<th>Criterion</th>
<th>Network</th>
<th>Route</th>
<th>Road section</th>
<th>Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactions between cyclist/ped. and other road users</td>
<td>Same direction or crossing</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Difference in speed and mass</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Priority regulation</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
VITAL CRITERIA OF CYCLING/WALKING AS AN ACTIVITY RELATED TO EACH OF THE INFRASTRUCTURE LEVELS

• Walking: a dangerous mode: second largest group of road casualties

• Two measures primordial for pedestrian safety
  • Area-wide speed reduction or traffic calming schemes
  • Provision of an integrated walking network
<table>
<thead>
<tr>
<th>Activities performed on pedestrian network</th>
<th>Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of trip</td>
<td><strong>Planning:</strong> e.g. information on facilities</td>
</tr>
<tr>
<td>Performing of trip</td>
<td><strong>Planning:</strong> e.g. shortest routes</td>
</tr>
<tr>
<td>Walking</td>
<td><strong>Planning/Design/Maintenance:</strong> e.g. shelters for rain, reduction of speed, repairs</td>
</tr>
<tr>
<td>Crossing</td>
<td><strong>Planning/Design/Maintenance:</strong> e.g. reduced waiting time, denivellation, repairs</td>
</tr>
<tr>
<td>Playing / exercising</td>
<td><strong>Planning/Design:</strong> e.g. playing area, low speed design</td>
</tr>
<tr>
<td>Social interaction / rest / waiting</td>
<td><strong>Planning/Design:</strong> e.g. car free, meetingpoint</td>
</tr>
</tbody>
</table>
• Cycling: some general remarks

• Risk per cycled km decreases as exposure increases

• Non-fatal injuries under-reported (Promising, 2001)
MEASURES FOR SAFETY AND MOBILITY

- restrictive measures incompatible with sustainability
- spatial proximity
- cycling network is different from motor traffic network (there is no three-level hierarchy of driver behaviour as for a motor traffic network)
## SAFETY AND ACCIDENT REDUCTION

<table>
<thead>
<tr>
<th></th>
<th>Through traffic route</th>
<th>Main street</th>
<th>Residential street</th>
<th>Walking street</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>longer journeys</td>
<td>car parking</td>
<td>priority locals</td>
<td>attractive</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>high standard alignment</td>
<td>one lane</td>
<td>pavements</td>
<td>street for everybody</td>
</tr>
<tr>
<td><strong>Behaviour</strong></td>
<td>max. 70 km/h</td>
<td>max. 50 km/</td>
<td>priority pedestrians / cyclists</td>
<td>priority pedestrians / cyclists</td>
</tr>
<tr>
<td><strong>Walking/Cycling</strong></td>
<td>separated crossings</td>
<td>cycle tracks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: Promising, final report*
SAFETY AND ACCIDENT REDUCTION

MAIN PRINCIPLES FOR HIGHWAY CODES

• for roads in urban areas with no traffic flow function, walking and cycling first priority

• waiting time for ped./cyclists at crossing same as for motor traffic

Ensure priority for cyclists & pedestrians through technical measures and rules
COST – BENEFIT ANALYSES

- ↓ cost + ↑ demand

- Promising project results: positive cost-benefit ratios for:
  - reducing driver speed
  - facilities for ped. and cyclists
  - improving conspicuity and visibility
  - injury protection
  - graduated licensing & licence on probation
10 MOST IMPORTANT MEASURES

(based on cost-benefit analysis)

1. separate networks
2. install transport alternatives
3. separate flow
4. reduce area wide speed
5. infrastructure design standards
6. priority rules for cyclist / ped.
7. favour motorised two-wheelers
8. use intermediate licensing system
9. focus education on respectful attitude
10. injury protection design
SPEED EFFECTS

• If speed increases (↑), then:
  • travel time ↓
  • operating cost ↑
  • accident risk ↑
  • noise and exhaust emissions ↑

• speed higher than optimal for society
SAFETY AND ACCIDENT REDUCTION

MASTER FRAMEWORK
A tool to assess impact of (changes in) speed

- Speed
- Speed management
- Vehicle operating costs
- Travel time
- Accidents
- Pollution
- Network level
- Acceptability
- Perceived accessibility
- Spatial socio-economic impacts
- Mobility and modal split

www.eu-portal.net
MASTER FRAMEWORK

3 phases:

• **Outlining**: decide on measure to be tested; link or network level; relevant impacts for this case

• **Measurement**: choose models and gather data; decide which impact to monetise; make calculations; analyse extent of non-quantifiable impacts

• **Assessment**: summarise net impacts; analyse distributional effects; do sensitivity tests; analyse acceptability of policy; analyse overall socio-economic feasibility of the policy
SAFETY AND ACCIDENT REDUCTION

MASTER FRAMEWORK

• Limitations

• Application & output
SPEED MANAGEMENT MEASURES AND TOOLS

Master provides an overview, listing for every measure:

- description
- impact on speeds
- other significant impacts
- cost-effectiveness
- other relevant information
ADVANCED TRANSPORT TELEMATICS

• ATT: information technology and modern communications applied to transport

• Can be informative / recording / intervening

• E. g. in-vehicle safety devices
  • collision warning and avoidance system
  • alcohol control systems
  • driver alertness monitoring
  • route information system
SAFETY AND ACCIDENT REDUCTION

EFFECTS OF ATT

• expected to reduce stress, but sometimes negative effect

• if used voluntarily and successfully ⇒ subjective safety & positive emotional states

• provides objective feedback ⇒ helpful with learning to drive

(Gadget, Telematics report, 1999)
# IN-CAR SPEED LIMITERS

<table>
<thead>
<tr>
<th>😊</th>
<th>🙁</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce excessive speed</td>
<td>Increase travel time</td>
</tr>
<tr>
<td>Can smoothen traffic</td>
<td>Time gaps in following car increases between 30 and 50 km</td>
</tr>
<tr>
<td>Time gaps in following car decreases at 70 &amp; 90 km</td>
<td>Collision risk higher with fixed limiter</td>
</tr>
<tr>
<td>Aversion to speed control systems decrease after usage</td>
<td></td>
</tr>
</tbody>
</table>
ACCIDENT FACTORS

Why do accidents occur?

• Inattention
• Not obeying the rules
• Misjudgement
• Poor visibility
  • one party being hidden
  • dazzling sun or rain

(Adonis, Final report, 1998)
IMPROVE ATTITUDES TO OTHER ROAD USERS

All groups behave badly: pedestrians, cyclists, car drivers
(Adonis, Final report, 1998)

More than (only ?) half of ped./ cyclists change their behaviour after they had an accident

To change behaviour of ped./ cyclists requires both

• clear road design and markings
• information and education (but an accident can also help)
IMPROVE ATTITUDES TO OTHER ROAD USERS

Important measures to reduce law offences

Important measures to increase awareness among road users

SAFETY AND ACCIDENT REDUCTION

SPEED DIFFERENCES, THE IMPACT ON ACCIDENTS

(Master, Final report, 1998)
SAFETY AND ACCIDENT REDUCTION

FACTORS AFFECTING SPEED CHOICE
(Master, 1998)

DRIVER

Attitude cognition
belief emotion

Subjective norm

Perceived behavioural control

Intention

Perception

Information processing

Decision making

Handling

Vehicle speed, heading, etc.

Road environment

Traffic environment
ROAD SAFETY CAMPAIGNS

Safety campaigns on:

- impaired driving
- speed
- aggression
- mastery of traffic situations

Research on road safety campaigns required

Setting up road safety campaigns
EFFECTS OF ROAD SAFETY CAMPAIGNS

- long-term effect

Possible unfavourable side effects due to reactance, comparative optimism, illusory self assessment, …

(Gadget, Safety campaigns report, 1999)
SAFETY AND ACCIDENT REDUCTION

ENFORCEMENT

Legal measures

Enforcement:

• should decrease accident risk

• is only effective if supported by regulations, a sensitive penal system and co-operation bodies

• is the strongest measure to ensure road safety, especially in short term

(Escape, Traffic Law Enforcement by non-police bodies, 2000)
ENFORCEMENT

Alternative enforcement
Continuous police surveillance is necessary for minimal safety

• Non-police enforcement
  From fully government controlled, but privately performed to public-private conjunction

• Best suited for:
  • standardised repetitive
  • specialised tasks
ENFORCEMENT

- Police enforcement
  Fully government controlled

- Best suited for:
  - mix of routine and specialisation
  - tasks where sensitive contact is important

- Non-police enforcement bodies
SPEED ENFORCEMENT

Impact depends on:

• subjective risk of getting caught
• penalty system
• publicity

Advice for speed enforcement:
Explicitly formulate government policy objectives; use speed cameras; Combine enforcement always with publicity, focus on target groups; etc.
ACCIDENT AND INJURY REGISTRATION

An EU-wide crash injury registration system and database would be of exceptional benefit

- identification of any safety problem in early stage
- quick and accurate evaluation of remedial measures

(Stairs, Final Report, 1999)
TYPES OF ACCIDENT STUDIES

• Categories based on moment of data collection
  • Retrospective studies
  • On the scene, on time studies
  • Hospital based studies

(Stairs)
TYPES OF ACCIDENT STUDIES

- Categories based on objectives of the study
  - Primary safety: prevent crash
  - Secondary safety: prevent injury after crash

(Stairs)
<table>
<thead>
<tr>
<th></th>
<th>Retrospective</th>
<th>On the scene</th>
<th>Hospital based</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Investigate accident</td>
<td>Primary &amp; secondary</td>
<td>Secondary</td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td>Inspection of vehicles</td>
<td>Collect data before removal of vehicles</td>
<td>Collect data in hospital</td>
</tr>
<tr>
<td><strong>Timing</strong></td>
<td>Afterwards (during working hours)</td>
<td>Immediately after accident</td>
<td>Afterwards</td>
</tr>
</tbody>
</table>
## SAFETY AND ACCIDENT REDUCTION

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<th>Retrospective</th>
<th>On the scene</th>
<th>Hospital based</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td>Investigation of vehicles &amp; information</td>
<td>All relevant data</td>
<td>Medical based data</td>
</tr>
<tr>
<td><strong>😊 Small costs</strong></td>
<td>Small costs</td>
<td>Possible note to validate</td>
<td>High quality data (hospital staff)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High quality data</td>
<td>Exhaustivity is possible</td>
</tr>
<tr>
<td><strong>🙏 Notification crash slightly delayed</strong></td>
<td>Notification crash slightly delayed</td>
<td>Expensive</td>
<td>Insufficient data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaboration ER is required</td>
<td>Hospital staff not always available</td>
</tr>
</tbody>
</table>
A PAN-EUROPEAN ACCIDENT DATABASE

• underestimation of accidents with minor injury ⇒ acceptability of national estimates uncertain

• countries use different sampling schemes ⇒ extra efforts to combine

• collect broad data, but not at the expense of sample size

• there is still a long way to go

(Stairs, Final Report, 1999)
SAFETY AND ACCIDENT REDUCTION

EXAMPLES AND STUDY SITES

New Policies and strategies for road safety

Sustainable safety concept in the Netherlands

Man is basically the standard.

Reduce accidents in advance by infrastructure design.

Eliminate virtually all serious injuries

Fatal accidents should be reduced with 60% - 80% within 30 years
CONCEPT OF SUSTAINABLE SAFE TRAFFIC SYSTEM

• Structure is adapted to limitations of man through proper design

• Roads have a neatly appointed function

• Vehicles fitted with ways to simplify the driver’s task

• Vehicles constructed to protect vulnerable user

• Road user is educated, informed, where necessary guided and restricted
PRACTICAL SAFETY PRINCIPLES
SUSTAINABLE SAFE TRAFFIC SYSTEM

• prevent inappropriate use of roads
• reduce possibilities of serious conflicts
• prevent uncertainty among road users
SAFETY AND ACCIDENT REDUCTION

VISION ZERO’ IN SWEDEN

Man is basically the standard.

Create a situation to minimise exposure to violence

Loss of health should be reduced to politically pre-defined level