DEFINING CRASH RELEVANT EVENTS IN THEORY AND PRACTICE

Webinar

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FOT-Net is a support action co-funded by the European Commission to network FOT activities at European, national and international level.

DEFINING CRASH RELEVANT EVENTS

Webinar Agenda

1. Introduction to the WG
2. What are CREs and why do we need them?
3. What to say on CREs in the revised FESTA handbook?
4. Other open questions

CRASH RELEVANT EVENT DEFINITIONS WORKING GROUP

Task	Who	Deadline	Result (milestone)*
1. Collect previous work on events and incidents definition	WG leader	Q1 2012	Report compiling existing incident and event definitions
2. Select and invite core group and make list of other members	WG leader	Q1 2012	List of members in core group
3. Brainstorming by inviting to an open meeting for input on the topic	Core group	Q2 2012	
4. Identification of specific items that need to be worked on, and have different categories of people give input on them	Core group and other members	Q2-Q3 2012	List of targeted items
5. Write a proposal for improved event and incident definitions	WG leader and core group	Q4 2012	Draft proposal
6. Arrange workshops/ webinars for additional inputs on the proposal.	Core group and other members	Q1-Q2 2013	
7. Finalize the proposal including identification of issues needing research to be properly addressed	WG leader and core group	Q3 2013	Report on the new suggested event and incident definitions including recommendations for focused research on remaining issues

DEFINING CRASH RELEVANT EVENTS

- Crashes are very rare events
- To estimate safety risks/benefits, one therefore needs something to stand in for those crashes
- The basic idea here is that less severe, but still critical, events can be used as surrogates

DEFINING CRASH RELEVANT EVENTS

- Many dimensions used to assess critical event relevance
  - Critical pre-response kinematics
  - Critical response kinematics
  - Driver's level of surprise (startledness) and fear
  - That looks dangerous (manual visual inspection)
  - This is a very unusual (given driver history)

DEFINING CRASH RELEVANT EVENTS

- Ideally, one would select and compare only CREs known to be predictive of actual crash involvement
- Unfortunately, CRE definitions that fulfill this criteria have yet to be fully established
  - In published studies, explicit descriptions on the connection between the CRE they use and crash risk is often lacking

DEFINING CRASH RELEVANT EVENTS

- Key question for all FOT/NDS: how can we establish the relation between crash relevant events and different types of crashes?
- Key question for the FESTA handbook: does there exist a “canonical” defintion which can be added?

DEFINING CRASH RELEVANT EVENTS

- Four theoretical approaches in general use:
  - Driver response based
  - Function response based
  - Driving context based
    - Static
    - Dynamic
  - Driving history based
    - Individual
    - Group

DRIVER RESPONSE BASED CRE IDENTIFICATION

- Drivers will not expose themselves to kinematically drastic maneuvers unless necessary
- Abrupt velocity are direction changes are out of the ordinary, indicating an urgent response to an unexpected situation
    - Assumed link: hard decelerations (or similar) are the “bottom” of an iceberg where lead vehicle crashes are the top

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DRIVER RESPONSE BASED CRE IDENTIFICATION

- CREs are identified based on how each driver evaluates the situation
  - In similar situations, Driver A may brake hard while Driver B might not
  - If a driver does not respond, it is by definition not an event
  - The CRE selection would exclude Driver B's event
  - The CRE selection will reflect the driver population's variability in terms of driving style, risk perception and capacity to respond
  - Representative selection of drivers is a key issue for this approach

Table copied from 100 car Phase II report

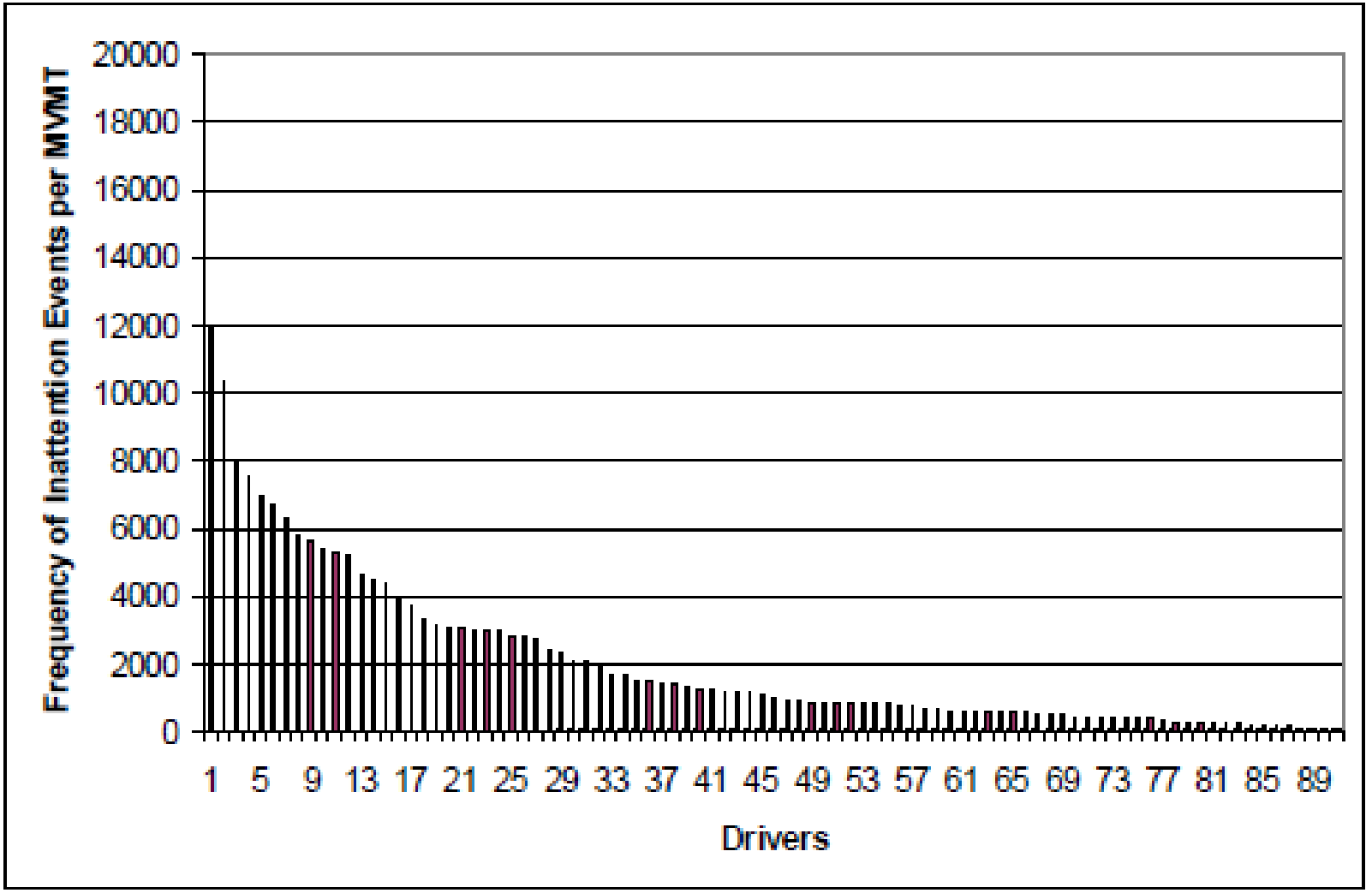


Figure 7.2. Frequency of inattention-related events per MVMT in which inattention is due to: (1) drowsiness, (2) inattention to the forward roadway, (3) secondary task, (4) specific eyeglance away from forward roadway (for crashes and near-crashes only) or (5) nonspecific eyeglance away from forward roadway (for crashes and near-crashes only).

FUNCTION BASED CRE IDENTIFICATION

- If an FOT assesses the effects of FCW, the warnings issued by FCW can be used as event identifiers
- Assumed link: events detected by the function are true CREs – i.e. are coupled to the underlying causation mechanisms of the crashes it is designed to prevent

FUNCTION AND DRIVER RESPONSE BASED CRE IDENTIFICATION EXAMPLE

- euroFOT lead vehicle conflict definition:
  - FCW warning issued
  - Brakes applied within 5 seconds after warning
  - Max Brake Jerk > 10
  - Max Brake Pressure > 20 (in bar)
  - FCW target = moving
  - Direction indicators not used right before FCW

FUNCTION BASED CRE IDENTIFICATION

- Due to sensing and/or threat detection algorithm limitations, the function may not capture all the critical situations you think it should
- It would be preferable to run your own threat detection algorithm on the collected data to avoid function based CRE selection bias
- However, function developers are more often than not clever people that have worked on the function for several years.
- Your algorithm has to beat theirs, while still being based on the same sensor data

FUNCTION BASED CRE IDENTIFICATION

- Another option is to add additional (better) sensors before running the FOT, thus giving your algorithm an advantage
- However, additional equipment costs might be large
- Upside: function availability and usage are automatically factored in
  - the function can only do something when on and available

DRIVING CONTEXT BASED IDENTIFICATION

- For certain vehicle and/traffic environment configurations, the safety margins are so small that it takes very little to crash
  - Assumed link: small margins equal elevated crash risk, and prevention of whatever it is that leads to these small margins will enhance traffic safety

DRIVING CONTEXT BASED IDENTIFICATION

- The definition of what constitutes small margins can be either static or dynamic
  - Static: lane markers, yield lines, etc
  - Dynamic: various kinematic conditions, such as high range rate changes within a given range

DRIVING CONTEXT BASED IDENTIFICATION EXAMPLE

- Static example: Gordon et al 2011
  - Single vehicle crash risk depends on lateral control
  - The underlying mechanisms leading to such crashes involve “disturbed” lane-keeping control
    The study compared lane deviation (not so good), lane departure warnings (better) and instances of very short distance to the road edge (best crash surrogate)

DRIVING CONTEXT BASED IDENTIFICATION EXAMPLE

- Dynamic: Najm et al 2006
  - Lead vehicle crashes are predicted by lead vehicle conflicts where the margins in time and space are less than X

Table copied from Najm et al 2006

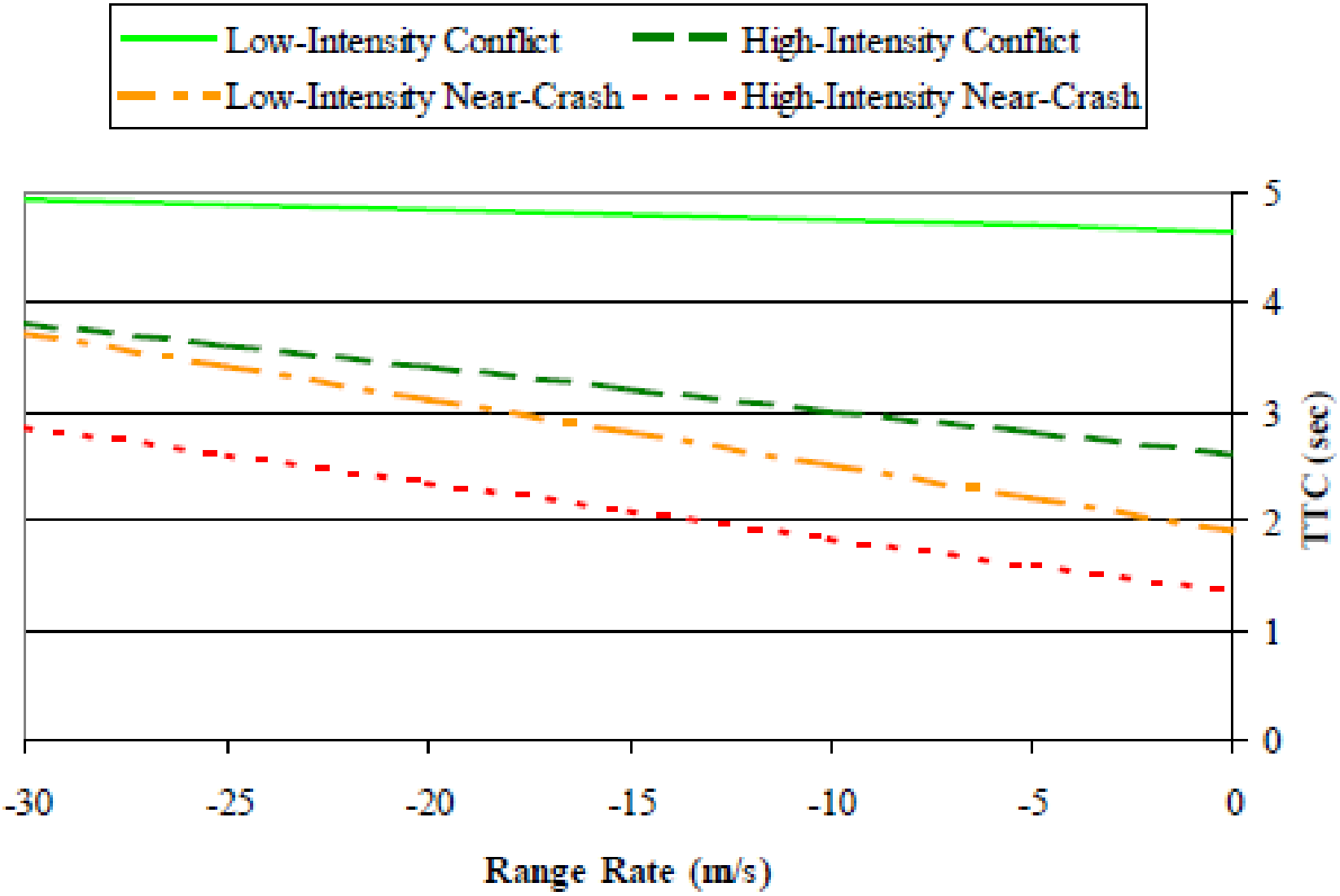


Figure 1 – Thresholds for lead-vehicle-stopped conflicts with brake response

DRIVING CONTEXT BASED IDENTIFICATION

- CREs are identified independently of driver response
- All drivers are thus equally covered, independently of their capacity or willingness to respond
- Drivers with a more kinematically aggressive driving style will therefore be overrepresented
- However, if you believe that small margins in and of themselves are predictive of crash involvement, then it does not matter that some drivers contribute with more CREs than others (by logical extension, these drivers do have a relatively higher crash risk)

DRIVING HISTORY BASED IDENTIFICATION

- Basic idea: unusual events in a person's or group's driving history are unusual precisely because drivers try to avoid them
- At least some of them should be safety critical situations

DRIVING HISTORY BASED IDENTIFICATION

- One can tailor the CRE selection to each participating individual
  - Drivers all respond to dangerous situations; but responses can be expected to vary even in complete surprise situations.
  - 0.7 G might be a normal deceleration level for one driver, another might never go above 0.6 regardless of situation criticality
  - If a 0.6 G deceleration occurs only once in a person's full driving history, one might draw the conclusion that it was a special event for that driver and that it warrants further examination

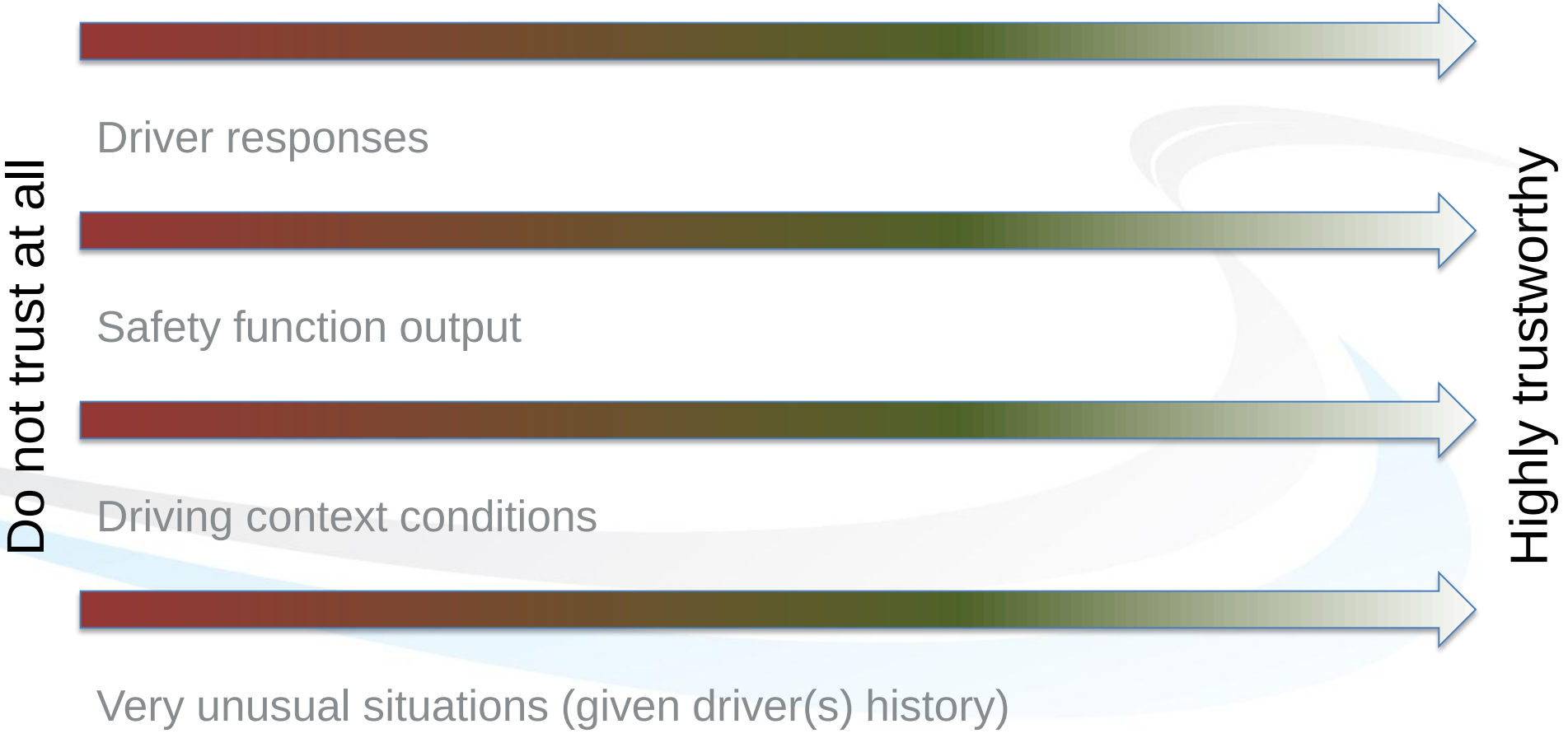
DRIVING HISTORY BASED IDENTIFICATION EXAMPLE

- EuroFOT - Gaussian Mixed Models example
  - Gaussian distributions fitted to seven longitudinal response variables (brake pressure, brake position, etc)
- Worked much better for truck drivers than car drivers
  - Truck drivers drive more consistently
  - Truck drivers have much smaller kinematic space to drift around in
  - End points in their distributions are therefore more likely to represent truly unwanted values rather than random occurances due to normal variability.
- GMM seems more applicable to professional drivers of large vehicles than to lay people driving regular cars

DEFINING CRASH RELEVANT EVENTS

- It is not obvious which approaches is best
- What is clear is that they may lead to different results
- Fitch et al (2008) selected CREs from the same data set as Honowski et al (2008)
- Both projects found hundreds of what they judged to be relevant CREs
- Only 7 of the 596 CREs found by Hanowski et al overlapped with those found by Fitch et al.

IN THE END, IT ALL COMES DOWN TO WHICH ONE(S) YOU TRUST



AIMS OF THE FESTA HANDBOOK

- To help new projects avoiding reinventing the wheel
- Question for this group: what can we put in the handbook that provide this help?
  - The lastest version of CRE definitions from the four approaches above?
  - The theoretical analysis in the report?
  - Any combination?

INPUT FROM PREVIOUS WORKSHOPS AND MEETINGS

- Crash Relevant Event definitions are moving targets
  - Project goal completion should beat desire for general event definitions
- Event definitions based on single measure unlikely to succeed
- Baseline selection is just as important as event detection

CRASH RELEVANT EVENT DETECTION

- For a CRE definition to survive over time, the thing measured needs to stay invariant
  - 2000 there were no cellphones in cars
  - 2013 every driver has a cellphone
  - 2026 there will be no cellphones in cars
- User centric definitions (e.g. Oops-reactions) might be preferred

CRASH RELEVANT EVENT DETECTION

- Recruitment bias → the ones who volunteer may be those least interesting to study
  - How do we make sure we get our demographics right?
- Broadening the scope:
  - Vehicle-To-Infrastructure CREs?
  - Vehicle-To-VRU CREs?
  - Vehicle-To-PTW CREs?

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