Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

Managing European Traffic using Human-Oriented Designs

Human Factors in Traffic Management

Information and advice for European traffic management practitioners

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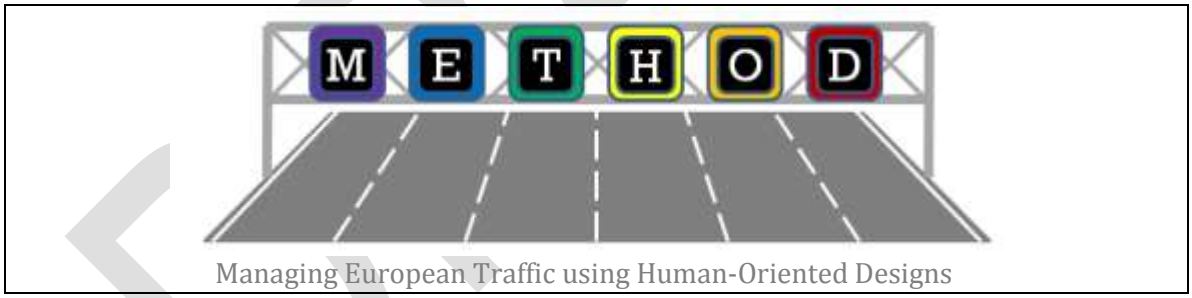

Colophon

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Preface

This booklet was compiled as part of the Managing European Traffic using Human-Orientated Designs (METHOD) framework, a research project in the Conference of European Directors of Roads (CEDR) Transnational Road Research Programme, funded by Belgium-Flanders, Denmark, Finland, Netherlands, Norway and United Kingdom.

The booklet is aimed at national traffic management professionals in Europe, providing concise and succinct information about human factors and their particular role in traffic management. Human factors refer to individual human characteristics that influence traffic behaviour and related choices. Whereas, the majority of the traffic management measures relate to motorised traffic, it also relates to bicycle and pedestrian travel.

The information presented in this booklet is based on scientific literature, information from road safety experts and traffic management operators in several European countries, as well as the results of targeted research in driving simulators. Details about these sources of information are available in several technical reports, produced in the METHOD project, notably:

- Vissers, L., Stelling, A., Hagenzieker, M.P., Van Schagen, I.N.L.G. & Maerivoet, S. (2015) *Human factors reflection on existing traffic management measures*. SWOV Institute for Road Safety Research, The Hague (NL) and Transport and Mobility, Leuven (B).
- Aittoniemi, E. (2016) *Human factors in traffic management operations – Best practices and recommendations*. VTT Technical Research Centre, Espoo (FI)
- Weare, A., Hof, T., & Moning, I. (2016) *Driving simulator studies evaluating in-vehicle information for traffic management using head-up displays and gamification techniques.* TRL, Crowthorne (UK) & TNO, Soesterberg (NL).

For more information, please contact the CEDR offices: http://www.cedr.fr/home/

The project team wants to thank the CEDR Programme Executive Board for their guidance and input during the course of the project. More specifically we would like to thank Chantal Merkx and Henk Schuurman of the Dutch National Road Authority for their constructive feedback on previous drafts of this booklet.

CEDR profile

The Conférence Européenne des Directeurs des Routes / Conference of European Directors of Roads (CEDR) transnational road research programme promotes co-operation between European national road administrations, contributing to the development of safe, effective, sustainable and efficient practices in road engineering.

Contents

Introduction

Why manage road traffic?

Road traffic management is an umbrella term. It encompasses all measures that (re)direct traffic flows over the road network, so that the movements of people and goods are optimised for reliability, safety and environmental sustainability. The levels of road mobility continues to increase year on year. In fact, the mobility demand is increasing faster than any increases in the overall road capacity. As a result, developments in traffic management become increasingly important. Traffic management is generally seen as linked to main arterial roads and involves motorised traffic, but it also relates to minor roads and non-motorised traffic.

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Examples of traffic management measures

Traffic management consists of a variety of measures that are applied for multiple purposes. Modern technologies make current traffic management more dynamic and flexible and hence, in theory, more effective.

Four clusters of traffic management measures can be distinguished:

- Dynamic speed management: e.g., dynamic speed limits, variable message signs.
- Local dynamic warning or informative systems: e.g., incident warning, local queue warning, weather warnings.
- Local traffic flow management: e.g., lane closures, peak hour lanes, overtaking prohibition for trucks, merging measures, ramp metering.
- Network-wide traffic flow management: e.g., dynamic route information, multi-modal information.

Why consider human factors?

Traffic management measures aim to influence traffic flows over the road network. However, traffic flow consists of numerous individual road users travelling from A to B, so traffic management aims to influence human behaviour. Consequently, the effect of a traffic management measure largely depends on the capabilities or motivations of these road users to comply with the measures. If designed and applied without accounting for human factors, effective traffic management measures may not have the intended effect.

Human factors in national or international legislation

Some human factor aspects are explicitly taken into account and integrated into (inter)national legislation. For example, human limitations in vision and information processing are accounted for in the United Nations Economic Commission for Europe (UNECE) Convention on Road Signs and Signals and the European Agreement on Road Markings[1]. These acts of legislation clearly prescribe the locations, size and material of signs and markings. However, the majority of human factors are not or hardly integrated into road traffic legislation. As a consequence, road traffic practitioners, including traffic managers, are not always fully aware of the important role played by human factors.

The booklet

This booklet targets national road administrations and their traffic managers. It provides concise information about the human factors in general and the crusial role they play in traffic management. This information gives a level of insight into how human factors influence the effectiveness of traffic management measures. The booklet presents:

- A human perspective on road traffic management
- An introduction to the four key human factors
- A view on individual differences and unintended side-effects of these factors
- Consideration of these factors in-vehicle traffic management information

Background and sources

The booklet is based on research performed in the CEDR project METHOD. The three resulting technical reports provide the scientific background as well as references to relevant documentation and research papers. Readers who are interested in the scientific background to this work are referred to these research reports[2]:

- Vissers, L., Stelling, A., Hagenzieker, M.P., Van Schagen, I.N.L.G. & Maerivoet, S. (2015) *Human factors reflection on existing traffic management measures*. SWOV Institute for Road Safety Research, The Hague (NL) and Transport and Mobility, Leuven (B).
- Aittoniemi, E. (2016) *Human factors in traffic management operations – Best practices and recommendations.* VTT Technical Research Centre, Espoo (FI)
- Weare, A., Hof, T., & Moning, I. (2016) *Driving simulator studies evaluating in-vehicle information for traffic management using head-up displays and gamification techniques.* TRL, Crowthorne (UK) & TNO, Soesterberg (NL).

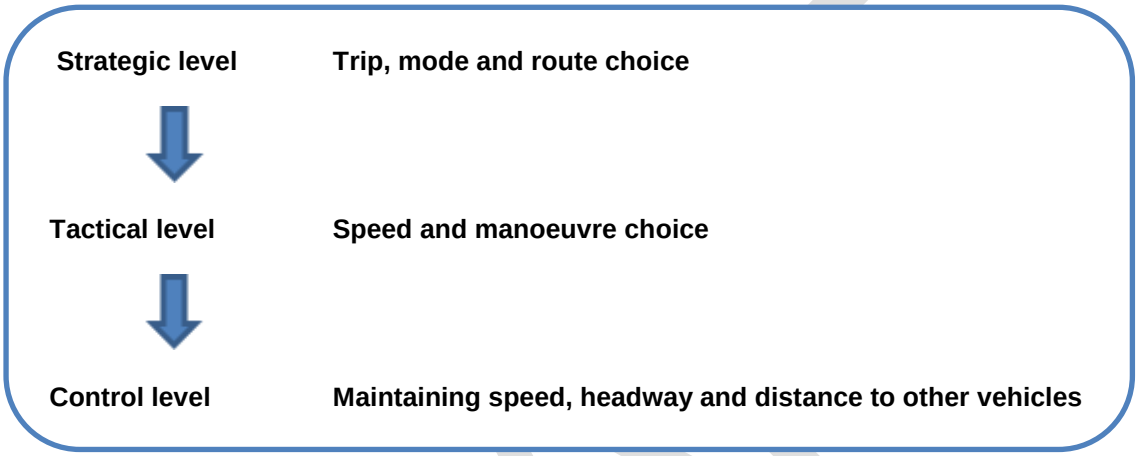
Further reading suggestions are listed at the end of this booklet.

[1] See the publications of the United Nations Economic Commission for Europe at http://www.unece.org/trans/conventn/legalinst.html

[2] For more information, please contact CEDR: http://www.cedr.fr/home/

A human perspective on road traffic management

Road traffic is 'the accumulation of road users moving from an origin to a destination along a road network'. So, it is people who make up road traffic; not the vehicles they ride or drive in. Hence, the only way of understanding, predicting and affecting road traffic is by looking at the tasks that a road user undertakes. About thirty years ago, the Dutch professor John Michon developed a basic driving task model[3], which is still a good starting point today for getting a feel for road traffic from a human perspective. The model divides the driving task into three levels: the strategic level, the tactical level and the control level. Traffic management mainly affects the road users' tasks at the strategic and tactical level.



The strategic level

The strategic level is the highest level. At the strategic level road users make strategic decisions about their trip. Do they actually want or need to undertake the trip? If they do; at what time, what transport mode, and along which route, will they choose? In principle, these are all conscious decisions that are made for each trip. However, many, if not most trips and their decisions are based on personal habits. An example is the daily commute, to and from work. Habitual commuting behaviour may be altered because of, for example, weather forecasts, road works, congestion, or a closed exit lane. This requires reconsideration of decisions at the strategical level, either before or during the trip. Decisions at the strategic level determine the origin-destination matrix and volumes of different traffic modes, and consequently, throughput, exposure to risk and environmental consequences at a network level.

The tactical level

At the tactical level, road users make choices about how to behave when they are on the road. For example, about the driving speed, about overtaking or not, about crossing the street, about switching lanes, about decelerating or accelerating when the light turns amber, etc. This tactical level is, again, in principle open for conscious decisions. They are very sensitive for individual differences in personality and related driving style, with some road users being more prepared than others to take risky or incautious decisions. Tactical level decisions affect throughput, safety level and emissions at a local level.

[3] Michon, J.A. (1985). A critical view of driver behaviour models: What do we know, what should we do? In: L. Evans & R.C. Schwing (Eds.). Human behavior and traffic safety. New York: Plenum Press, p 485-520

The control level

The third and lowest level is the control level. The control level consists of tasks to control the vehicle. This includes operating the accelerator pedal, the gear, the steering wheel, etc. in order to maintain the desired speed, journey time, and correct course. Behaviour at this level, is largely automatic.

Traffic management

As indicated, traffic management mainly affects road users' behaviour at the strategic and the tactical level. Examples of traffic management measures that might affect road users' strategic pre-trip decisions are:

- Providing general traffic congestion information
- Warning for adverse weather conditions
- Providing multimodal travel information

Examples of traffic management measures that might influence road users' strategic on-trip decisions are:

- Providing roadside or in-vehicle information about travel times along different routes
- Providing roadside or in-vehicle information about travel times for alternative transport modes

Examples of traffic management at the strategic level (other 'free-to-use' pictures needed!!)

Examples of traffic management measures that might affect drivers' tactical on-trip decisions are:

- Setting local dynamic speed limit
- Implementing time-related truck overtaking prohibition
- Temporary lane closures or extra lanes

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Examples of traffic management at the tactical level

Most measures aimed at road users' strategic decisions are voluntary. For example, when planning a trip, it is up to the individual road user to decide whether or not to take account of a weather warning or traffic information. Most measures at the tactical level are mandatory, either physical (e.g., a blocked lane in a working zone) or legal (e.g., a temporary reduced speed limit or a lane closed sign). However, in the latter case, there is no guarantee that road users will comply. They may exceed the speed limit or drive in a closed lane. In order to optimise use of and compliance with traffic management measures, four key human factors have to be accounted for. These are presented in the next Chapter.

Four key human factors

In the context of traffic management, human factors refer to human and individual characteristics that influence traffic behaviour and related choices. The four key human factors are:

1.	**Perception**:	Can road users see and read (or hear) the signs, signals and information?
2.	**Comprehension**:	Do road users understand signs, signals and information and what needs to be done?
3.	**Capability**:	Are road users able to perform the desired behaviour?
4.	**Motivation**:	Are road users willing to perform the desired behaviour?

Perception: can road users see and read (or hear) the information?

A first prerequisite relates to the perception of traffic-related signs, signals and information, both at the roadside and in-vehicle. Two aspects are important here. First, road users must be able to see the information (visibility) or hear the information (audibility), and second, once they have identified the source of information, they must be able to read the text or decipher the symbols (legibility). In general, a balance must be found between attracting attention and avoiding distraction. Some of the important aspects to take into account are:

<u>Visibility of roadside information:</u>

- Location: Information should be located so that it is visible; not hidden behind other objects, e.g., trees. Moreover: trees grow and turn green in summer: maintenance is important.
- Positioning: Information should be positioned within the road scene such that it is clear for whom the information is intended. Users must know that the information is being presented to them in the first place in order to process it.
- Conspicuity: Information should be clearly discernible and not lost in its surroundings (for example, a green sign in front of bushes, a yellow sign in between other yellow signs).
- Visibility in darkness: Use (and maintenance) of lighting or reflective materials if relevant.

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Visibility (and audibility) of in-vehicle information:

- Location: Information should be provided close to the field of vision of the driver.
- Timing and prioritising: Information must be provided at the right moment (not too early/not too late; guidelines still missing) and prioritised based on relevance.
- Mode: Provide oral information instead of or in addition to visual information. Oral information must of course be audible.

Legibility of roadside and in-vehicle information:

- Size: letters, pictures, symbols should be sufficiently large; acceptable size depends on driving speed.
- Quantity: not too much information on a sign; the recommendable amount depends on driving speed.
- Presentation and special effects: avoid animations, moving images or alternating (text) messages; this takes too much time to see (and distracts road users from the traffic task).
- Contrast: letters and pictures should sufficiently contrast with background of the sign and the direct surroundings, contrast may deteriorate due to dirt and sunshine: maintenance is important.

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Many aspects related to the perception of roadside traffic signs and information is regulated by UNECE requirements[4,5]. Rules and guidelines for in-car information are still limited and require more targeted research.

[4] UNECE (1995) Convention on road signs and signals done at Vienna on 8 November 1968; Incorporating the amendments to the Convention which entered into force on 30 November 1995.

Comprehension: do road users understand the information?

Once road users have actually seen the information, the second prerequisite is that they understand the information. It should be immediately clear what they have to do. If they do not understand what they are supposed to do, they cannot follow-up the instructions. Some of the important factors related to comprehension are:

- Use of language: When using language to provide a roadside message, it is important to be aware of cross-border traffic and foreign road users who may not understand; for some messages bi- or three-lingual messages can be an option.
- Use of icons: In principle, icons overcome the language problem. The comprehensibility of icons (both by national and foreign drivers) is something that needs to be tested extensively.
- Expectations: Information should match with road users' expectations in contents, time, and location. Uniformity is an important aspect here. If not, the information may be misunderstood and lead to uncertainty and indecisive behaviour.

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Cross border traffic may require multi-lingual messages or a combination of text and icons

[5] UNECE (2010) Consolidated resolution on road signs and signals.

Capability: are road users able to comply with the instructions?

The third prerequisite: capability. Even if road users have seen the information and understood what they are supposed to do, they must be capable of complying with the instructions. This depends on:

- The complexity of the required actions.
- The local circumstances, e.g. traffic volume, traffic composition, weather and light characteristics.
- The physical motor skills and cognitive capabilities of road users.

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For example, an unannounced work zone requiring a cyclist to stop and get off his bike within a few meters may be challenging. It may be even more challenging when it is raining and the surface is muddy, and the cyclist is an older, less mobile rider. Another example: when driving on a motorway, it may be difficult to obey an arrow indicating that you have to change lane, if the next lane is heavily trafficked and the available time/distance is limited.

A special threat to capability is 'information overload'. People only have limited information processing capacity. If at a certain point of time the amount of information exceeds what people can deal with, they will simply not be able to process and use it. This can be the case with too many or too complex signs alongside the road. Similarly, and increasingly, this can be the case with in-vehicle information, when different (commercial) traffic information providers offer their services. In addition to information overload, excess information may lead to distraction from the immediate traffic task.

Motivation: are road users willing to comply with the instructions?

Finally, as the fourth prerequisite for effective traffic management, road users must be willing to comply and perform the required behaviour. Motivation or willingness is a complicated construct. Factors that are important include:

- The (perceived) advantages and disadvantages for their own goals and the importance of these goals.
- The (perceived) advantages and disadvantages for societal goals and the importance of these goals.

- The (perceived) behaviour of other road users related to the human inclination to imitate and conform to the majority.
- Attitudes and personal preferences and style, for example level of law-abidingness and risk-mindedness.
- The (perceived) fairness of the required behaviour and the credibility of a measure.

Explaining the reason for a locally reduced speed limit can help to increase credibility

Individual differences: not all people are the same

The four key human factors in traffic management, as listed, are universal and apply to all road users. However, the exact values and minimum requirements largely differ between road users, for example:

- How well does an individual road user see and understand the information?
- How capable and willing is (s)he to actually behave as prescribed?

In most countries, guidelines seem to be largely based on the characteristics of the 'average road user', i.e. a middle aged male car driver. Although it is impossible to account for each individual road user and his/her idiosyncrasies, it is important to be aware of existing differences between people and choose the correct solutions that fit 'more' rather than 'fewer' people. Individual differences relevant for traffic management measures and their effectiveness relate to, for example:

- Age
- Intelligence and cognitive style
- Experience and familiarity
- Personality

In addition, the same person may behave differently at different moments:

- Temporary factors.

Age

On average, and compared with younger road users, older road users, for example,

- Have a reduced acuity of vision and a limited peripheral view.
- Are more susceptible to glare and require more contrast.
- Require more time for identifying and processing relevant information.
- Have motor skills that are more limited and less fluid.
- Have more difficulties in learning to master new skills or new regulations (e.g., new concepts like dynamic speeds or peak hour lanes).

These features affect requirements concerning design, location and timing of roadside and in-vehicle information.

On average, and compared to adults, children are less able to, for example,

- Estimate driving speeds and judge gaps to cross.
- Detect and judge (potentially) risky situations.
- Control impulses (e.g., running blind into the street after a ball).
- Manoeuvre and control their bicycle.

Intelligence and cognitive style

Traffic management information needs to be understandable for all road users, across all intelligence levels. Very complicated signs or very abstract icons may not be understandable for everyone at first sight.

Furthermore, it is important to realise that people have different cognitive styles. People, for example, differ in the way they search for and process information. A relevant distinction in this context is that observed between field dependency and field independency, when acquiring and processing information. Field dependent people are strongly dominated by the overall picture: they see the forest. Field-independent people are more inclined to see the individual items: they see the trees. Field dependent people need more time to process information, have longer reaction times, and have more problems picking out the relevant information.

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These types of differences between people show the importance of simple straightforward messages, located at a highly visible and conspicuous place. Thorough pre-testing of new signs, icons, messages etc. helps to ensure that different types of people can understand and use them.

Experience and familiarity

The level of experience a road user has with traffic in general or with a particular type of vehicle as well as his familiarity with the road network affects his traffic behaviour. Experienced road users know better than novice road users what is important information and where this information can be found. That capability makes experienced road users more effective and efficient in searching for relevant information. Consequently, this means that it is important to locate and time traffic management messages logically and uniformly, i.e. in accordance with what these experienced road users expect. At the same time, logical and uniform messages might help the less experienced road users to learn faster about where to find relevant information. If location or timing do not match road users' expectations this may lead to uncertain and indecisive behaviour or they may simply miss the information.

Familiarity refers to road users' familiarity with a specific road network and its routes. Familiarity can be helpful for road users because then they do not need to consciously look for signs and other information. However, exactly because of this, familiarity can also be counterproductive. The fact that road users who are familiar with the network or the traffic situation look less actively for traffic information also means that they are less likely to note (temporary) changes. Hence, traffic management signs and messages

need to be extra conspicuous when applied in neighbourhoods with high volumes of local travel and on well used routes, to and from work.

Personality

Furthermore, road users behave differently because of personality characteristics. When looking at road user behaviour in relation to traffic management measures, especially relevant are; the readiness to comply with instructions, rules and regulations, and to take risks. Well-known, but not mutually exclusive examples of personality characteristics related to this are:

- Sensation seeking:
  Sensation seekers are people who tend to look for new, challenging, and exciting activities, accepting the concomitant risks. For example, in traffic, sensation seekers have been found to travel at higher speeds and violate the traffic rules more often than non-sensation seekers.
- Anger/aggression:
  Anger is a personality trait and one way of expressing anger is through aggression. Anger has been found to go together with riskier behaviour and led to a higher degree of crash incidents.
- Social value orientation:
  The social value orientation distinguishes between prosocial, individualistic, and competitive people. Prosocial people are cooperative and strive for equality by maximising the joint outcomes. Individualists tend to maximise their own outcome with little or no attention to the outcomes for others. Competitive people tend to maximise their own outcome, seeking relative advantage over others.

Temporary factors

Differences between people are one thing, but there are also differences ‘within’ people. In other words, even in similar situations, one and the same person may feel and behave differently at different moments of time. This may be related to either fluctuations in motivation or fluctuations in capability.

Temporary factors that affect motivation and/or capability include:

- Alcohol and drugs use
- Fatigue
- Distraction
- Illness
- Time
- Stress
- Emotions

Fatigue affects both capabilities and motivation

Behavioural adaptation and other unintentional effects

Behavioural adaptation

Human beings are very adaptable and able to respond rapidly to changes in their environment. They easily adapt their behaviour to maximise (supposed) positive effects and minimise (supposed) negative effects. This is also known as behavioural adaptation. In a traffic context, behavioural adaptation may occur unconsciously, following a permanent or temporary change of the road, the vehicle or the regulations.

Some examples of traffic situations where behavioural adaptation might occur:

- Increasing your speed in order to catch up with (supposed) time loss due to a local speed limitation, e.g., following a work zone or a traffic jam.
- Accepting smaller gaps for overtaking after a stretch of road where overtaking was prohibited.
- Stopping at an amber traffic light after a series of green traffic lights or accelerating at an amber light after a series of red traffic lights.

Behavioural adaptation is also used to explain why some vehicle safety features have a smaller net effect than theoretically expected. Though hard to prove scientifically, such smaller-than-expected effects have been reported, for example, ABS and seatbelts. Similar reservations could be made for in-vehicle traffic management systems and therefore warrant careful monitoring of effects.

Other unintentional side effects

Behavioural adaptation is one source of unintentional, unforeseen and generally unwanted side effects from traffic management measures. Other unintentional negative side effects of traffic management measures include:

- Information overload:
  People have limited information processing capacity. Messages and instructions should be prioritised and well spread in place and time.
- Information underload:
  On the other hand, for maintaining a sufficiently high attention level, and preventing drivers from dozing off, it is important that drivers have some information to process. In particular, in increasingly automated cars, but also on long stretches of motorway, messages may help to prevent information underload.
- Distraction:
  Due to their limited information processing capacity, people can only multi-task to a limited extent. Messages and instructions should be avoided that are so extensive or complicated, that it diverts attention from the primary traffic task.
- Over-reliance:
  Over-reliance on information or systems should be avoided. Drivers' expectations of a traffic management measure must be realistic and they should not rely too much on it.

Information overload? *©SWOV/Paul Voorham*

Information underload?

The unintended and/or negative side effects of road traffic measures in general and of road traffic management measures in particular, have hardly been studied. Hence, we do not have a reliable estimate of their nature and prevalence. Nevertheless, it is important for road traffic managers to be aware of the behavioural adaptation phenomenon and other unintended side effects, both when working out specific measures and after having implemented them.

Considerations for in-vehicle traffic management information

Technology continues to progress rapidly, influencing all of our daily lifes and this includes road traffic and road traffic management. Technological developments have a huge potential for optimising road traffic and road traffic management, but it also brings forward some challenges. This section briefly lists some of the main considerations.

Real-time and network-wide information

The currently available technologies allow for traffic management information to be real-time, taking account of the actual traffic and weather situation, as well as situations elsewhere in the network. This dynamic traffic information is more or less common throughout Europe, but generally limited to motorways and main arterial roads with messages posted along the roadside using the provided signing equipment.

Personalised information, instructions and advice

Increasingly, this dynamic traffic information will be made directly available in the vehicle and this allows for direct tailoring of information to the individual preferences and needs of the drivers. In-vehicle information also allows for direct personal and real-time instructions, and advice about required behaviour, or more generally, about driving style. For example, when traffic management instructions are violated the driver can be warned through a visual or auditory message, or alternatively: the driver can get a reward when he obeys the instructions. The knowledge gained through examination of gaming principles has shown promising approaches for developing in-vehicle applications.

The same four key human factors

In-vehicle information has to be tailored to human capabilities and limitations. It has to take account of the four key human factors as described and illustrated in the previous sections of this booklet: perception, comprehension, capability and motivation. In other words, it must be ensured that road users can perceive and understand the in-vehicle information, and that road users are able and willing to comply to the rules and instructions.

Be aware of information overload and distraction

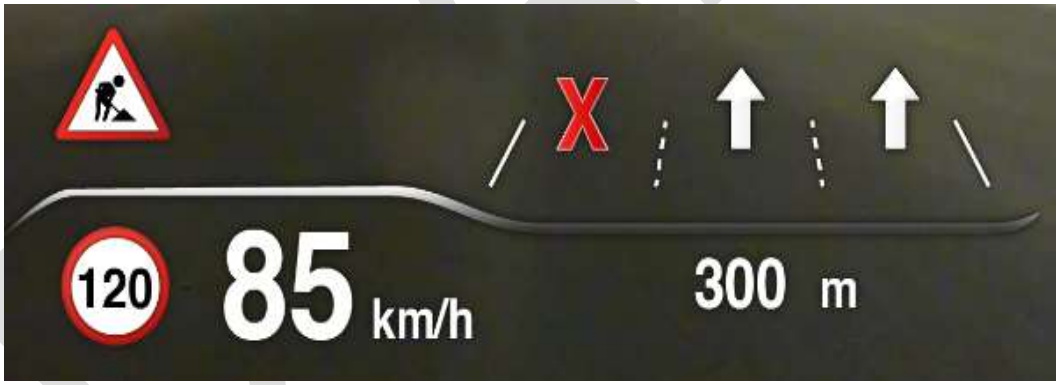
However, there are two related factors that require specific attention when developing in-vehicle traffic management information systems and providing personalised feedback to drivers: information overload and distraction.

- Information overload

Not only road authorities but also the private sector, collects and makes available traffic data. The private sector generally has a commercial interest and, consequently, an interest that its information is actually displayed and gets sufficient attention. People, however, are limited in the amount of information they can handle within a certain timeframe. Too many service providers may easily result in too much information for the driver. This may lead to an overload from the less relevant information presented, which road users are unable to properly select, process and use.

- Distraction

  Distraction is one of the most critical crash-inducing factors in traffic. Distraction in traffic is generally associated with non-traffic related activities such as calling, texting, and watching the children on the back seat. But obviously, traffic related information can also be a significant source of distraction. Aspects that need to be considered for in-vehicle information are the amount of information, the priority of the information, and the method of presenting the messages:
    - What is the main message, how long, how complex?
    - How is it presented: orally, visually or both?
    - Where is it presented: on the dash-board, on the window (head-up displays) or both?
    - When is it presented: how many forewarnings and how far in advance?



Example of in-vehicle information *© TNO*

These types of questions, as well as many others, are increasingly the subject of research, but conclusive answers to these issues are not yet available.

In summary

Traffic management (re)directs traffic flows over the road network with the aim of optimising movements of people and goods in terms of reliability, safety and environmental sustainability. Traffic management measures are becoming increasingly important, because the levels of road mobility continue to increase and it does so at a faster rate than any increases in road capacity.

However, traffic management measures do not always yield beneficial results in terms of throughput and traffic safety. An important reason for this is that road users often do not behave as intended or anticipated by the traffic manager. In order to get the best out of traffic management measures, it is essential to explicitly address the limitations, strengths and peculiarities of road users. In other words, it is essential to take account of human factors.

In this respect, the four basic and fundamental questions to pose before introducing a measure are, successively:

- Perception: can road users see and read (or hear) the signs, signals and information?
- Comprehension: do road users understand signs, signals and information and what needs to be done?
- Capability: are road users capable of performing the desired behaviour?
- Motivation: are road users willing to perform the desired behaviour?

In particular, the role of motivation is often underestimated or overlooked. Explaining the reasons for a measure and providing feedback are crucial means to increasing motivation.

Furthermore, it is important to keep in mind that:

- There is no average road user.
- There is great diversity in road user competence which is determined by biological and acquired characteristics.
- Road user behaviour is affected by temporary features such as fatigue, distraction, and stress.

Traffic management measures should take these human factors into account and gear them to the ‘weakest link’.

The possibility of in-vehicle information and direct feedback offers a huge opportunity for personalising the messages. Although, the prevention of information overload and distraction is an important challenge and cannot be solved without significant co-operation; co-operation between all actors, nationally and internationally, public and private.

Further reading

Campbell, J.L., Lichty, M.G., Brown, J.L., Richard, C.M., et al. (2012). *Human Factors guidelines for road systems; second edition*. National Cooperative Highway Research Program, Report 600. Transportation Research Board, Washington, D.C. http://www.trb.org/Main/Blurbs/167909.aspx

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