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SIXTH FRAMEWORK PROGRAMME
PRIORITY 1.6. Sustainable Development, Global Change and Ecosystem
1.6.2: Sustainable Surface Transport

SOMS/IN-SAFETY

Final Report

Summary of the Results of Deliverable D2.3 "Proposal on unified pictograms, keywords, bilingual verbal messages and typefaces for VMS in the TERN"

Coordination: International Institute for Information Design (IIID)

Supported by:

European Commission DG TREN

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SOMS/In-Safety Abstract

D 2.3 “Proposal on unified pictograms, keywords, bilingual verbal messages and typefaces for VMS in the TERN” is based on a concept, submitted 2003 by the International Institute for Information Design (IIID) to the European Commission in a proposal “SOMS / Substituting/Optimizing (variable) Message Signs for the Trans-European Road Network”, before it got merged with “IN-SAFETY / Infrastructure and Safety”.

At that time the TERN (Trans-European Road Network) covered 15 countries with 11 languages spoken plus 3 additional states which are not EU members. These countries and languages, together with 10 “new member states” with 9 official languages, were considered with the aim to derive at feasible suggestions of the cross-language and language independent display of information on VMS (Variable Message Signs) and static message boards on motorways.

The need

Considering the rapid development of traffic on European motorways, there is an undeniable need for improved and harmonized signalisation of traffic related messages in general, and danger warning information in particular throughout the TERN. Drivers cover ever wider distances – crossing several borders on one trip – require language independent, clearly understandable messages. Messages, which must allow for early recognition and comprehension, giving drivers the extra time to adjust their driving behaviour in critical situations, thus avoiding collisions and injuries.

The process: designs and tests

IIID with 9 Consortium members of 7 EU member states started by investigating requirements indicated in official documents and other relevant literature.

The Consortium members, fully aware of the potential of the emerging new generation of freely programmable VMS (Variable Message Signs) based its considerations on the insight that effective communication often requires the combination of various information elements and that it should be possible to display information in animated mode whenever heightened alertness is on demand.

With the assistance of a design panel of experts of 5 EU countries, 457 pictograms, matching the listed symbol referents/meanings to be visualized, have been collected. Subsequently, altogether 2.977 (documented) symbol/pictogram variants have been elaborated for submission to an iterative process of testing (according to ISO 9186 “Test methods for judged comprehensibility and for comprehension”) and redesign. In addition, a Comprehension Test on Animated Pictograms, an Evaluation of Warning Elements for Matrix Displays, a (VMS) Content Structure Test and – for the newly designed highway alphabet – an Impaired Visibility Typeface Test have been conceived. The tests were coordinated by Danube University Krems and conducted in the Czech Republic, in Hungary, Spain, and in Austria, involving 2.667 test persons.

Results

The Deliverable, by relating to the physiological, cognitive and technical requirements on information to be displayed on VMS and conventional road signs, presents the achieved results:

- A wide range of symbols/pictograms, tested and optimized for understanding and early recognition
- A traffic typeface for both VMS and conventional signs, tested and designed to provide enhanced legibility, capable of displaying 20 EU languages (typeface “Tern”)
- “Key meanings”– representing short verbal messages, a set of traffic relevant vocabulary to be understood throughout Europe, identified by INFOTERM
- A proposed content structure for the emerging generation of freely programmable VMS, employing the elements stated above.

These results may be reviewed at http://www.iiid.net/SOMS.htm.

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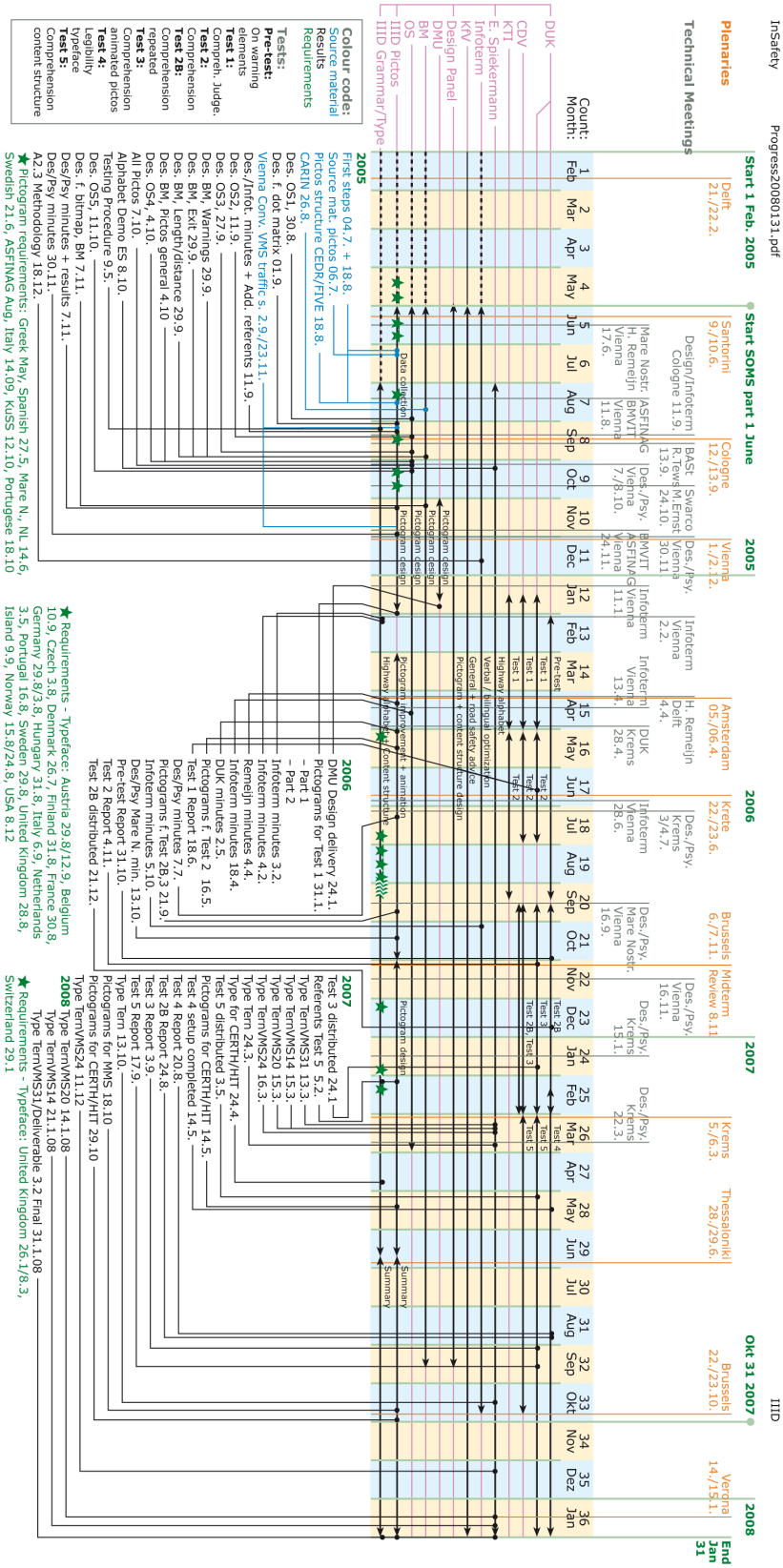
0.2 Project development



0.3 Introduction

The goal of the SOMS/In-Safety project is the harmonization of messages provided to drivers along the Trans-European Road Network (TERN). The main concern of activities was the substitution of text-based information by newly created symbols (pictorams), verified for comprehension by a series of tests and optimized for enhanced discrimination.

In addition, messages beeing abstract or too general to be converted into symbols were identified and condensed into short, internationally understood text messages called “Key meanings” or “Europeanisms”.

To improve legibility of text messages, the traffic typeface “Tern” was developed, based on insights acquired in an extensive comparative typeface test.

Both pictorial and textual messages were conceived for deployment on VMS (Variable Message Signs) and conventional signage and accordingly, formally harmonized to allow for mixed application (eg. traditional sign boards, partially employing VMS for variable information elements only).

To cater for means of structured (combined) employment of elaborated information elements, rules governing application on freely programmable VMS were conceived. To tackle the issue of possible information overload posed to drivers, a resonable method based on the now known comprehension degree of information elements was established.

1 Results

1.1 Discriminability of Information

1.1.1 Prerequisites governing dimensions

Based on Snellen´s Optotype (“Snellen-Hook”), to discriminate two identical parallel lines, the minimum distance must be at least one Minute Of Arc (1 MOA). Undercutting 1 MOA causes the eye to perceive the two lines as one object.

In this way, 1 MOA also defines the size of the Smalles Graphical Detail (SGD) allowed in a displayed information element (a symbol or typeface character). The actual size of 1 MOA/SGD is dependend on vsiual distance: the greater the distance, the larger the necessary size of 1 SGD. For instance, at a viewing distance of 10 metres, 1 MOA/SGD = 3 mm.

These specification implies that the perceiving eye operates at “normal” visual acuity, which is given if the two lines mentioned above can be descriminated from a distance of 6 metres (“6/6” or decimal 1.0 = normal acuity).

1.1.1.1 To drive a car visual acuity of 10/20 resp. 0,5. suffices

Annex III of Council Directive 91/439/EEC of 29 July 1991 on driving licences (http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=31991L0439&model=guichett)" requires a visual acuity of only 0,5, instead of 1,0:

"Group 1 (drivers of vehicles of categories A, B and B+E and subcategory A1 and B1):
(6.1.) Applicants for a driving licence or for the renewal of such a licence shall have a binocular visual acuity, with corrective lenses if necessary, of at least 0,5 when using both eyes together.

Group 2 (drivers of vehicles of categories C, C+E, D, D+E and of subcategory C1, C1+E, D1 and D1+E):
(6.3.) Applicants for a driving licence or for the renewal of such a licence must have a visual acuity, with corrective lenses if necessary, of at least 0,8 in the better eye and at least 0,5 in the worse eye."

Considering this, mesurement of the smallest graphical detail based on 1 MOA ought to be duplicated for visual acuity 0,5.

The 1991 directive seemingly adopted regulations for visual acuity carried forward from a time where:

- Motor vehicles going faster than 100 km/h were rare,
- Traffic on roads was low; in Austria a mere 3,4% of 2006: 143.000 passenger cars in 1955 against 4.205.000 in 2000)
- Motorways in many European countries did not exist; in Austria the "network" of motorways amounted to 27,6 km against 1.677,5 km in January 2007 (plus 400 km of highways)

1.2 Tern Symbols - Pictograms

The outset of the project. IIID conducted investigations and interviews of stakeholders. This enabled the consortium to derive a collection of meanings ("Referents") for European motorways, to be transformed into pictorial information (symbols/pictograms).
Deliberately excluded were traffic signs and symbols governed by the "Convention on Road Signs and Signals done at Vienna on 8 November 1968, United Nations, Economic Commission For Europe, Inland Transport Committee" (short: Vienna Convention). A range of motorway relevant "signs" from this source were also optimized for comprehension requirements. Complementing the set, standardized public information symbols from various sources (such as ISO 7001 and ÖNorm 3011 were added.

In consecutive design phases followed by psychological tests (in compliance and derived from ISO 9186 "Test methods for judged comprehensibility and for comprehension") symbols were systematically optimized or, due to lacking test performance, excluded from further development. The remaining (final) set represents symbols approved for comprehension and, according to performance, categorized into comprehension "class" 1, 2 or 3.

Special attention was payed to the exploration of alternative, improved forms of signalling danger warnings, fostered by new possibilities induced by the upcoming generation of freely programmable VMS systems. Symbols representing the danger to be warned of were shown full size, superimposed by a flashing categorizing element (warning: red warning triangle, closed or impassable: red diagonal cross). In this way, a much larger than usual depiction of a danger source is possible, allowing the driver to perceive it from a greater distance, and to adjust his/her driving behavior much earlier than it is possible if standard warning signs are shown.

1.2.1 Final table of pictogram referents

1 REGULATIONS
1-1 Lane Allocations
1-1-1 Lane control signals
1-1-2 Lane indication
1-2 Carriageway Guidance
1-2-1 Closure ahead
1-2-1-1 Closure ahead: Road (Similiar meaning to 1-2-2)
1-2-1-2 Closure ahead: Pass / Mountain road
1-2-1-3 Closure ahead: Tunnel
1-2-1-4 Closure ahead: Bridge
1-2-1-5 Closure ahead: X exit
1-2-2 Take next Exit (Similiar meaning to 1-2-1-1)
1-2-3 Lane closure ahead
1-3 Speed Control
1-3-3 Speed limit 10km/h
1-3-4 Speed limit 20km/h
1-3-5 Speed limit 30km/h
1-3-6 Speed limit 40km/h
1-3-7 Speed limit 50km/h
1-3-8 Speed limit 60km/h
1-3-9 Speed limit 70km/h
1-3-10 Speed limit 80km/h
1-3-11 Speed limit 90km/h
1-3-12 Speed limit 100km/h
1-3-13 Speed limit 110km/h
1-3-14 Speed limit 120km/h
1-3-15 Speed limit 130km/h
1-4 Regulations
1-4-1 Regulations of use/Dedicated lanes for target groups
1-4-1-1 Dedicated lanes: Buses
1-4-1-2 Dedicated lanes: Lorries
1-4-1-3 Car sharing lane/HOV lane
1-4-1-4 Dedicated lanes: Taxi
1-4-1-5 Dedicated lanes: Emergency vehicles
1-4-2 Smog/Inversion weather/Environmental Zone
1-4-3 No lorries at night
1-4-4 No Lorries over x tonnes
1-4-5 Temporary prohibition: Dangerous goods
1-4-6 End of (temporary) restrictions/limitations
1-4-7 Use/Don´t use hard shoulder (see 1-1-1)
1-4-9 No entry for vehicles having a mass exceeding x tonnes on one axle
1-4-10 Prohibited vehicular traffic in both directions
1-4-11 No entry
1-4-12 Overtaking prohibited
1-4-13 End of prohibition of overtaking
1-4-14 Overtaking prohibited for goods vehicles
1-4-15 End of prohibition of overtaking by goods vehicles
1-4-16 Driving less than x metres apart prohibited
1-4-17 Direction to be followed
1-4-18 Direction to be followed

2 DANGER WARNING
2-1 Danger warning (general)
2-2 Immediate warning on weather conditions
2-2-1 Flooded road
2-2-2 Fog
2-2-3 Freezing fog
2-2-4 Snow/Ice
2-2-5 Cross-wind
2-2-6 Road surface temperature
2-2-7 Slippery road
2-3 Immediate warning on traffic status- close ahead
2-3-1 Traffic congestion/Queue
2-3-2 Accident (has happened)
2-3-3 Vehicle broken down
2-3-4 Wrong way driver
2-3-5 Pedestrian(s) on the road
2-3-6 Horse(s) on the road
2-3-7 Cattle on the road
2-3-8 Deer on the road
2-3-8-1 Elk-Rreindeer on the road
2-3-11 Objects/obstacles on road
2-3-12 Two way traffic
2-3-13 Road uneven
2-3-14 Light signals
2-3-15 Road works
2-3-16 Swing bridge

3 INFORMATIVE
3-1 Advance warning
3-1-1 Traffic status (see 2-3)
3-1-2 Weather Condition (see 2-2)
3-1-3 Speed camera
3-2 (Implicid) advice
3-2-1 Rerouting
3-2-2 Last exit before
3-2-2-1 Last exit before toll station
3-2-2-1-1 Toll road ahead
3-2-2-2 Last exit before pass / mountain road
3-2-2-3 Last exit before tunnel
3-2-2-4 Last exit before tmporarily closed tunnel
3-2-2-5 Last exit before bridge
3-2-3 Exit after next exit closed
3-2-4 Fog speed control
3-2-5 Filling station
3-3 Driver comfort
3-3-1 Temporarily free lane ahead (see 1-1-1)
3-3-2 Services
3-3-2-1 Parking facilities
3-3-2-2 Park and ride
3-3-2-3 Tram
3-3-2-4 Ferry boat
3-3-2-5 Sport events
3-3-2-6 Fair
3-3-2-7 Picnic/Rest area
3-3-2-8 Childrens play area/Playground
3-3-2-9 Internet
3-3-2-10 Caravan site
3-3-2-11 Mobile home
3-3-2-12 Information
3-3-2-13 Camping site
3-3-2-14 Refreshments or cafeteria
3-3-2-15 Hotel or motel
3-3-2-16 Drinking water
3-3-2-17 Full accessibility/Toilets accessible
3-3-2-18 Hospital
3-3-2-19 Restaurant
3-3-2-20 WC/Toilet
3-3-3 Parking space available
3-3-4 Emergency phone
3-3-5 Emergency phone number
3-3-6 Snow chains mounting area
3-3-6-1 Snow chains compulsory
3-3-7 Length/Distance

4 MISCELLANEOUS
4-1 Direction (see 1-4-17/1-4-18)
4-2 Follow (see 1-4-17/1-4-18)
4-3 Reachable
4-4 Fines doubled
4-5 Switch off engine if congestion persists
4-6 Switch on hazard warning lights
4-7 Motorway entry ramp/junction
4-8 Motorway exit
4-9 Height control
4-10 Truck-to-rail terminal
4-11 Motorail station
4-12 City centre
4-13 Compulsory direction for lorries to check point
4-14 Peage/Toll (see 3-2-2-1-1)
4-15 Underground trains depart every x minutes

1.3 Key meanings (“Europeanisms”)

From an early stage of the project on it was clear that not all messages could be communicated by symbols, leading to the need to establish a compendium of textual messages generally understood (and bearing the same meaning) all over Europe. The vehicle for this investigation was provided by a comprehensive questionnaire sent to all EU Member states. From obtained data, discrepancies between standards and the need for harmonization became evident: e.g. time indications (and durations) should be applied as proposed by ISO. Furthermore, it is recommended to accurately employ SI Units (Système International d'Unité / International System of Units), such as the lower case letter “t” for “tonnes”, instead of “T” as shown in the Vienna Convention.

Excerpt:

Place names	Place names are to be shown according to cartographic principles in capitals (e.g. for major cities) or in upper and lower case (for places of minor importance) to facilitate ease of comprehension whenever a diver needs to compare information displayed in maps and on in-car navigations displays on one hand side and on static signs and on VMS along the road on the other. Unfortunately no binding standard(s) on the number of inhabitants of places which require that place names are to be shown in capitals could be traced.
SI units	and their multiples (like km = kilometre, t = ton)
Imperial system units (US, UK, …)	ISO 31 (SI units) deprecated “m” for unit “mile” which is to be indicated unabbreviated in lower case letters only
Special characters	like % (for indicating gradients), ° (with dispensable “C”, indicating temperature in centigrades)
Time specifications	ISO 8601:2004 “Data elements and interchange formats — Information interchange — Representation of dates and times” applies. Example: 07:30 – 19:00 to indicate a time span. *Note:* Whilst ISO 8601 advises to use a solidus [/] to separate the two time components for specifying time intervals it also says: “In certain application areas a double hyphen is used as a separator instead of a solidus.” To facilitate understanding: many people would prefer to call the “double hyphen” a “dash” (= wider than a hyphen), more formally known as “em dash” (the width of an M character) as applicable in the given situation, or an “en dash” (the width of the N character).

1.4 Tern Typeface (Traffic typeface)

The development of the new traffic typeface had to fulfill the requirement to allow for the display of all official EU languages (excluding those added in 2007 at the last EU expansion), for a unified appearance of textual information on European motorways. Insights gained on the reading habits of drivers unfamilliar with the local language and area do not read word-by-word, but letter by letter, prompting the need to create characters specially designed to be easily discriminated from great distances. For this reason, the three most influential traffic typefaces (DIN Mittelschrift, D; Transport, GB; RWS, NL) were analyzed, paving the grounds for the development of the typeface “Tern”, which underwent a comparative discrimination test to evaluate every single character. After redesign according to the test results, Tern consitutes a most legible traffic typeface, for (pixelled) use on VMS, as well as for conventional road signs (printed and plotted).

Tern is available in several versions:
“Tern”- “Normal”- face for connventional use on information boards
“TernVMSonefour”: 14 pixels of height, the smallest TernVMS-typeface for four lines of text
“TernVMStwozero”: 20 pixels of height, for three lines of text
“TernVMSthreeone”: 31 pixels of height, for two lines of text
“TernVMStwofour”: 24 pixels of height, to substitute text of the same height on older VMS systems

1.5 Minimum size of information to be perceived at 100 km/h

The most important factor for the successful transmission of visually provided information on roads is viewing time: the longer the viewing period, the higher the chance for correct communication and comprehension. The only flexible enough source for calculating the relations between speed and viewing time, to derive an appropriate viewing distance, is provided in the “Danish Technical Handbook for VMS”: according to this paper, 3.33 seconds of viewing time are required to “read” four information elements. When related to 100 km/h, a viewing distance of 92.51 metres (the point the VMS display disappears out of sight) is calculated, which is exactly 14.55 m before passing the VMS. Summing up, 107.06 m of viewing distance are required to view Information for 3.33 seconds at 100 km/h. Regarding this, 1 MOA, at visual acuity of 0.73 = 44 millimetre.

This figure translates to multiples of 22 mm as the basic increments of the grid underlying the positioning of the LEDs on VMS. For driving speed exceeding 100 km/h, LED increments are to be enlarged accordingly.

Note: 0.73 visual acuity is baseded on the conclusion that the “normal” acuity of a healthy eye is approximately 1.25 to 1.67. Its mean value, 1.46, was cut in half, resulting in 0.73, to account for drivers with poor eyesight.

1.6 VMS display size for 100 km/h

Display height: serving as a basis for calculation, the complex letter “e” requires 5 MOA to be fairly discriminable. Related to typeface “TernVMStwozero” 5 MOA translate to 24.2 cm (11 LEDs). Accordingly, the full body size sums up to 44 cm (20 LEDs). Applied to three lines of text, the full VMS display height sums up to 140.8 cm (64 LEDs). Pictograms/symbols elaborated in this project were conceived to fit this measure full size.

Width: Theoretically, It is possible to adapt the proposed modular concept to applications on roads allowing for average speeds higher than 100 km/h by increasing the overall dimensions of VMS along with the increments of the grid underlying the displayed information, to ascertain the required viewing time of 3.33 seconds. Compared with the width of an average two lane motorway which is 7.5 m in countries like Germany, arranging four full size symbols laid -out for 100 km/h (140.8 cm each) does not pose problems. Higher speed requirements would certainly exceed available space. In some exceptional cases, (eg. signalization of lane dedicated information such as “Lane dedicated for emergency vehicles“) it might be permissible to extend th VMS display width by adding the with of the hard shoulder.

1.7 Proposal of a European guideline for content structure on VMS

1.7.1 The basic grid

The content of VMS can be composed by relating to a well defined layout architecture. The standard layout consists of 3 lines of text (typeface “TernVMStwozero”), resulting in 64 RGB LEDs (vertical), corresponding to a symbol displayed full size.

Deviating from this principle, the small-sized TernVMSonefour can accommodate 4 lines of text, but should be used with discretion, displaying only short generally understood terms, such as “key meanings” or ancillary information, like length/distance indications, accompanying a symbol (reduced to a height of 46 LEDs).

Additionally, TernVMSonefour could be employed for simultaneously displaying bi-lingual place names, provided the necessarily longer viewing time can be assured, possibly by placing a conventional speed restriction sign prior to the VMS.

For displaying extra-large textual information “TernVMSthreeone”, restricted to two lines of text, can be used if deemed appropriate.

1.7.2 Danger warning

To warn of dangers and atypical road conditions (e.g. ”impassable”) it might be sufficient, to show the respective symbols/pictograms on VMS full size. Test results indicate that danger warning symbols/pictograms must be as large as possible to be quickly and correctly comprehended from a distance.
To alert drivers to a rapidly approaching danger it is suggested to superimpose the symbol/pictogram with a graphical element indicating the general nature of the message (danger warning or “out of order/not acessible/not available”) in flashing mode, e.g. 3 tenths of a second in intervals of 8 tenths of a second.

1.7.3 Rules governing VMS content structure

- Information on VMS, unless related to lanes below, must always be placed centered.

- To safeguard longest possible viewing duration (text) messages must always be built from bottom to top.

- The ranking of information elements, from left to right, should be as follows:
  Information on danger hazard or “out of order” ahead – Prohibition, restriction, and/or mandatory information – Ancillary information.
  In case the danger is signalled by a directionally dependent symbol/pictogram the order is to be reversed: a symbol/pictogram indicating an approaching danger (e.g. “animal on the road”) must not only be shown against reading direction it also reverses the sequential order of the overall composition of the display.

- To avoid information overload the following rules governing the permissable maximum number of information elements on a VMS apply:
- 4 information elements of Class 1 or
- 2 information elements of Class 1 and 1 information element of Class 2 or
- 1 information element of Class 1 and 1 information element of Class 3.

- Spaces between symbols/pictograms should equal 120% of the body height of related type of three lines of text;
  this would be 24 pixels between symbols/pictograms of 64 pixels (body of reference type TernVMStwozero is 20 pixels high, 120% of this = 24 pixels).

- Spaces between information elements belonging together: 8 pixels

- Symbols/pictograms provided for small size application (46x46 pixels) may be applied with discretion. They might prove to be useful e.g. in combinations with indications of length/distance below.

- Symbols/pictograms referring to a further away danger may be either provided in small size application (46 x 46 pixels) with an indication of distance below or full size with indication of distance sidewise. In close range of the hazard, such symbols/pictograms should be shown full size with superimposed danger warning triangle or diagonal cross in flashing mode without any further indication of distance.

- Lane specific information should be separated through broken/full vertical lines in analogy with such lines between the lanes on the road below the VMS. This makes down-pointing arrows dispensable.

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