Human Factors Guideline for Safer Road Design

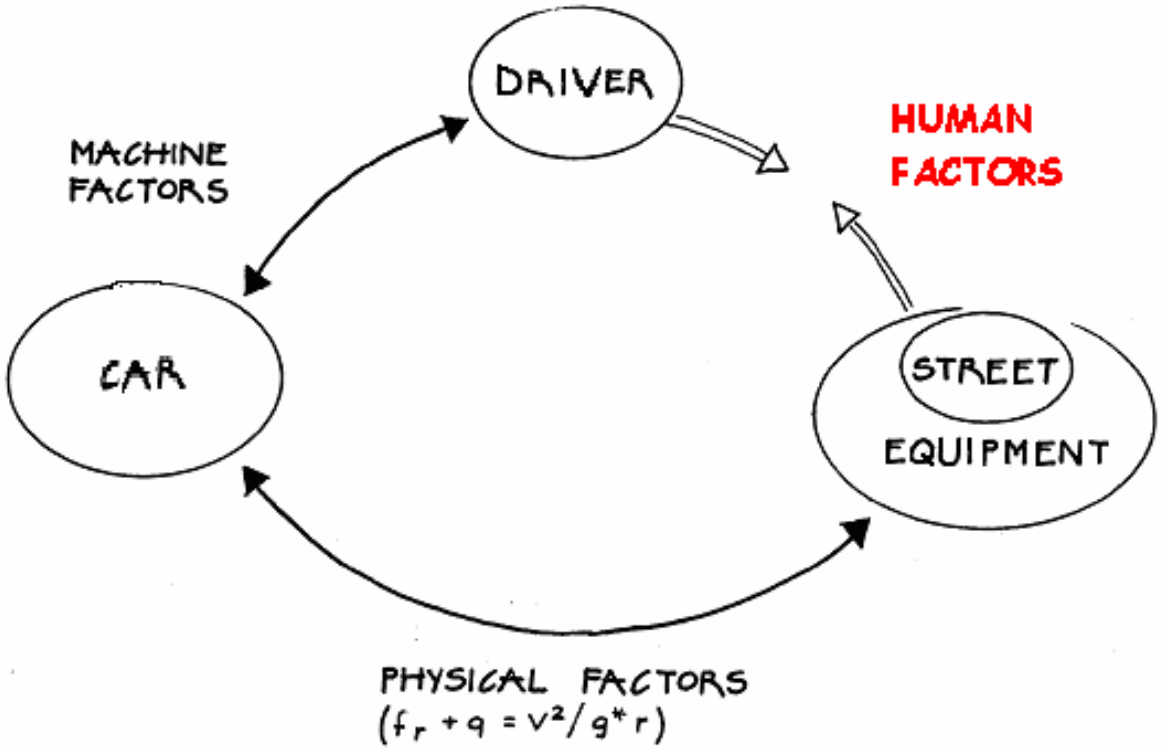
Dipl.-Psychologist Dr. Sibylle Birth

- Director Intelligenz System Transfer Potsdam GmbH, Institute for Applied Psychology
- Leader of the Human Factors Section
- Intelligenz-System-Potsdam@ t-online.de

Human Factors:
= human contributions to damaging events

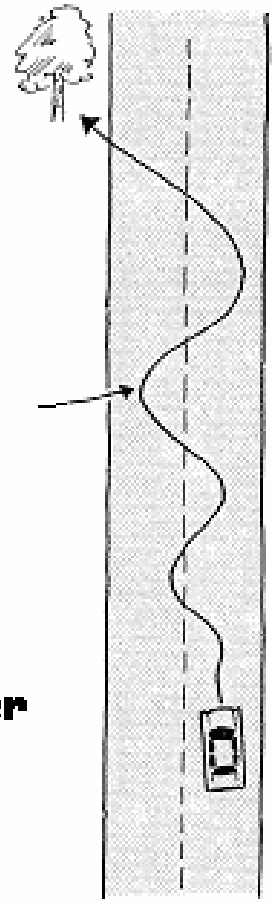
➔ Psychological / physiological limits of perception, information processing, decision making, act regulation

Aim = Identification of accident triggers by wrong road design



The two-world dilemma in “Accident Analysis”

➔ Consequent on-the-spot investigation of accident triggers before the crash point; based on of analysis of accident data!



Final point
e.g., damage/collision

Process
vehicle is swerving

Cause = trigger
e.g., optical illusion

INSURANCE: POST-ACCIDENT APPROACH

Place of accident = final point

Classification of conflict situation and damage consequences

→ Focussed on conflicts + consequences

Human Factors: pre-accident approach

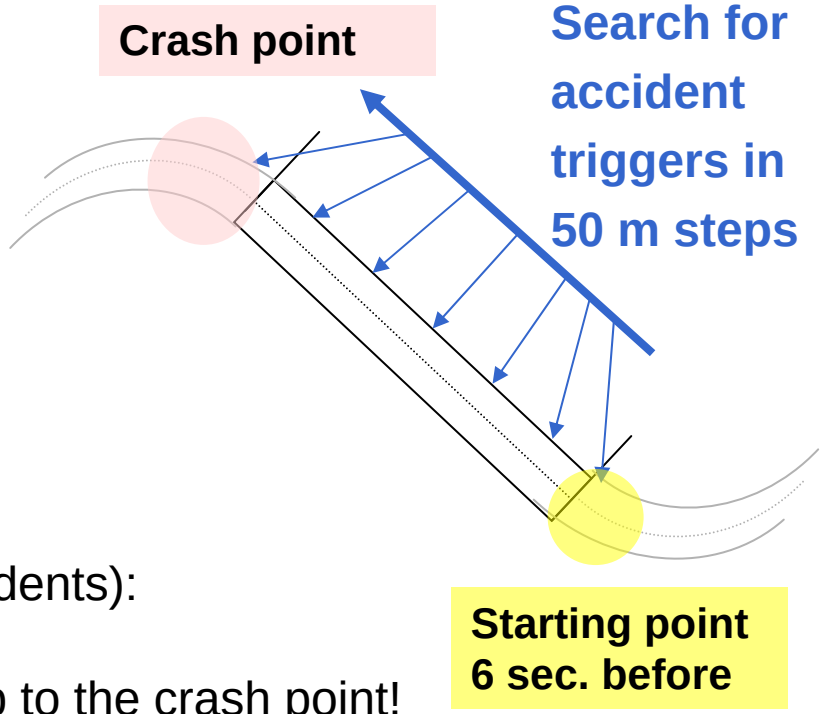
Place of accident = trigger point

Detection of causes of operational errors

→ Focussed on triggers + prevention

HF-Profiling in accident points:
Try to find an accident trigger = an incident!

- 1. Irregularities or changes in roads function or characteristic?
- 2. Critical points at minimum 6 sec. before clear and visible?
- 3. Evaluation of accident-triggering road features (incidents): beginning 6 sec. ahead going on in 50 m intervals up to the crash point!

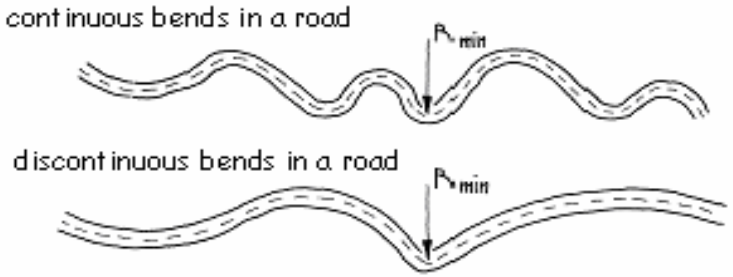


Three Classes of Human Factors Design Mistakes

I. 6-Second Axiom:
Road must give enough reaction time!
Shock reaction needs at minimum
4 - 6 sec --> 100 m - 300 m.

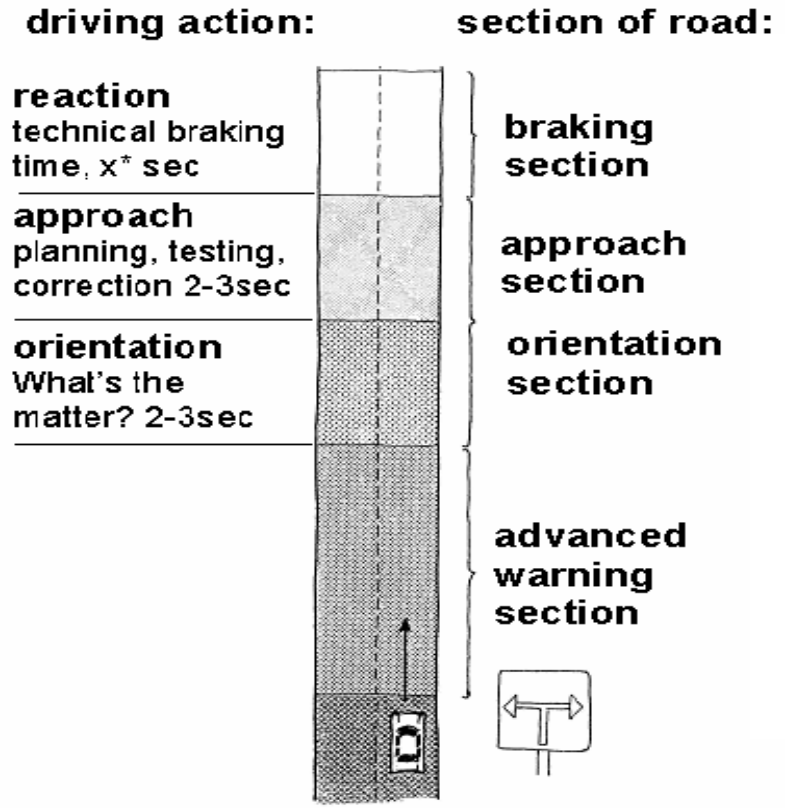
II. Field of view Axiom:
Road must offer a safe
field of vision!
Roads periphery sets behaviour.

III. Logic Axiom:
Road must follow driver's
perception logic!
The stair-stumbling-effect works.



6-Second Axiom: Never Surprise the Driver!

Minimal adaptation time = 4-6 sec. (100 m - 300 m)



6-Second Axiom: Never Surprise the Driver!

Invisible crossing, 150 m before	Invisible course, 50 m before
	

Field of View: Never Misguide the Driver!

➔ **Optical density influences speed**

high monotony -> high speed

high contrasts -> low speed

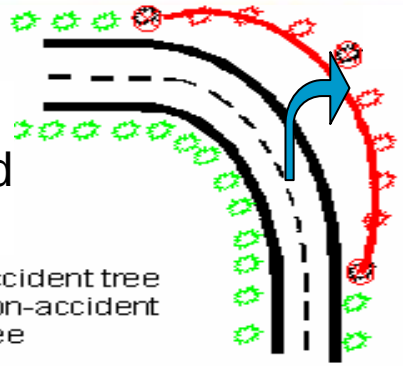
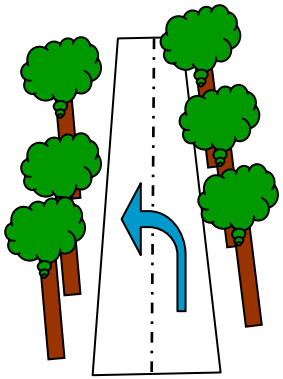
➔ **Lateral space structure influences track precision**

➔ **Depth of space structure influences speed + tracking precision**

fixation point = 600m --> v_{85} = 100km/h

fixation point = 350m --> v_{85} = 65 km/h

Field of View: Misguiding Orientation Lines

Bend illusion by non-parallel orientation line	Space illusion by non-orthogonal objects
	
tendency to run-off-road accidents 	 tendency to head-on collision with oncoming traffic

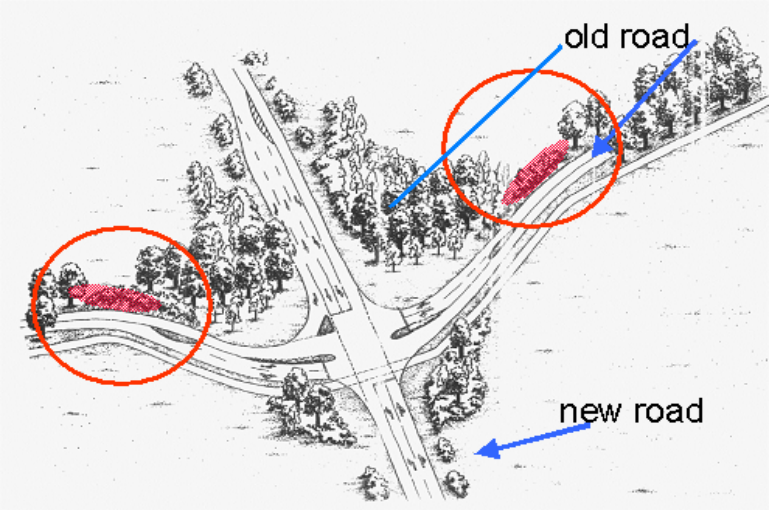
Logic Axiom: Never Disturb Driver's Expectation!

➔ **Town entrance effect**

Road characteristics signalise
a completely different function

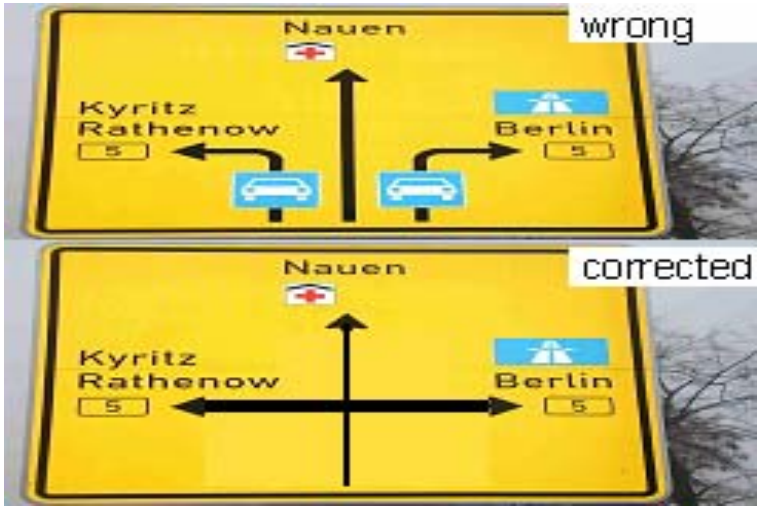
➔ **City by-pass dilemma**

Changed direction despite guidance



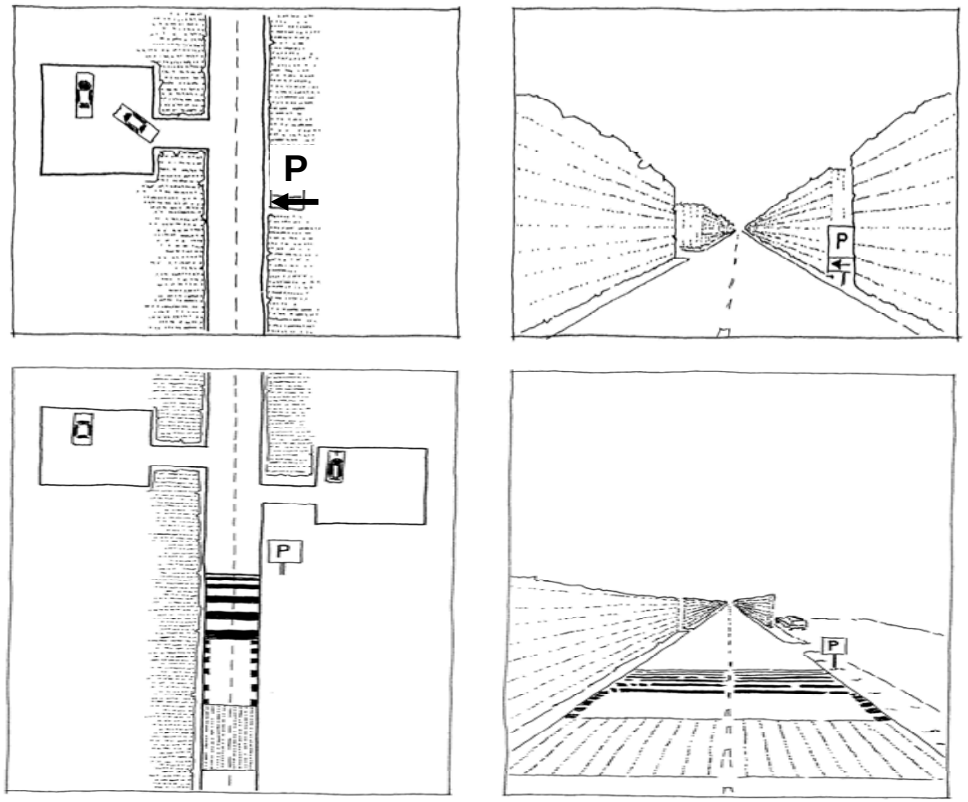
➔ **Deficits in signposting**

Wrong information about right of way



Logic Axiom: Never Disturb Driver's Expectation!

Driver expects parking site at the right.
Unusual arrangement leads to irritation and accidents.



Accident Situation:
Driver expects parking place at the right. The expectation dominates his perception.

Corrected Situation:
Parking place is according the expectation at the right.

Human Factors training: Which HF design mistakes do road engineers identify before/after a Human Factors training?

- Sample: 34 road engineers from Germany, Spain, Netherlands, Croatia, Finland, Sweden
- Contest between teams of road engineers during the on-the-spot investigation
- Result: greatest difficulties in identifying deficits in the field of view.

Rate of identified HF design mistakes

		Before	After
1.	Deficits 6-Second Axiom	35%	66%
2.	Deficits Field of View Axiom	13%	29%
3.	Deficits Logic Axiom	27%	48%

68% of accidents are caused by HF mistakes in road design!

Thus: Improve road design appropriate to human needs.
Go for a self-explanatory road design!

- ➔ Only 3% (!) are caused by driver's deficits (alcohol, aggression, medicine, ..)
- ➔ **68% (!)** of 1400 accidents are triggered by HF-mistakes in road design

Statistics of HF design mistakes 2001-2006			
I. Not Influencable by Road Design		**383**	**27%**
1.	Animals (crossing deer)	**219**	16%
2.	Weather, technology, road works	**117**	8%
3.	Driver's deficit (alcohol, aggression, ...)	**47**	3%
II. Influencable by Road Design		**953**	**68%**
1.	Deficits 6-Second Axiom	**451**	32%
2.	Deficits Field of View Axiom	**228**	16%
3.	Deficits Logic Axiom	**274**	20%
III.	**Unexplained**	**64**	**5%**
Sum of damaging events		**1400**	100%

Conclusions and Perspectives

- Working group “Human Factors” of PIARC technical committee 3.1 developed a Human Factors Guideline for a safer road design:
  - ✉ new state-of-the-art is achieved
- Accident commissions can use it for a new approach in judgement of accident causes:
  - ✉ additional module for Road Safety Inspections
- Road constructors can use it to qualify their planning process:
  - ✉ additional module for Road Safety Audits
- Pre-Condition:
  Instruction for road engineers in Human Factor demands
- **During the next working period it should be the goal to transfer the knowledge into design recommendations.**