Surrogate measures in traffic safety analysis

ALIAKSEI LAURESHYN
Technology & Society, LTH
What is "surrogate"?

"surrogate" = not accidents
What is wrong with ”accidents” then?

- Few and random
- Under-reporting
- Scarce/biased information
- Process?
- Retro-active approach
What can we learn from "not-accidents"?
“Pyramid” concept

Hyden, 1987
Concept of "severity"

• Nearness-to-collision?
• Consequences IF a collision?
• Both? How to “weigh” together?

From Vision Zero perspective:
• **Nearness-to-severe injury**
How to measure severity?
Time-to-Collision (TTC)

- $\text{TTC}_{\text{min}}$
- TA – Time-to Accident
- TET, TIT
- ...
Post-Encroachment Time (PET)

- PET
- TAdv – predicted PET
- Time Gap
- Headway
- ...

\[ \text{PET} = t_2 - t_1 \]

conflict zone
Deceleration

- Deceleration-to-Safety (DST)
- Max deceleration
- Proportion of stopping distance
- Jerk
- ...
Other

- Subjective scores
- Combined indices
- Traffic conflict techniques
Conflict techniques (TCT)

• Swedish – Hydén (1987)
• Dutch (DOCTOR) – Kraay et al. (1986)
• British – Baguley (1984)
• Canadian – Sayed & Zein (1999)
• Finnish – Kulmala (1984)
• French – Muhlrad & Dupre (1984)
• Belgian - Mortelmans et al. (1986)
• German – Erke (1984)
• Czech – Kocárová (2012)
• Austrian - Risser & Schutzenhofer (1984)
Swedish TCT

![Graph showing conflicting speed (kph) vs. TA-value (sec)]

- **Serious conflict**
- **Non-serious conflict**
Validity & reliability

- **Reliability** – can we measure accurately enough?

- **Validity** – do we measure the desired property (safety)?
Relation between conflicts & accidents

- Traffic dynamics
  - Undisturbed
  - Conflict

- Evasive action
  - Successful
  - Not successful

- Traffic continuation
  - Collision
Relation between conflicts & accidents
Exposure, conflicts, accident

Amundsen & Hydén, 1977
Exposure, conflicts, accident

Amundsen & Hydén, 1977
Conflict

Probability \( p \)

Accident

Probability \((1-p)\)

Avoided accident

Observed in conflict studies

But why should it have any explanatory power?
Definition should start here

Conflict

Probability $p$

Accident

Probability $(1-p)$

Avoided accident
In a view of Vision Zero...

Conflict

Severe injury/injury accident

Avoided injury

Probability $p$

Probability $(1-p)$
Relation between conflicts & accidents

\[ \lambda = c \cdot \pi \]

\( \lambda \) – expected number of accidents;
\( c \) – conflicts;
\( \pi \) – accident-to-conflict ratio.
Extreme value theory

Observations

TTC = 0
PET = 0
Causal model

Initial conditions \([U]\)

Evasive actions \([X]\)

Outcomes \([Y]\)

Probability

Deceleration, m/s^2
Validity

Validity of Surrogate Safety Measures:

- Absolute product validity
- Relative product validity
- Process validity
Validation

Product validity:

• Observed conflicts vs. reported accidents - linear regression
• Observed conflicts vs. SPF - linear regression
• Ratio observed conflicts/expected accidents – variance
• SPF based on conflicts as input
• Extreme value theory methods
• Before-after studies based on conflicts vs. accident history
• Accidents vs. conflicts as functions of traffic flow
Current status

Number of publications

Publication year

Included
Not located
Analysis tools

• Human-based
Analysis tools

• Human-based
• Semi-automated / watchdog
Analysis tools

- Human-based
- Semi-automated / watchdog
- Fully automated
Looking forward ...

• Good evidence for the sound approach (from the past)
• Rapidly developing technologies for data collection
• New traffic conditions -> new validations
• New tools -> new validations
• VRU to be better included
• Many accidents outside intersections -> single accidents
• Triangulation of methods
I am still not persuaded this is unsafe. 

Let’s wait for some more planes to crash…
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What was not mentioned…

• Micro-simulations of conflicts
• Naturalistic studies
• Behavioural observations