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Ben-Gurion University of the Negev

Crash Causation, Countermeasures, and Policy Implications

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Presentation to the Ontario Road Safety Forum

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What I plan to talk about

- Crash causes and the evolvement of the driver's responsibility for 90 percent of crashes
- Assumptions and thresholds: biases in causal assessment
- Defining the size of the problem: prevalence vs. risk in crash causation
- The link between crash causes and countermeasures: is it a natural one? Does the medical model apply?
- How to move from countermeasures to safety policy. Spoiler: it is not a scientific issue
- Emerging common approach - Safe System

What is a crash cause?

- An event/behavior/situation that immediately preceded the crash and made it inevitable
- Had all else been the same except for that event/behavior/situation the crash would not have occurred
- Are these necessary and/or sufficient conditions?

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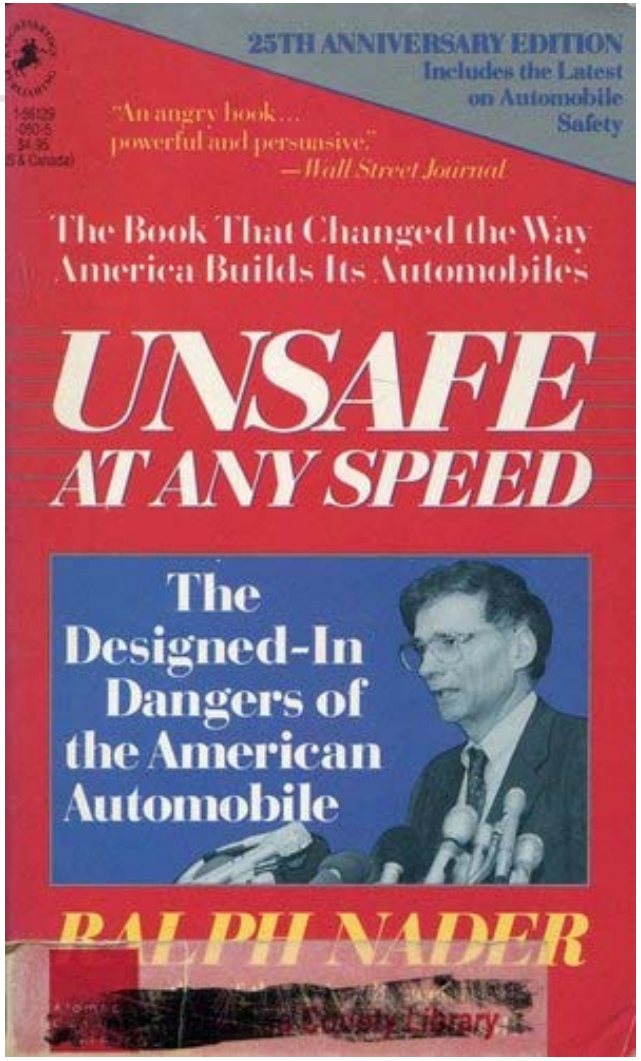
Assessment of Crash Cause Depends on:

- Who you ask
- What is 'normal'? What is a deviation? Need for Norms
- The data source: police accident reports (PARs), hospital records, self- reports
- The tools you have for gathering data: objective case details vs. interviews vs. statistical data
- Study orientation: causality versus prevention

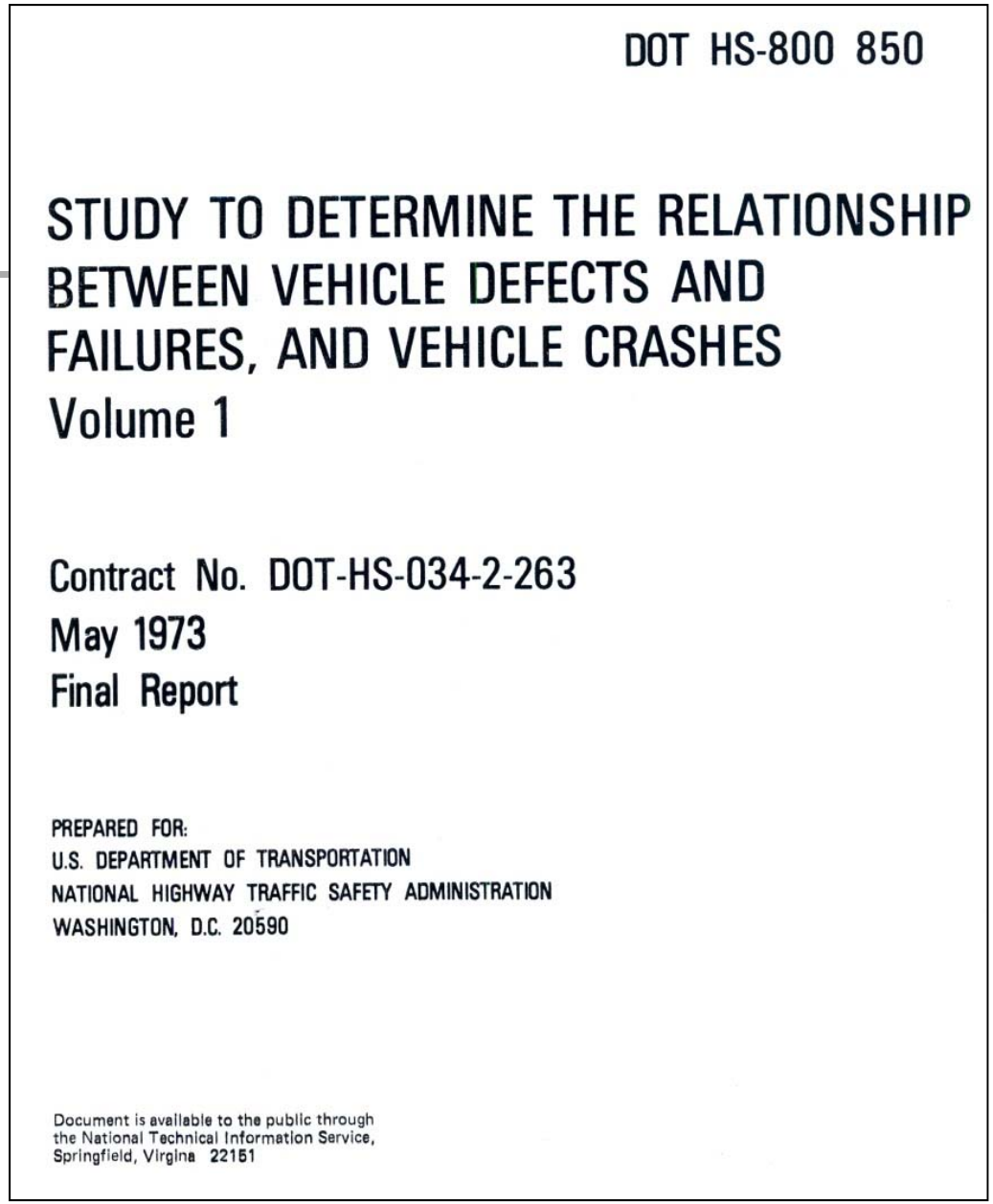
Some Background on Crash Causation Research

- Ralph Nader. Unsafe at Any Speed (1965)
- Highway Safety Act - 1966: Creation of NHTSA 1970
- So, the first large-scale study on causes of traffic accidents focused on the safety defects of the American automobile



Seminal study: Indiana University "Tri-Level Study of the Causes of Traffic Accidents"

PIs: John R. Treat and Kent B. Joscelyn



DOT HS-800 850

STUDY TO DETERMINE THE RELATIONSHIP BETWEEN VEHICLE DEFECTS AND FAILURES, AND VEHICLE CRASHES
Volume 1

Contract No. DOT-HS-034-2-263
May 1973
Final Report

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

Document is available to the public through the National Technical Information Service, Springfield, Virgina 22151

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THE IU study: Tri-Level Study of the Causes of Traffic Accidents

TRI-LEVEL STUDY OF THE CAUSES
OF TRAFFIC ACCIDENTS: FINAL REPORT

VOLUME I: Causal Factor Tabulations and Assessments

Institute for Research in Public Safety
School of Public and Environmental Affairs
Indiana University
Poplars Research and Conference Center
400 East Seventh Street
Bloomington, Indiana 47401

March 31, 1977

Prepared for:
United States Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20591

Final Report
Report No. DOT-HS-034-3-535-77-TAC

Availability is unlimited. Documents may be released to the public through the National Technical Information Service, Springfield, Virginia 22151.

DOT HS-805 085

TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS:
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J.R. Treat, N.S. Tumbas, S.T. McDonald, D. Shinar,
R.D. Hume, R.E. Mayer, R.L. Stansifer, N.J. Castellan

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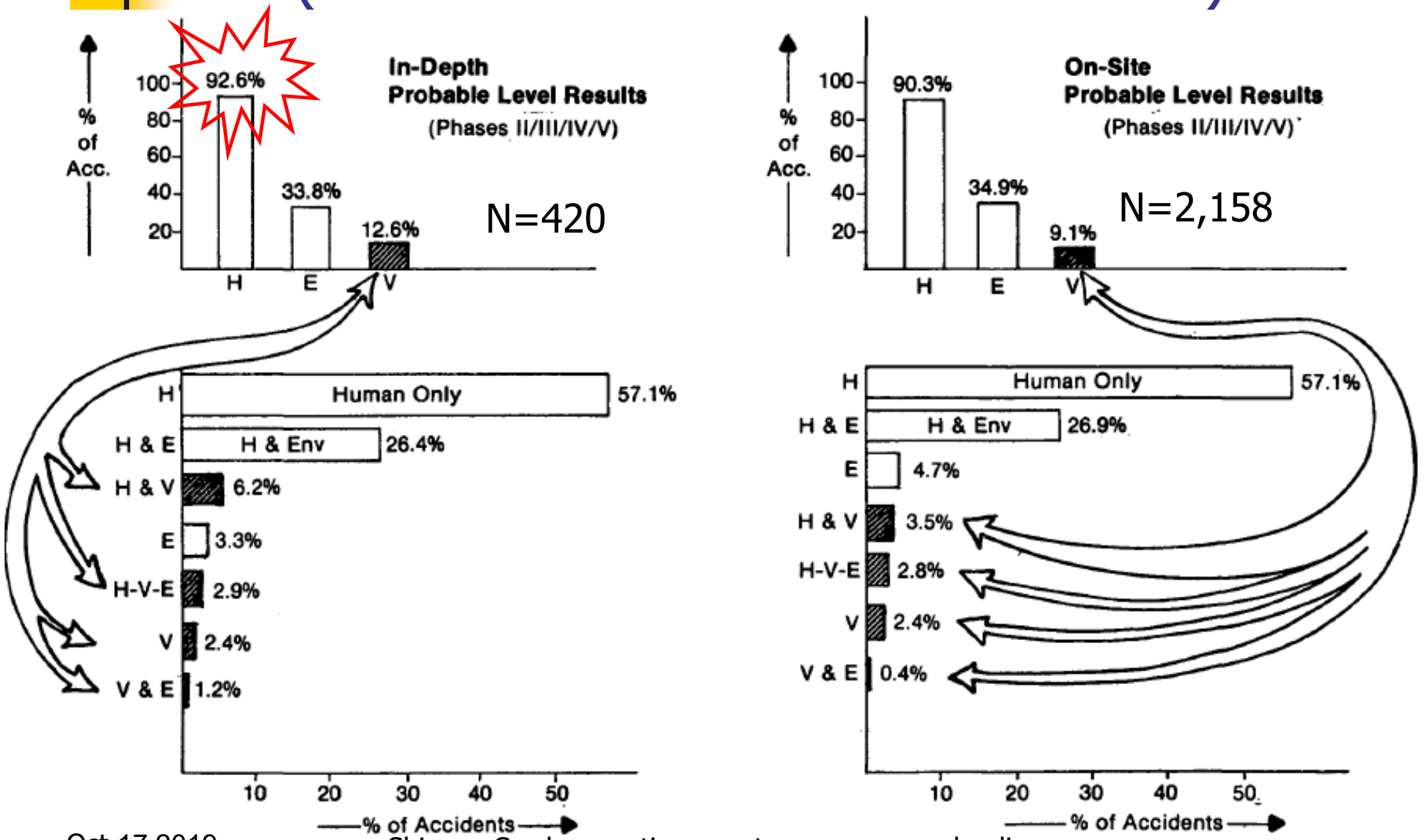
The Human causes 92% of crashes (but there are >100% of causes)



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Amazing consistency over Places and times in Percent H/E/V Crash Causes

% H/E/V Causes	UK 1975 (N=2,130)	IU 1977 (N=420*)	UDA 1999 (N=723)	NMVCCS 2008 (N=6,950)	GIDAS 2009 (N=248)	SHRP2 2016 (N=905)
Human	94	93	99	97	97	88
Environ-ment	28	34	5	33	6	12
Vehicle	8	13	1	12	2	0.1
Total %	130	140	105	132	105	100

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Is the Consistency in the Crash Causes or in Our Mindset?

- Hypothetical 2018 crash: a 50 years old driver, on old rural two-lane road, in 2002 Toyota Yaris, at 90 kph, goes off the road in a 30^{o} curve.
- What are possible causes?
  - Human
  - Environment
  - Vehicular

- The issues of ‘normal’ and ‘deviation’ are linked to ‘who decides’

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Question the Assumption of Norms – for all components

- The human – always alert and attentive?
- The roadway – what's the proper scope of Crash Modification Factors?
- The vehicle – beyond maintenance and meeting PMVI criteria, is the design state of the art?

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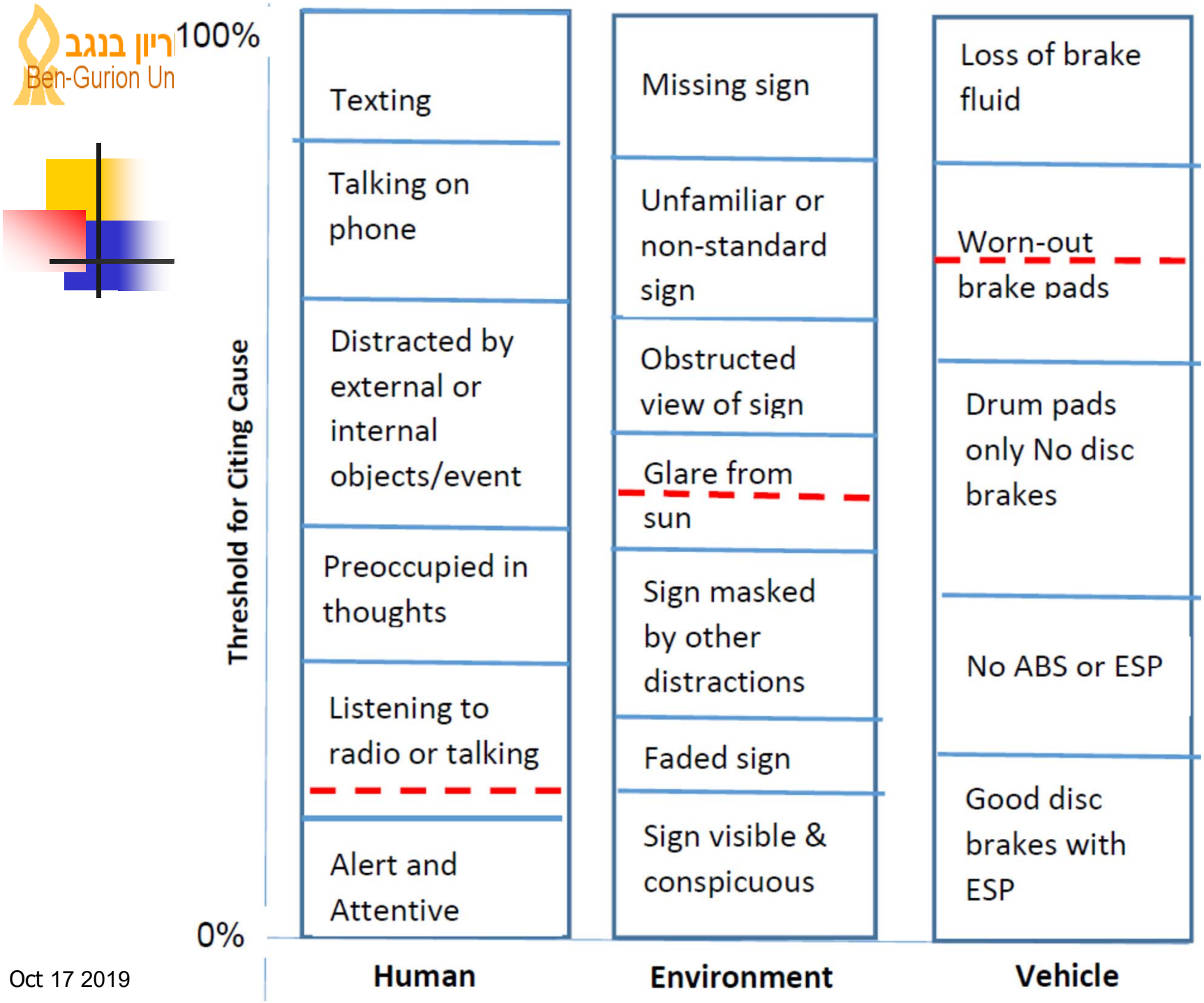
Who you ask and the Threshold Issue: what is 'normal', what is a 'deviation'

- "Who" is asked
  - Gilutz (1937) – 148 Oxfordshire crashes. Police: human 99%, CE 76% "major and ordinary" road defects
  - Hauer (2016) – Let's go back beyond "immediate"
- Thresholds for different 'causes' that may be associated with a crash vary widely.
- Consider an intersection collision with "failure to stop in time at a STOP sign".


100%
0%
Threshold for Citing Cause
Texting
Talking on phone
Distracted by external or internal objects/event
Preoccupied in thoughts
Listening to radio or talking
Alert and Attentive
Missing sign
Unfamiliar or non-standard sign
Obstructed view of sign
Glare from sun
Sign masked by other distractions
Faded sign
Sign visible & conspicuous
Loss of brake fluid
Worn-out brake pads
Drum pads only No disc brakes
No ABS or ESP
Good disc brakes with ESP
Human
Environment
Vehicle

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Scope of Problem: What We Measure - Prevalence versus Risk

Outcome Measures ↓			
Prevalence			
Risk/Over-involvement			

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Scope of Problem: What We Measure - Prevalence versus Risk

	Type of Study		
Outcome Measures ↓	In-depth Crash Studies	Naturalistic Driving Studies	Epidemio-logical Studies
Prevalence	✓	✓	
Risk/Over-involvement		✓	✓

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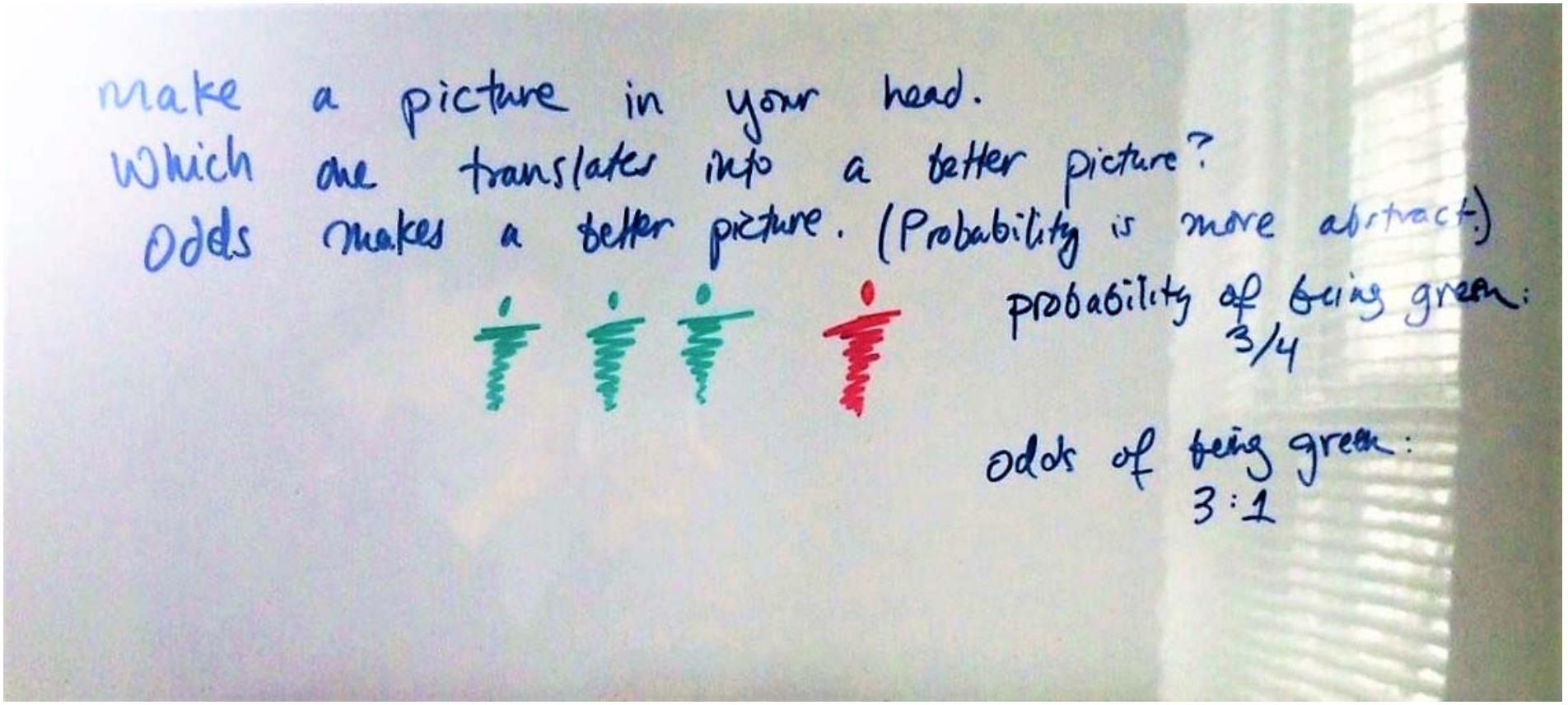
Odds Versus Probability/Risk



How can we show over-involvement? Odds Ratio and Relative Risk

Frequencies	Factor Present	Factor Absent	Total Counts
In crashes	a	b	a+b
In traffic	c	d	c+d
Total Counts	a+c	b+d	

Odds = a/b and c/d
Odds Ratio (OR) = [a/b]/[c/d]

Risk = a/(a+b) and c/(c+d)
Relative Risk (RR) = [a/(a+b)]/[c/(c+d)]

The Importance Issue: Is It Prevalence or Risk or Both?

- For countermeasure development we need to focus on:
  - Impact and cost-effectiveness (e.g., CHMSL)
  - Other issues (e.g., belts in bus, rear-facing camera)
- Impact wise, should we focus on high-risk events or prevalent events?
  - For individual road user: focus more on relative risk.
  - For public health: focus on prevalence and risk

The threshold effect: in summary

- The threshold we choose – for 'normal' and 'abnormal' - affects both the prevalence and the likelihood/risk we report
- The lower the threshold in each domain, the more causes can be listed for a crash.
- Shifting thresholds directly affects the relative role of the human, the environment, and the vehicle

Linking Causes and Countermeasures – It is Not Direct, Not Intuitive

- The ‘medical model’ assumes causal identification is necessary for cure.
- Crash causal assessment studies do not point at practical cures/countermeasures. E.g., ‘inattention’, ‘failure to stop at stop sign’
- Countermeasure-oriented studies attempt to identify “causes they might have prevented” e.g., grooving edge lines to counteract fatigue and distraction.

Selecting Countermeasures: the Policy Issue

- Consequently, a given crash can be described in terms of both multiple causes *and* multiple countermeasures
- Some causes can be linked to several countermeasures; some countermeasures can be linked to several causes.
- With so many options for defining a crash cause and its prevention, how do we choose?
- This is where *external factors* enter to yield policy implications.

External Relevant Factors

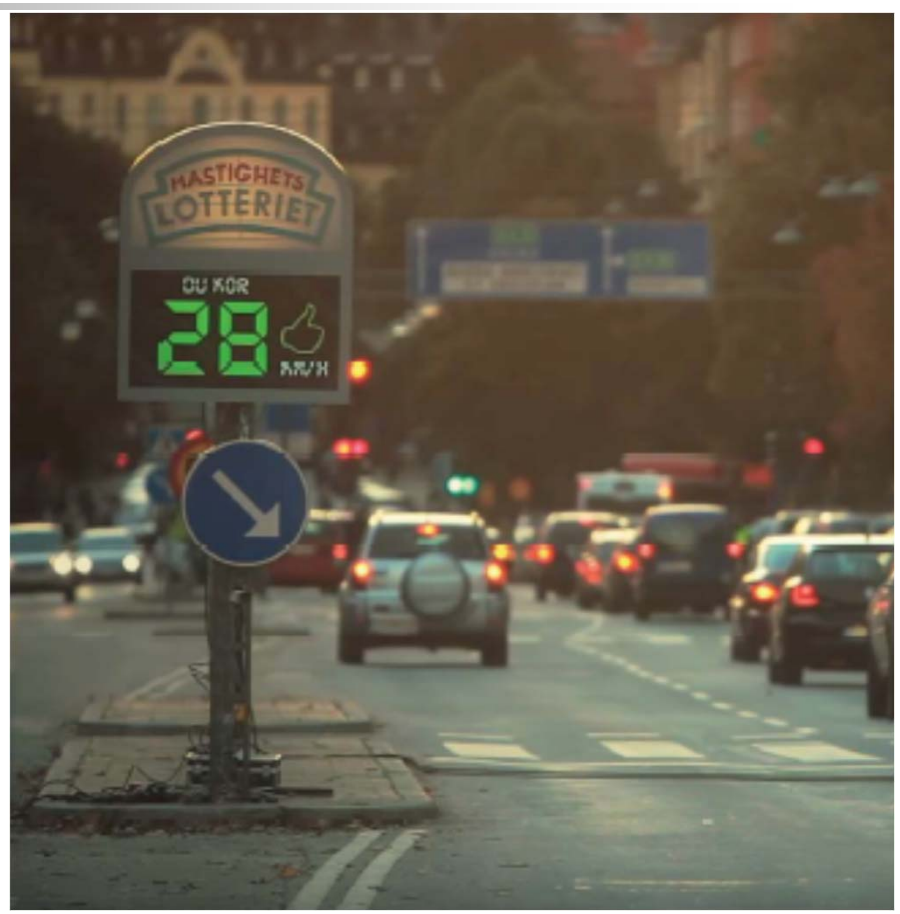
- Political will (including cost) – Vision Zero
- Ambient culture and expectation from government/regulator – e.g., causal assessment by Arabs vs. Jews in Israel
- Stake holders' biases; e.g., gun control, mc helmets
- Public acceptance of laws and morays; e.g., 'reasonable laws' (bicycle helmets in NL)
- Availability of solutions; e.g. functional road pavements for all users in NL, bike lanes

The Safe System Approach

- Safe System is a common name for programs adhering to similar principles
- It is NOT A SPECIFIC SOLUTION to safety problems in different contexts (SUNflower, 2002)
- Refrain from blaming the road user
- Government should assume prime responsibility for safety – as for security, health, and education
- Reconsider the context, eliminate the breeding ground for the 'human cause' (e.g., 'woonerf', 'shared space' rather than enforcement)

Context: Thinking out of the box, e.g., Behavioral Economy and Gamification

- Public health: reducing obesity by sugar availability and by exercise ('fun theory' in stairs) https://www.youtube.com/watch?v=2IXh2n0aPyw
- Traffic Safety: Speeding by Stockholm drivers* (vs. Intel. Speed Adapt.)



In Summary: Improving Road Safety over the past Half Century

- We started with blaming the vehicle and the automotive industry (1966)
- We then blamed the road user (1977~ Present)
- Next we thought to reassess the link between causes and countermeasures ('Sustainable Safety' 2005-Present)
- We now place prime responsibility for countermeasures with the regulator ('Vision Zero' 2000~Present)
- Recommend the 'Safe System' approach (2004~Present)

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THANK YOU

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Policy for countermeasures: safe system approach

- Centered on forgiving errors and containing crash energy levels below the limits that cause catastrophic harm (ITF, 2018)
- There is no single way for the adoption, and implementation of a Safe System …
- The SUNflower experiences of the pioneering countries show that each follows its own journey, shaped by cultural, temporal and local context, but guided by the four underlying principles”

Safe System: Central Tenets (ITF, 2018)

I. People make mistakes that can lead to crashes
II. The human body has a known, limited physical ability to tolerate crash forces before it is harmed.
III. Individuals have a responsibility to act with care and within traffic laws, BUT the regulator - who designs, builds, and manages and us roads and vehicles - shares responsibility to prevent injury crashes and to provide post-crash care; i.e., *forgiving roads and vehicles*.
IV. All parts of the system must be strengthened to multiply their effects; users are still protected if one part fails

Sustainable Safety – the Dutch Safe System Approach

- Road functionality – Hierarchy of through, distributor, access roads
- Homogeneity of vehicle mass/speed/direction -
- Forgiveness towards the road users and environment – anticipation of road users errors' and providing forgiving environments
- Predictability of road course and road users' behavior through self-organizing roads – consistency in design compatible with users' expectations
- Awareness of the road users' state – comply with users' ability to handle task

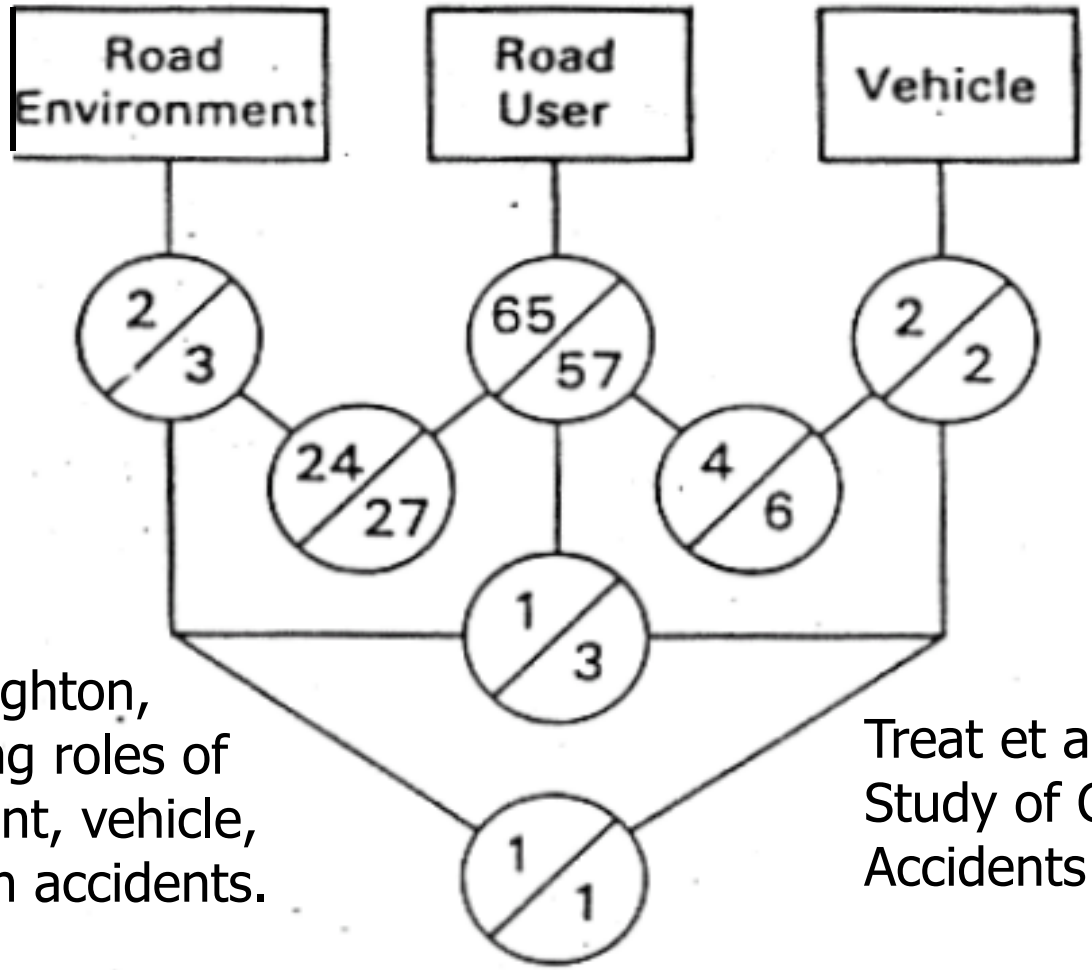
Indicators in the SUNflower pyramid

1. Road safety performance indicators. Outcome measures based on the number of killed and injured road users.
2. Implementation performance indicators. Quality of the implementation of road safety policies
3. Policy performance indicators. Quality of response in policy documents to improve safety.

The three types of indicators are embedded in a policy context: the structure and culture of a country, considered as background variables.

In-Depth Analysis: UK vs. US

(Rumar, 1985)



Sabey and Staughton, 1975, Interacting roles of road environment, vehicle, and road user in accidents.

Treat et al., 1977, Tri-Level Study of Causes of Traffic Accidents