Variables influencing driver speed
Safety on inter-city roads

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Main design issues

• “The documents that guide highway and traffic engineering practice suggest that many of these decisions be made by ‘engineering judgment’. One would like this judgment to be informed by

  – Evidence-based anticipation of their likely safety consequences plus a professional ability to balance safety against mobility and other dimensions of ‘utility’. » (Hauer, 2019)

  – Compatibility between the decisions made by designers and the drivers needs to perform their driving task efficiently and safely and to achieve the goal related to the task (Saad, 2004)

Ezra Hauer (2019) Engineering judgment and road safety, Accident Analysis & Prevention, Volume 129, Pages 180-189
On the engineering’s perspective

- Safety by norms and standards rather than Safety by risk objective

“Roads designed to standards are neither safe nor unsafe, their safety is largely unpremeditated.” (Hauer, 2000, 2019)


On the Ergonomics’ perspective

The design of the infrastructure and the formulation of the traffic rules determine its use and affect the safety of road users:

Decisions made by the designers of the road system including road and traffic engineers and the legislators of the highway code

Two faces: physical/organisational, things/words, visible/enunciable

The road infrastructure conveys a wealth of information that guides drivers’ activity and their interactions with others in situ

- explicitly through devices such as road signs and road markings,
- implicitly by means of the environmental context and road layout, for example.

A system image: the information conveyed by the physical product itself, the interface image resulting from the physical structure that has been built (including documentation and instructions).

Road infrastructure as an interface between Designers and Road Users

1.10 Conceptual Models. The design model is the designer’s conceptual model. The user’s model is the mental model developed through interaction with the system. The system image results from the physical structure that has been built (including documentation, instructions, and labels). The designer expects the user’s model to be identical to the design model. But the designer doesn’t talk directly with the user—all communication takes place through the system image. If the system image does not make the design model clear and consistent, then the user will end up with the wrong mental model. (From Norman, 1986.)

A mental model is a kind of internal symbol or representation of external reality. It is an explanation of someone’s thought process about how something works in the real world.
• We define a driver **task** as “a goal to be attained under given conditions” related to the driving situation (what we have to do)
  – A goal is a specified state of the system driver–vehicle-infrastructure which the driver wishes to achieve,
  – The **conditions** are relative to the states of the system driver–vehicle-infrastructure (prescriptions about admissible states), to the operations by means of elementary rules, to the procedure to implement them.
• An intention is the decision to act so as to achieve the goal.
• A task is an organised collection of actions carried out by an agent in order to achieve a goal or an objective.
• It is an objective (externalized) and subjective (internalized) model of the **activity** (what we do)
The prescribed (or formal) task  
“Work as imagined”

- The task to be carried out as conceived by the designer of the system and/or the safety manager.

- It sets out (more or less explicitly) a number of prescriptions, which are supposed to influence and to some extent guide driver activity (formal rules).

- In other words, the prescribed task defines the model of the expected driving behaviour, what the driver should do (externalized and normative in terms of performance and/or procedures to follow).

The effective task  
“Work as done”

- The task carried out by the driver with the goals and conditions effectively taken into account

- The redefined/effective task operationalizes the prescribed task according to the demands and constraints. It is the result of a trade-off between two rationalities: objective/subjective (plus “others”).

- Identifying the actual task calls for a detailed analysis of driver behaviour (do/say) with the aim of determining exactly how drivers organise and perform the driving task (informal rules).

Prescribed          Represented          Redefined          Effective
Performance levels model (Rasmussen)
Regulation of activity

Performance levels

Modes of regulation

Process

Knowledge-based

Goal-Controlled
Mental model feedback

Conscious

Rule-based

Goal-oriented
Feedforward

Automatic

Subconscious

Skill-based behavior
Main source of problem in road safety

Managing non controlled changes/variations in road situations or in other drivers’ behaviors pose serious problems that are known to have a significant impact on the reliability and safety of man-machine systems (Hale and Glendon; Leplat).

For the driver, these changes may be more or less predictable and more or less expected, depending on whether or not s/he has the knowledge and the information needed to detect and identify them as s/he drives along.

The disparities between drivers' expectations and anticipations, specially of

- functional constraints
- future driving situations

and the unintended events that actually modify the driver’s spatio-temporal field, could be seen as the origin of processing errors and a belated detection of critical situations, reducing the safety margin for resolving them.
Drivers’ speeds in traffic

Monitoring and control of driving speed = crucial subtask in driving

Speeding, which covers excessive speed (i.e. driving above the speed limits) as well as inappropriate speed (driving too fast for the prevailing conditions), is often a leading cause for many the road accidents

Speeding can be seen as a multidimensional issue,

- Sometimes unintentional (associated with perceptual errors)
- Sometimes deliberate (lack of knowledge, negative attitudes towards speed regulation, under-estimation of the risk associated with speed, or suboptimal compromise between the various demands of the driving task, collective traffic pressure).
Many research devoted to analysing factors influencing speed behaviour

- perceptual aspects of speed control
- cognitive and motivational aspects of speed control
- drivers’ representations, attitudes beliefs and norms with regard to driving speeds and the regulation or enforcement of speed limits

with a view to identifying ways of influencing driving speeds through various countermeasures such as:

- Design of road infrastructure
- Design of new driver support system
- Drivers’ training
- Design of safety campaigns
Cognitive and motivational aspects of speed control

The cognitive and motivational aspects of speed choice include:

- The knowledge,
- The mental representations
- And the strategies

that drivers use to remain in control of a given driving situation and to adjust their speed to comply with

- “regulatory” requirements relating to speed limits
  - Acceptance of speed limitation
  - Margins of tolerance: magnitude and duration
  - Perceptual level of enforcement
- and/or “functional” requirements relating to road infrastructure characteristics and traffic conditions (Saad, 1983)
  - Perception and identification of functional constraints
  - Prediction of changes in situations

Double regulation
Drivers’ attitudes and representations of the speed

Aberg et al. (1997) studied the same phenomenon in Sweden and in Denmark on eleven main roads traversing built-up areas with a speed limit of 50 Km/h, and then questioning drivers (both on the spot and by questionnaire).

In both countries, over 50% of drivers failed to respect speed limits despite most claiming to be in favour of compliance.

It was concluded that variables other than willingness to obey the law must influence observed speeds.

– Most drivers overestimate the speeds of other drivers
– As many drivers also state that they want to travel at the same speed as other road users, overestimation of the speed of other road users is probably one of the factors that accounts for speeding.
– The results also showed that drivers who were least negative towards speeding drove faster than other drivers.
– The drivers who thought that other road users were driving fast, or who wanted to drive like other road users, maintained a higher speed than other drivers.
Synthesis

• Incompleteness of formal rules (prescribed driving task) and necessity to study informal rules (effective driving task) with a pluridisciplinar approach of the driver’s activity through its exteriorized behavior and perceptual/cognitive/motivational models.

• The existence of two formal and informal rule systems in road driving must be recognized and taken advantage of in order to reconcile two modes of safety: regulated and managed.
Synthesis

Studies examining the contribution of legal speed limits to speed behaviour show that drivers do not usually comply strictly with speed limits.

Drivers exceed speed limits to varying extents, depending on the driving context and their own characteristics.

Drivers’ attitudes to speed limits, the importance they attach to compliance with local traffic conditions, as well as their representations of the speeds of other road users, also account for the diversity of speed adjustments made by drivers.