Human Factors Analysis

- Design Through the Lenses of Human Behavior

Knowledge-Sharing Session with the ARC Regional Safety Task Force

05/13/2021

Health & Safety Moment
Proper Bike Helmet Fitting

1. You want the helmet to be level on the head, not tilted back or sideways.
2. You want the fitting pads inside to be touching all the way around.
3. You want the strap to be comfortably snug.
4. With the strap fastened you should not be able to get the helmet off with any combination of twisting and tugging
5. The helmet should not bump on your glasses or sunglasses in the front.
6. The helmet should be comfortable enough to forget that it is on your head after only a few minutes.

Resources: https://www.trafficsafetystore.com/resources/kids-bike-helmet
https://www.auburnalabama.org/cycle/frequently-asked-questions/fitpam.pdf

Incorrect

Correct

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Human Factors Analysis

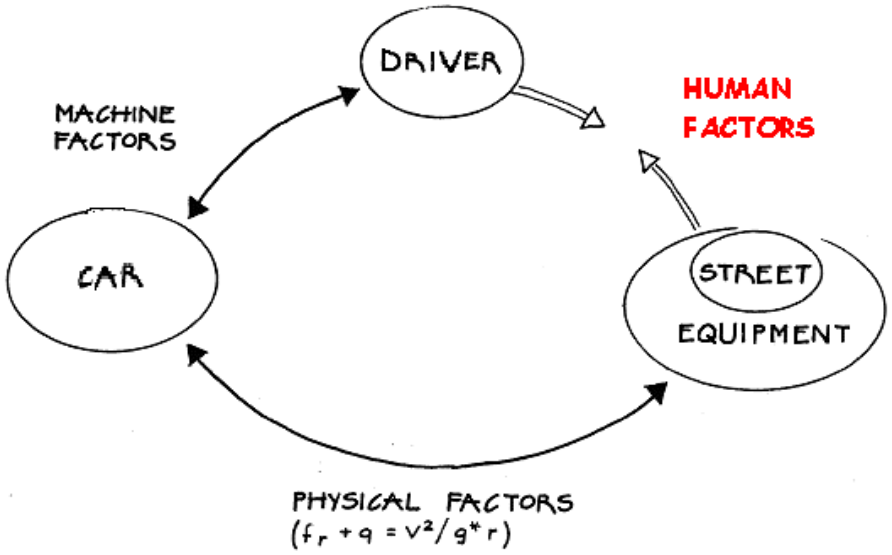
History and evolution of Human Factors Analysis in transportation

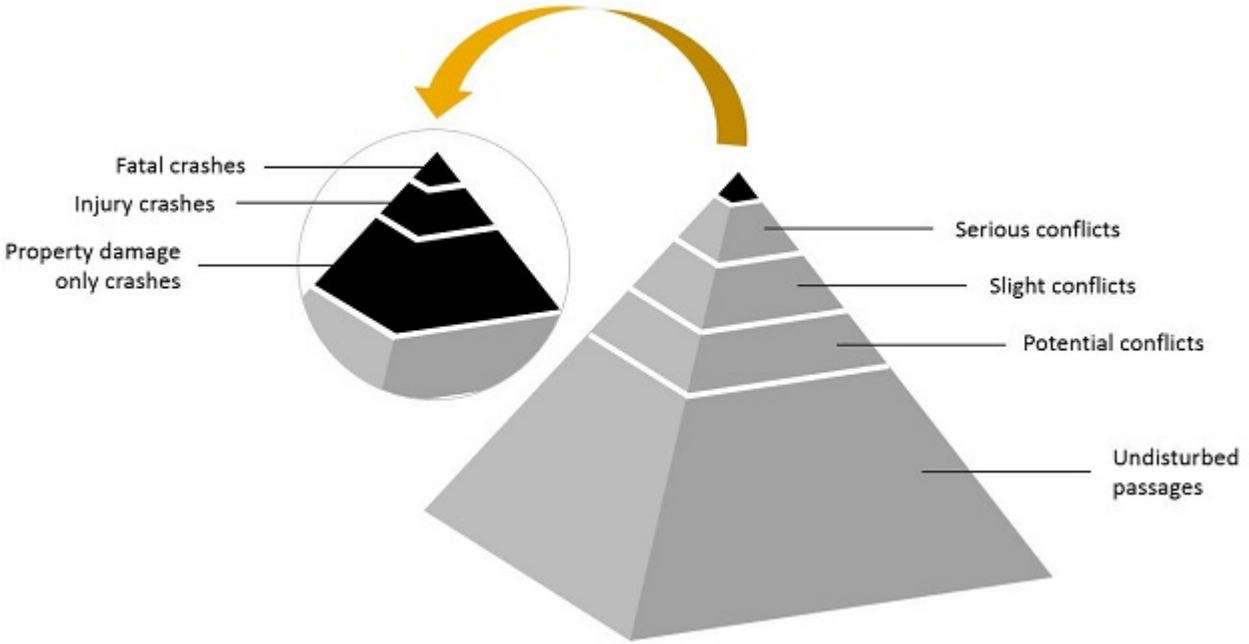
Applied examples of Human Factors Analysis

Introduction of Human Factors Approach

- **Fundamentals:**

Taking the capabilities and limitations of (different types of) users as a starting point



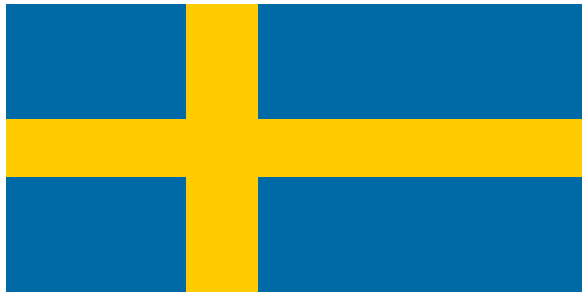


From PIARC Road Safety Manual, 2019, available at https://roadsafety.piarc.org/en/planning-design-operation-designingroad-users/introduction

Safe System

Creating a "safety net" that uses mutually reinforcing approaches to create safer roads, safer speeds, safer vehicles, safer users and effective post-crash care.

1. Anticipating Human Error
2. Accommodating Human Injury Tolerance



Sweden

Vision Zero

60 -70%

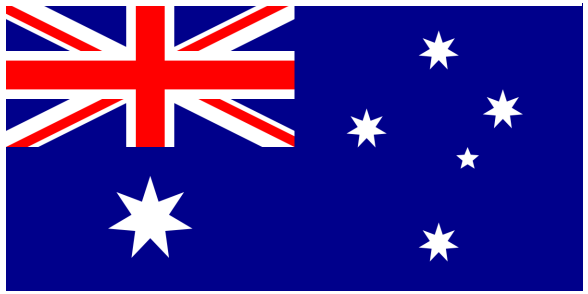
Reduction in fatalities

Netherlands

Sustainable Safety

50 -60%

Reduction in fatalities

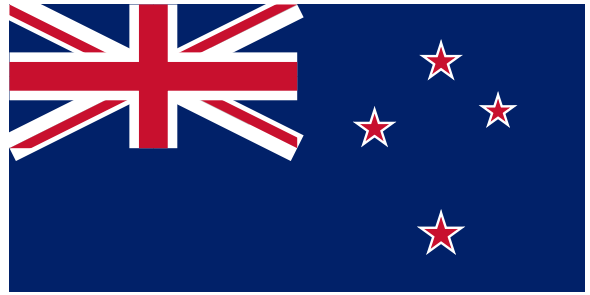


Australia

Safe System

50 -60%

Reduction in fatalities



New Zealand

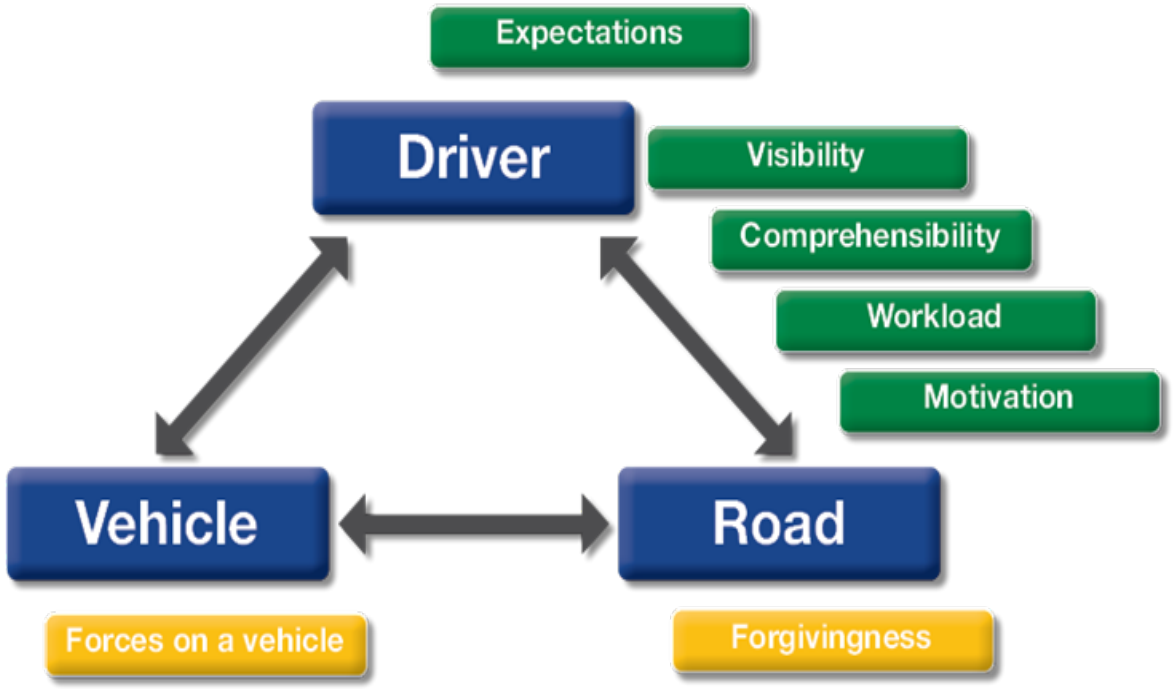
Safer Journeys

50 -60%

Reduction in fatalities

Human Factors Transportation Analysis Model

- 5 behavioral principles + roadway forgivingness
- Methodology was developed by Dutch National Road Authority
- Arcadis contributed to the development
- Not only applicable to car drivers, but also to other transportation modes



Human Factor Principles

- Expectations
- Visibility
- Comprehensibility
- Mental Workload
- Motivation

Comprehensibility

Mental Workload

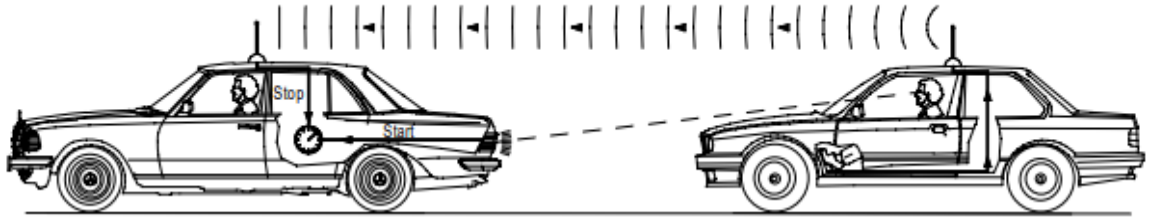
Motivation

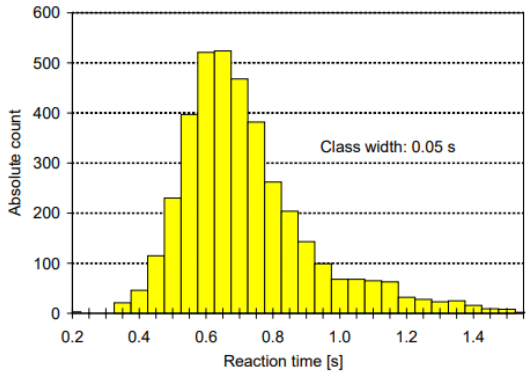
Expectations

Visibility

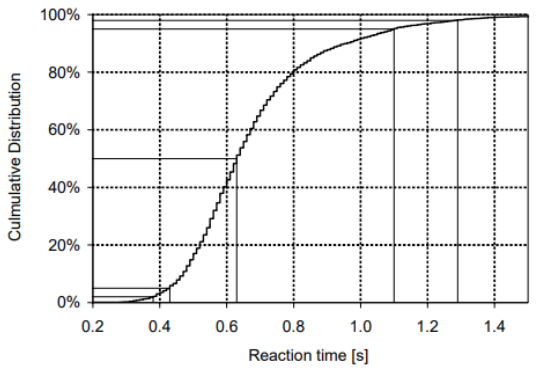
Human Factor Principles

- **Different types of road users and conditions**



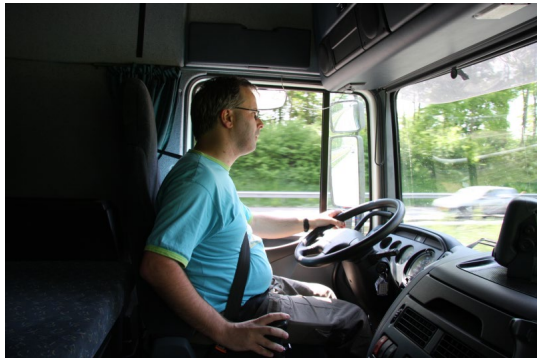


a) Histogram



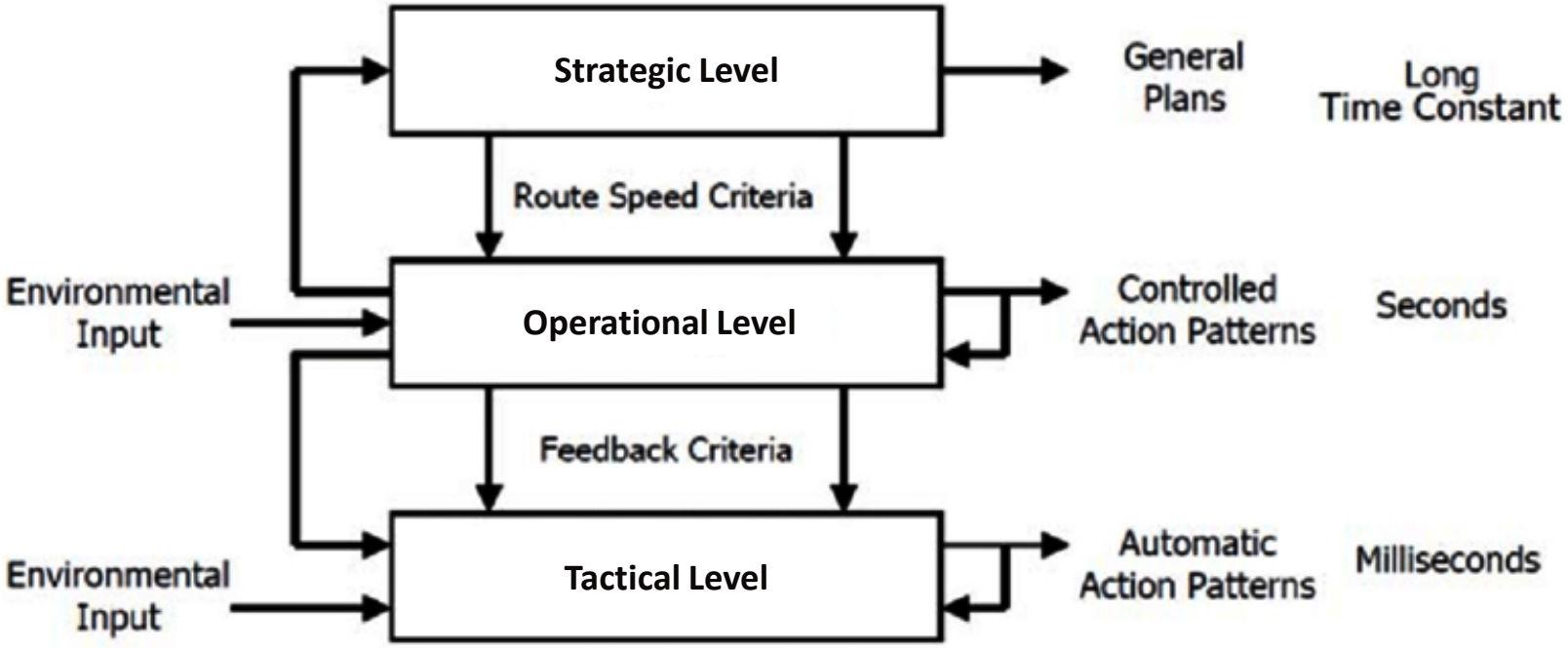
b) Cumulative distribution

Example: Reaction time



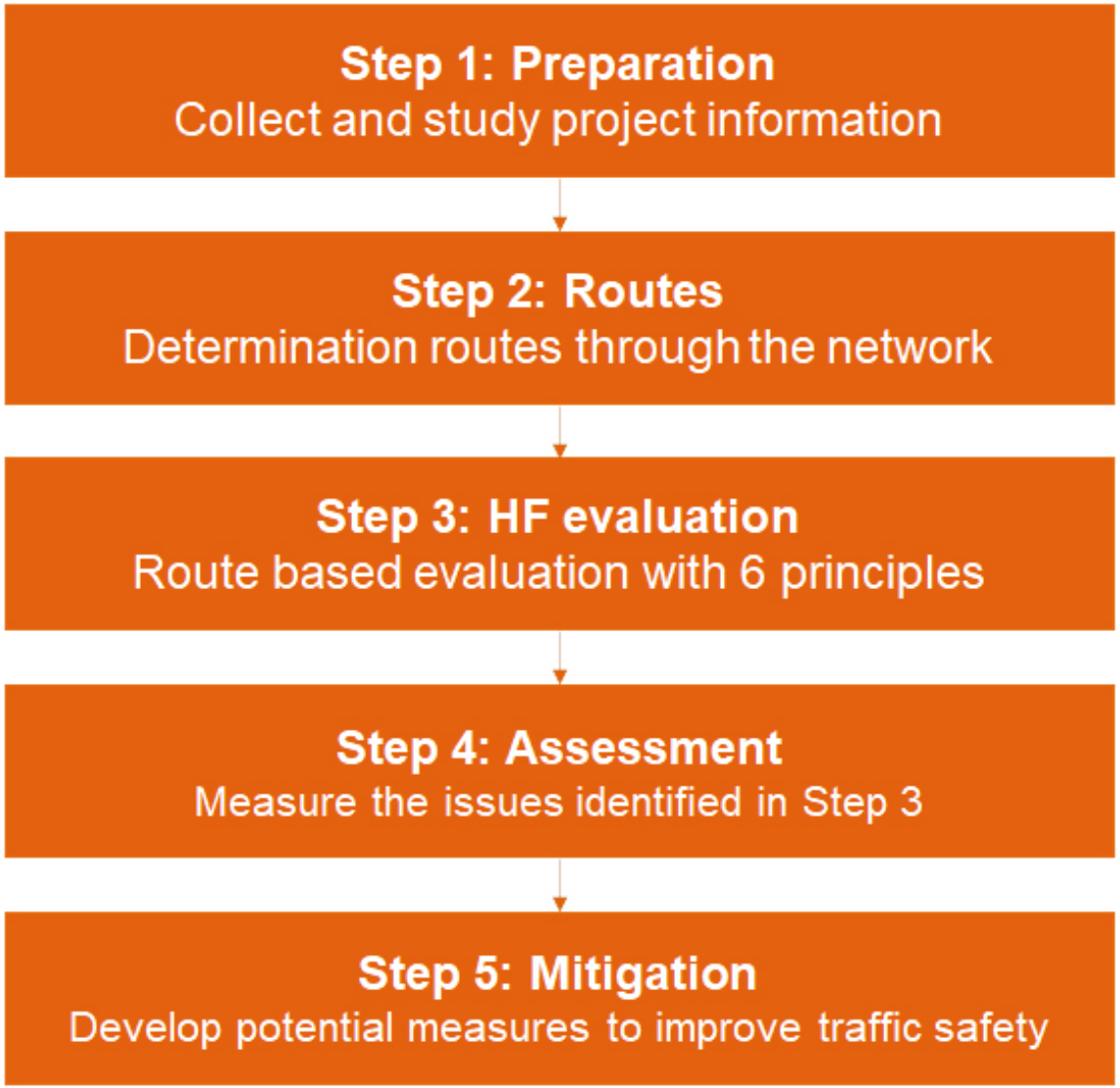
Three Levels of Travel Decision-Making

- **Strategic Level** – Long-term decision-making.
  - ex. Determining travel route
- **Operational Level –** Short-term decision-making.
  - ex. Making a turn at an intersection
- **Tactical Level –** Very short-term decision-making.
  - ex. Emergency braking



Levels of decision-making can be combined with behavioral principles

Human Factors Evaluation Methodology



Human Factors Evaluation Methodology

Systematic approach of human behavior can be applied to many projects and studies

I-85 Planning Environmental Linkages (PEL) Study

HFA Application

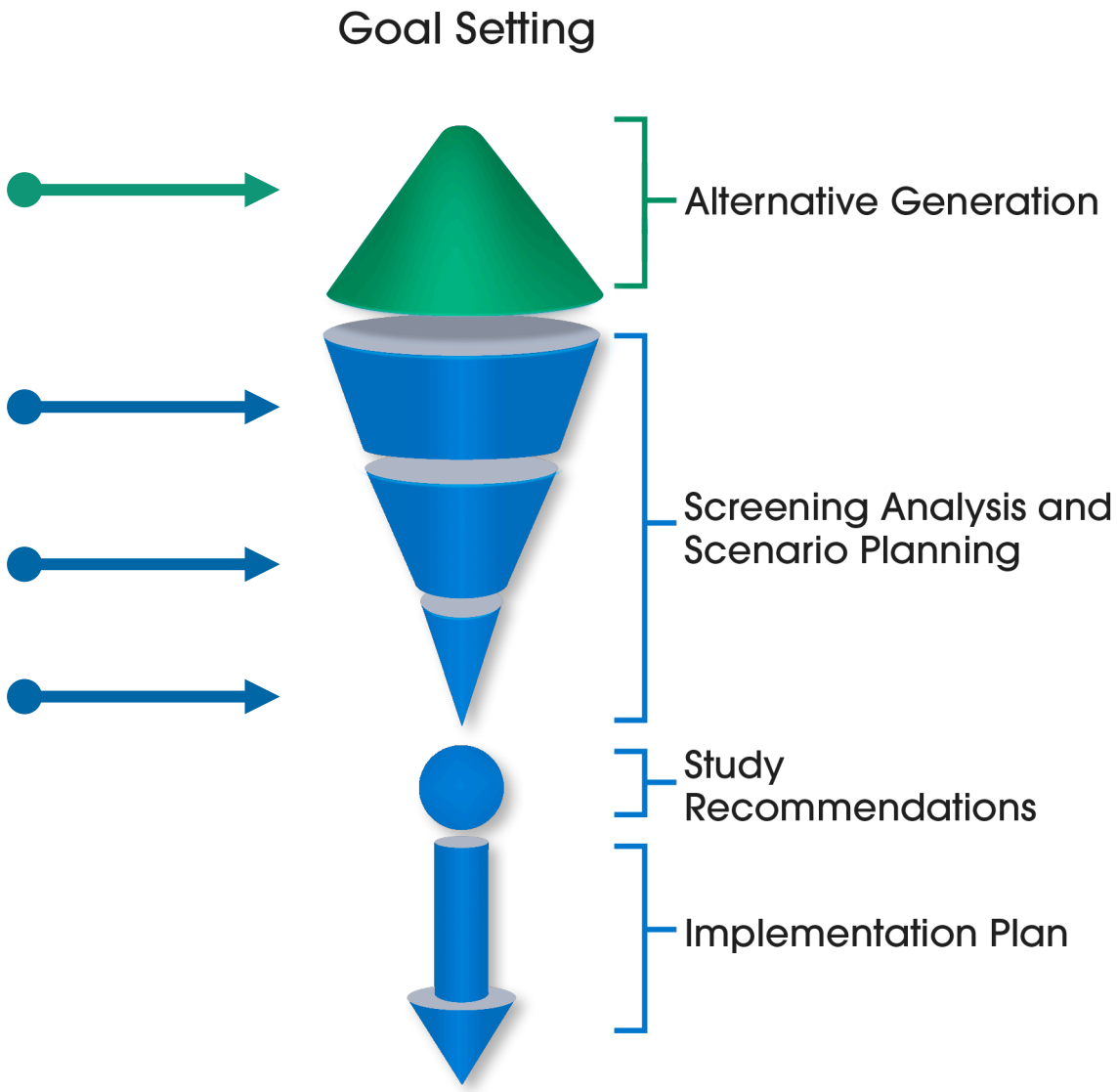
- Evaluating existing conditions
- Identifying alternatives

- Tier 1: Evaluating alternatives qualitatively

- Tier 2: Refining alternatives

- Tier 3: Evaluating the impacts when alternatives are combined

Major Phases of the I-85 PEL Study



Non-Motorized Conflicts in Amsterdam:

Cyclist and pedestrian behavior at high-volume crossings

- City of Amsterdam selected several unsafe signalized intersections:
  - Bike – bike conflicts
  - Bike – pedestrian conflicts
- After analysis, safety improvement measures were implemented
- Before-after comparison of human behavior and traffic safety
- Conclusions and recommendations: was safety improved?

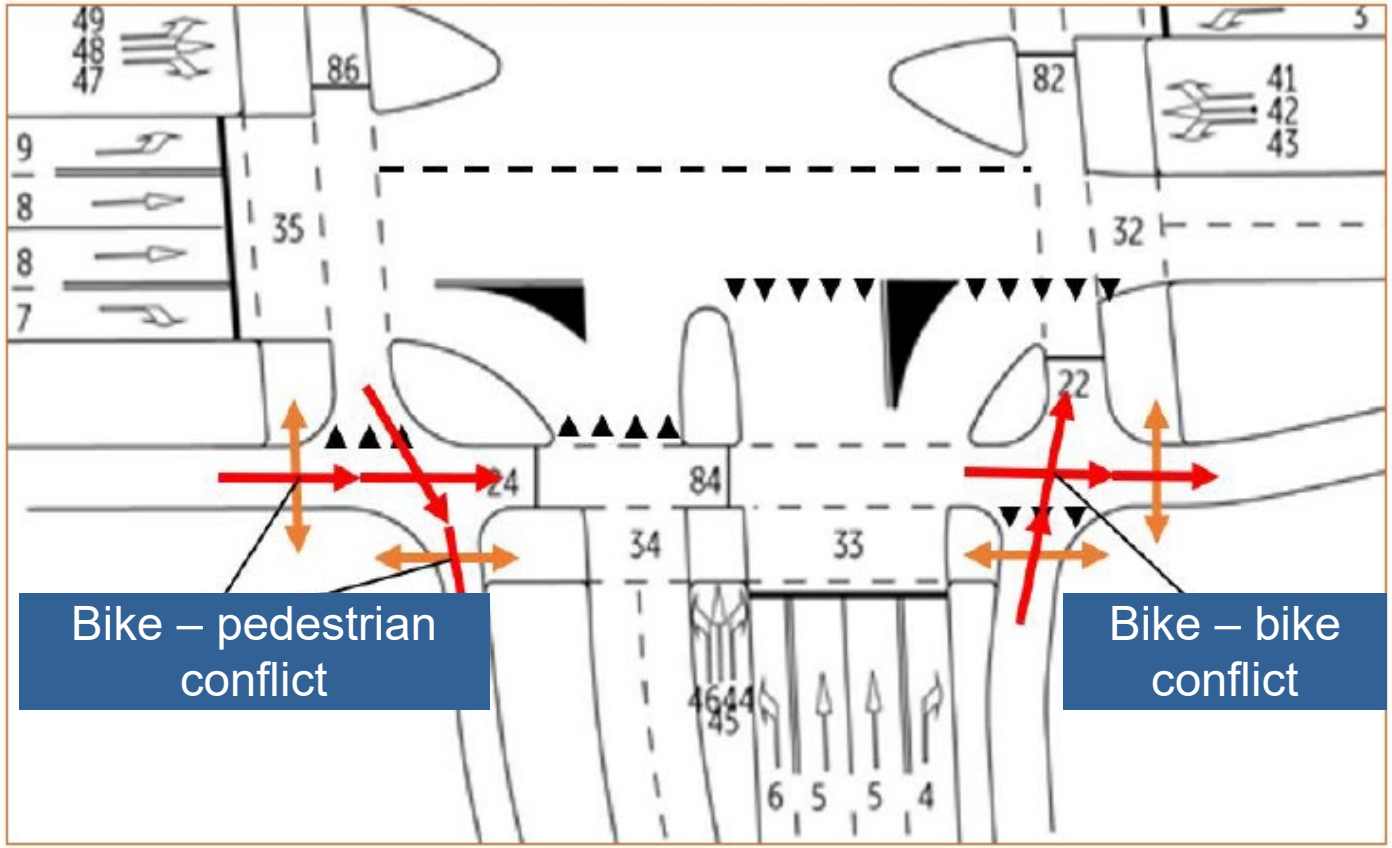
Non-Motorized Conflicts in Amsterdam:

Cyclist and pedestrian behavior at high-volume crossings

- **Step 1: Preparation**
- **Step 2: Routes**
- **Step 3: HF evaluation**
- **Step 4: Assessment**
- **Step 5: Mitigation**

Bikes

Pedestrians



Non-Motorized Conflicts in Amsterdam:

Cyclist and pedestrian behavior at high-volume crossings

Step 1: Preparation

↓

Step 2: Routes

↓

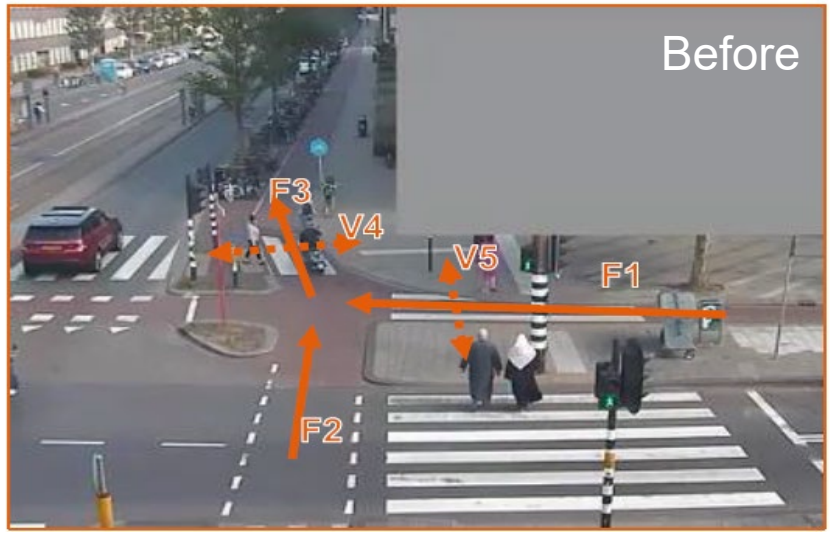
Step 3: HF evaluation

↓

Step 4: Assessment

↓

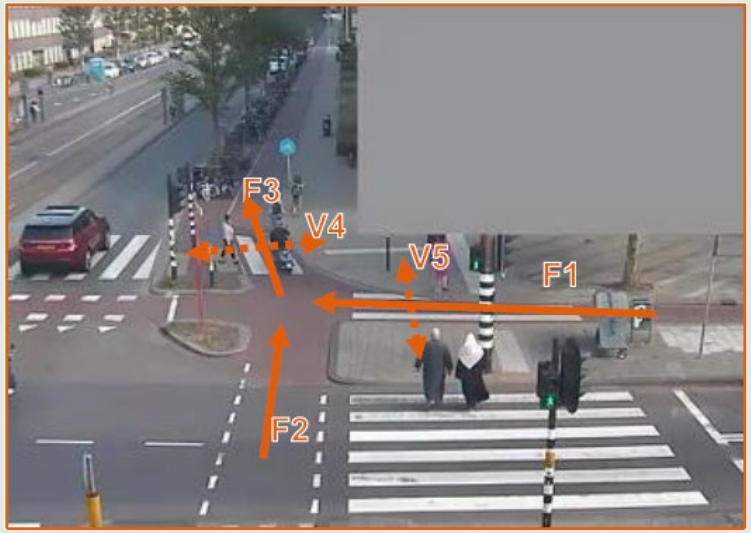
Step 5: Mitigation



- Blue arrow (emphasizes bike priority/direction)
- Crossing removed (right of way changed)

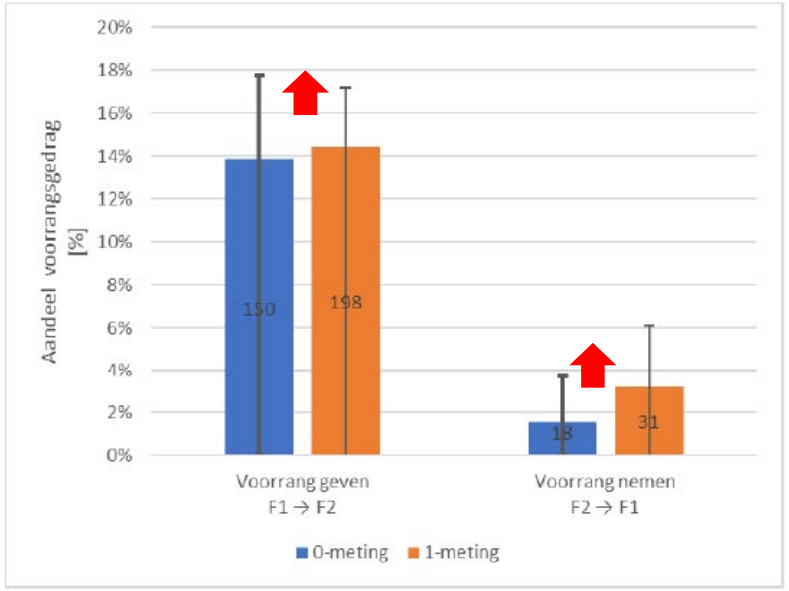
Non-Motorized Conflicts in Amsterdam:

Cyclist and pedestrian behavior at high-volume crossings

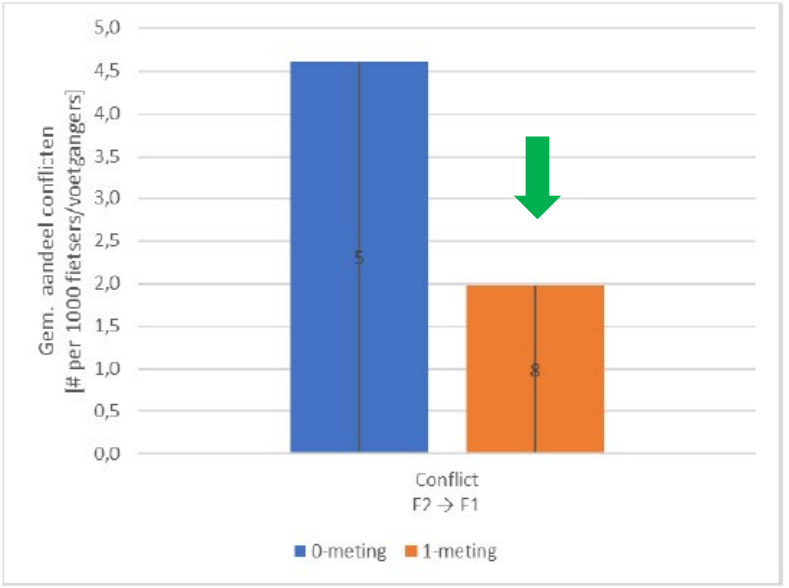


Bike – bike right-of-way

F1 has the right of way (before and after)



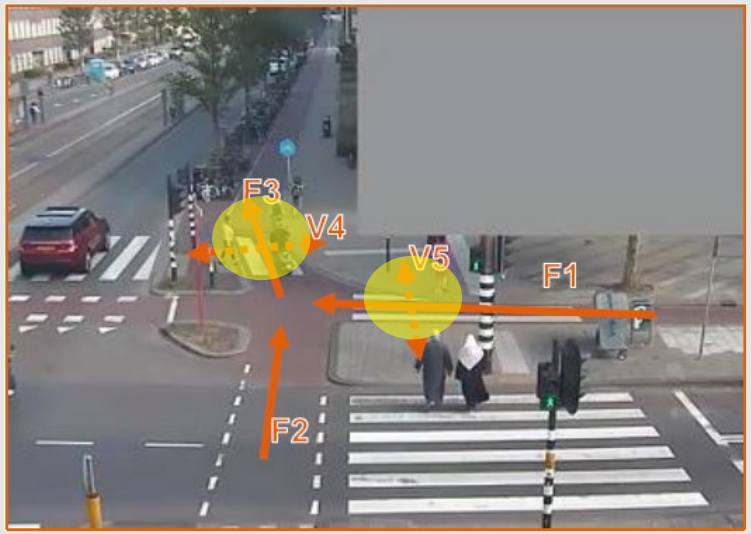
Bike – bike conflicts



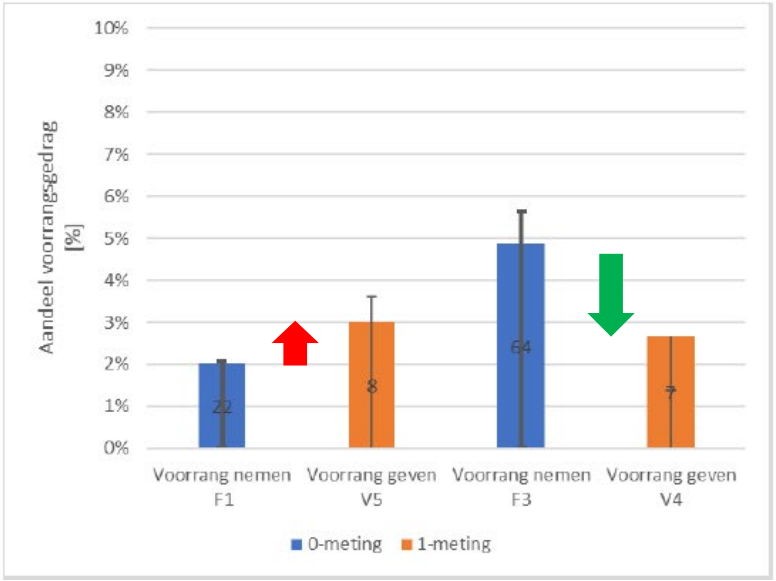
- Little decrease in the correct right of way behavior
- Less conflicts observed: cyclists used available space better
- Behavioral principles ‘Visibility’ and ‘Comprehensibility’:
  - Cyclists are more attentive to each other (eye contact)
  - The potential conflict is recognized easier (arrow increases attention level)

Non-Motorized Conflicts in Amsterdam:

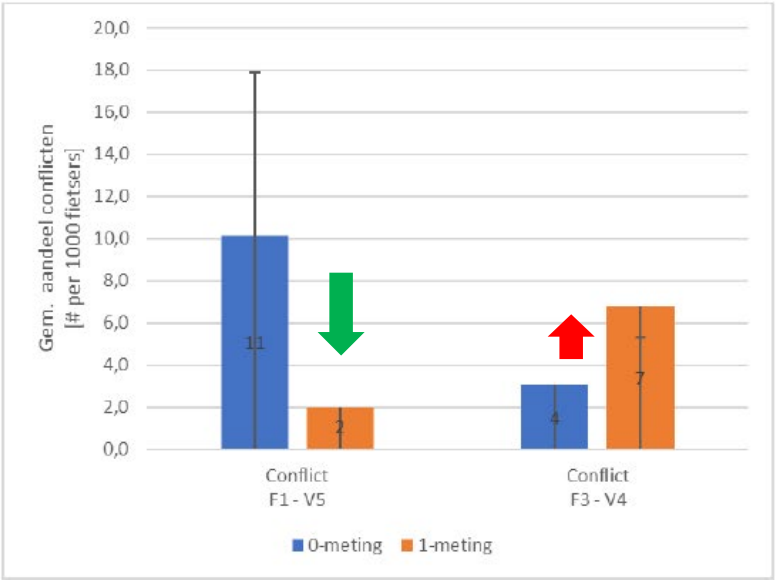
Cyclist and pedestrian behavior at high-volume crossings



Bike – pedestrian right-of-way



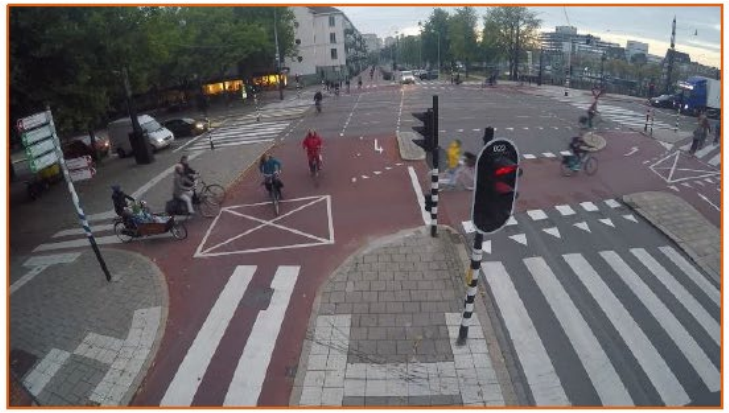
Bike – pedestrian conflicts

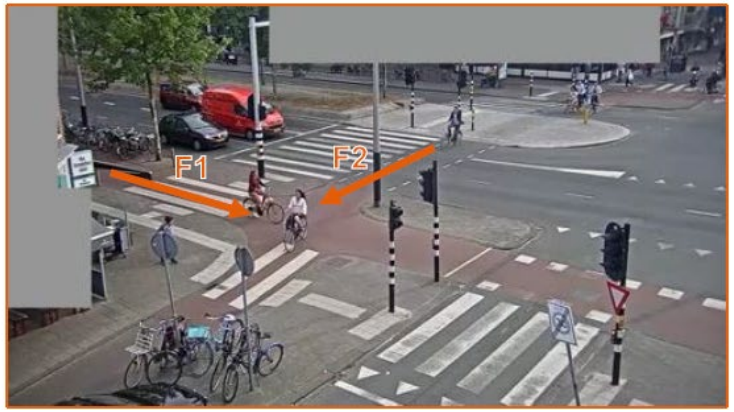


- For F1 – V5 the correct right of way behavior decreased, but the number of conflicts also decreased
- For F3 – V4: the opposite occurred
- Behavioral principles ‘Visibility’ and ‘Expectations’:
  - Pedestrians have poor sight on the cyclists
  - Pedestrians expect that they have the right of way (they had a green sign on the previous crossing)

Non-Motorized Conflicts in Amsterdam:

Cyclist and pedestrian behavior at high-volume crossings





- Other tested improvements for pedestrians and cyclists:
  - Elevated intersection
  - Accentuate crossings (with pavement markings)
  - Change the right-of-way between directions
  - Enlargement of the cyclists' space within the intersection
  - All directions are green at the same time (for bikes)

Take-aways

- In designing safe transportation systems, taking into account human factors is essential.
- Human factors are one of the basic principles for Safe Systems
- The human factors approach can be applied to all traffic modes.
- Analyzing transportation user behavior can help explain environmental and infrastructural influences in conflicts and crashes.
- Human factors and traditional crash analysis are complimentary and should be used together where possible.
  - Especially insightful for complex corridors or intersection and systems.

Thank You!

Questions & Discussion

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