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

INFRASTRUCTURE AND SAFETY

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Proposal on unified pictograms, keywords, bilingual verbal messages and typefaces for VMS in the TERN			
Deliverable No.	**D 2.3**		
Workpackage No.	**WP2**	Workpackage Title	Implementation scenarios and concepts towards self explaining roads
Activity No.	**A2.2**	Activity Title	Pictograms substituting verbal messages on VMS Leader: IIID
	A2.3	Activity Title	Key meanings and bilingual messages in VMS Leader: INFOTERM
	A2.4	Activity Title	Content structure of pictorial and verbal messages on VMS and typeface Leader: IIID
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List of abbreviations and meanings

2ndCT	Second Comprehension Test
A2.2	IN-SAFETY Activity 2.2: Pictograms substituting verbal messages on VMS
A2.3	IN-SAFETY Activity 2.3: Key meanings and bilingual messages in VMS
A2.4	IN-SAFETY Activity 2.4: Content structure of pictorial and verbal messages on VMS & typeface
ASECAP	Association Européenne des Concessionnaires d'Autoroutes et d'Ouvrages à Péages European / European Association of Tolled Motorway, Bridge and Tunnel Concessionaires
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft / Motor- and Highway Financing Corporation
BM	Bureau Mijksenaar
BMVIT	Bundesministerium für Verkehr, Innovation und Technologie / Austrian Federal Ministry for Transport, Innovation and Technology
CAT	Comprehension Test on Animated Pictograms; procedure for quantifying the degree of understanding of animated pictograms/symbols
CEDR	Conference of European Directors of Roads
CT	Comprehension Test; procedure for quantifying the degree of understanding of pictograms
CST	Content Structure Test; procedure for quantifying the degree of understanding of pictograms shown in context with Vienna Convention symbols and other information elements on VMS
DD	Directional Dependency
Descender	Part of a typeface character reaching below the baseline, e.g. "g", "j" or "p"
IIID	International Institute for Information Design
IMPROVER	IMPact Assessment of Road Safety Measures for Vehicles and Road Equipment, Subproject 4 Harmonisation of road signs and road markings on the TERN from a safety point of view Final Report, April 2006
INFOTERM	International Information Centre for Terminology
IVT	Impaired Visibility Typeface Test; procedure for quantifying the degree of correct interpretation of typographic characters (letters and numerals)
CJT	Comprehensibility Judgement Test; procedure for eliciting judgements of the comprehensibility of pictograms/symbols
LED	Light Emitting Diode(s)
MARE NOSTRUM	The Mare Nostrum VMS Long Distance Corridor Group (MN VMS), a joint venture of the ARTS, CORVETTE and SERTI Euro-regional projects under the auspices of the European Commission's MIP program, originally aiming at harmonization of VMS messages along the long distance corridor Seville – Trieste, lately shifting its interests to VMS harmonisation in all Europe
MOA	Minute of arc/angle: angular measurement subunit, 1 MOA = 1/60 degree
Optotype	Test symbol which may be a number or a letter
OTF	Open Type Font, a typeface file format suitable for PC and MAC systems
Pictogram	correct: "pictograph", is a visually perceptible figure referring to a 'real object' by *resemblance* used to transmit information independently of language
RDS	Radio Data System
Referent	Idea or object that a graphical symbol/pictogram is intended to represent
Resolution	adequate image resolution is given, if a sufficient amount of displaying units (e.g. LED) is used to allow a viewer to unboubtedly discriminate a shape as it was intended to be conveyed
RGB	Is short for Red, Green, and Blue, denoting an additive color model in which Red, Green, and Blue light is added together; in freely programmable VMS the colours are created by LEDs emitting red, green, and blue light
SI	Système International d'Unité / International System of Units
Snellen Chart	A chart used to measure visual acuity, usually displaying several rows of optotypes (test symbols), each row in a different size
(Graphical) Symbol	A visually pertecptible figure considered to be backed by a convention
TERN	Trans-European Road Network
Tern	the newly developed highway alphabet
Tern Symbols	Traffic signs/symbols/pictograms elaborated in Activities A2.2/ A.2.4
TLD	Top Level Domain (e.g. ".at")
TROPIC	TRaffic OPtimisation by the Integration of information and Control
Vienna Convention	Convention on Road Signs and Signals done at Vienna on 8 November 1968 United Nations, Economic Commission For Europe, Inland Transport Committee
VMS	Variable Message Sign(s), also called Changeable Message Sign(s), Dynamic Message Sign(s); freely programmable VMS also called Full Matrix Displays, Graphical Displays and M-VMS (= Multipurpose-VMS, a term promoted by the Mare Nostrum Consortium)
WET	Evaluation of Warning Elements for Matrix Displays
WP2	IN-SAFETY Work Package 2: Implementation scenarios and concepts toward self-explaining road environments
x-height	Height of a miniscule (lower case letter), descender excluded, eg "a", "e" or "x"

Table 1: Abbreviations and meanings

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EXECUTIVE SUMMARY

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 (see 0.1) of 7 EU member states started by investigating requirements indicated in official documents and other relevant literature (see 5).

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 for understanding and early recognition (see Figure 7)
- A traffic typeface for both VMS and conventional signs, tested and designed to provide enhanced legibility, capable of displaying 20 EU languages (typeface “Tern”, see 2.3)
- “Key meanings”– representing short verbal messages, a set of traffic relevant vocabulary to be understood throughout Europe, identified by INFOTERM (see 2.2)
- A proposed content structure for the emerging generation of freely programmable VMS, employing the elements stated above (see 2.4)

0 Introduction

When SOMS “Substituting/Optimizing (variable) Message Signs for the Trans-European Road Network”, the Specific Targeted Research Project (STREP) originally proposed by IIID, got merged with IN-SAFETY, its goals became Deliverable D2.3.

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 (Iceland, Norway, Switzerland). At the outset of the project 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 variable message signs and static message boards on motorways.

The complete list of 25 EU countries and 20 languages considered:

Austria	Latvia / Latvian
Belgium	Lithuania / Lithuanian
Cyprus	Luxembourg
Czech Republic / Czech	Malta / Maltese
Denmark / Danish	Poland / Polish
Estonia / Estonian	Portugal / Portuguese
Finland / Finnish	Slovenia / Slovene
France / French	Slovakia / Slovak
Germany / German	Spain / Spanish
Greek / Greece	Sweden / Swedish
Hungary / Hungarian	The Netherlands / Dutch
Ireland	United Kingdom / English
Italy / Italian	

Table 2: Considered EU countries/languages

Figure 1: Trans European Road Network 2008

Source: DG TREN

0.1 Participating bodies

The work of D 2.3 was done with the assistance of Consortium partners resp. their representatives, designers who contributed designs and researchers who collaborated in testing:

International Institute for Information Design (IIID), Wien/Vienna, AT Stefan Egger, Wien/Vienna, AT DI Peter Simlinger, Wien/Vienna, AT Prof. Dr Erik Spiekermann, Berlin, DE IIID Design Panel Giuseppe Attoma, Attoma Design, Paris, FR Paul Kahn, Kahn + Associates, Paris, FR Helmut Ness, Fünfwerken Design AG, Berlin, DE Claus Michael Semmler, Werkstatt für Kommunikationsdesign, Hamburg, DE David Somers, Trevezel Systems GmbH, Lipperscheid, LU Prof. Michael Twyman, The University of Reading, GB Thomas Vavrinek, Breitenfurt, AT
International Information Centre for Terminology (INFOTERM), Wien/Vienna, AT Dr. Christian Galinski, INFOTERM, Wien/Vienna, AT Prof. Dr. Klaus-Dirk Schmitz, INFOTERM, Köln/Cologne, DE Mag. Anja Drame, INFOTERM, Köln/Cologne, DE Mag. Blanca Nájera, INFOTERM, Köln/Cologne, DE Fabienne Nawrat, INFOTERM, Köln/Cologne, DE Dorothée Eichfelder, INFOTERM, Wien/Vienna, A
CDV Centrum Dopravniho Vyzkumu / Transport Research Centre, Brno, CZ Dr Jan Weinberger Mgr Jiri Vasek
KTI Közlekedéstudományi Intézet Kht. / Institute for Transport Sciences Ltd., Budapest, HU Dr Péter Hóllo Dr Imre Büki
Bureau Mijksenaar b.v., Amsterdam, NL Paul Mijksenaar Fred Inklaar
Ole Søndergaard ApS, Helsingør, DK Ole Søndergaard Lennert Carlsen
Kuratorium für Verkehrssicherheit (KfV), Wien/Vienna, AT DI Martin Winkelbauer DI Cornelia Nussbaumer MMag. Sandra Reichenauer
DUK Danube University Krems, Krems, AT Dr Karin Siebenhandl Mag. Michael Smuc Dr Christof Brugger, Psychologist, Wien/Vienna, AT Viktor Solt-Bittner, Bonsai Cuts, Wien/Vienna, AT
De Montfort University, Leicester, GB Prof. Ian McLaren
Prof. Dr Heiner Erke †, Consultant Applied Psychology, Muenchen/Munich, DE
Expert advisors Dr Günter Breyer, BMVIT Austrian Federal Ministry for Transport, Innovation and Technology, Wien/Vienna, AT DI (FH) Marko Jandrisits, ASFINAG Verkehrstelematik GmbH, Wien/Vienna, AT Ing. Wolfgang Ernst, swarco FUTURIT Verkehrssignalsysteme GmbH, Neutal, AT Dr Antonio Lucas, INTRAS Road Safety & Traffic Institute, Universitat de València, ES ir Hans Remeijn, Rijkswaterstaat, Transport Research Centre, Test Centre for Traffic Systems, Rotterdam, NL

Table 3: Participating bodies

Project development

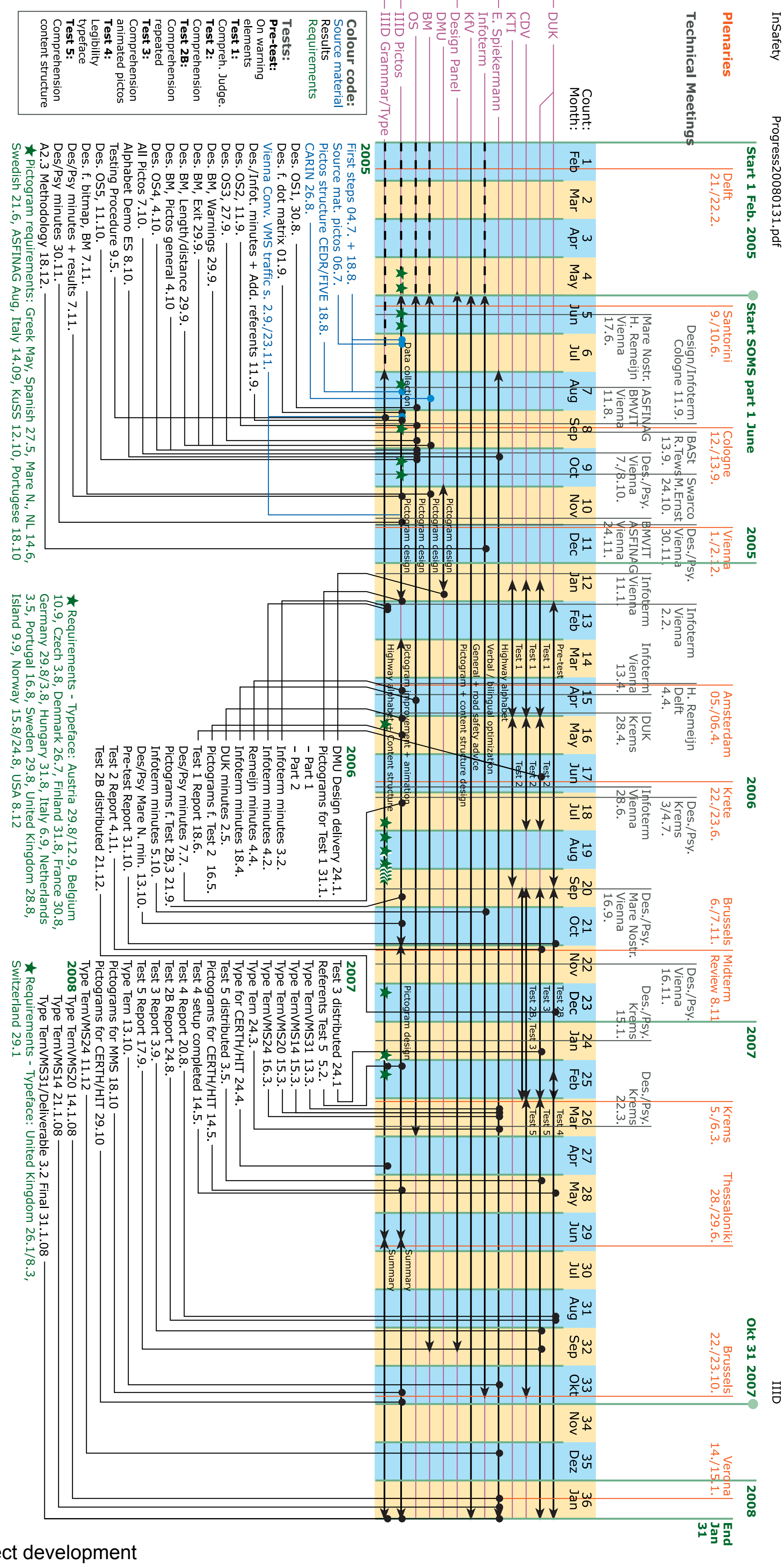

Figure 2: Project development

Having closely studied the requirements of the drivers, the highway operators, and the technical possibilities of the related signage industry it became clear that many conclusions of related reports need to be revised. This deliverable shows the direction to take.

0.2 Circumstances that ask for a new approach

Basically it is the emerging new generation of freely programmable VMS (Variable Message Signs) along with the insight that effective communication often requires the combination of various information elements, e.g. symbols/pictograms (plural) with (or without) text below or alongside, that such information can be displayed big enough so that it can serve all lanes of a motorway simultaneously, with the option to also display lane-specific information, and that information can be animated whenever heightened alertness is on demand.

In all cases safety relevant information took precedence over purely service relevant information.

Considering the limited life span of VMSs with manufacturer's guarantees not exceeding 10 years, it makes sense to shift the focus from presence to future.

0.3 Composition of the Deliverable

After ingoing considerations concerning the physiological (1.1), cognitive (1.2) and technical requirements (1.3) on information to be displayed on VMS, the Deliverable summarizes the achieved results with regard to pictograms for static and variable message signs (2.1), “Keywords” (2.2), typeface (2.3), and VMS content structure (2.4).

The report closes with a chapter on suggested further research (3) and policy recommendations (4).

Special attention is given to the fundamentals laid down in the Vienna Convention, requirements defined by CEDR - Conference of European Directors of Roads and other bodies (5), the notion of “visual acuity” (1.1), and the demands on drivers with regard to information load, display size and speed (1.1.5).

1 Requirements

The following requirements on VMS have been identified:

- physiological requirements with regard to conspicuity and discriminability,
- cognitive requirements with regard to understanding,
- technical requirements with regard to the size and quality of the presentation of the information.

1.1 Physiological requirements

Conspicuity and discriminability depend on the visual quality of an image (picture, symbol/pictogram or letter/numeral) and the acuity of the viewer.

Images displayed on LED based VMS are bitmap images. The visual quality of a bitmap image is governed by its overall size, the size of its smallest graphical detail, which, despite the name, needs to be large enough to be clearly discriminable from a give distance (e.g. about 3 mm seen from a distance of 10 m = 1 MOA), its colour(s) and contrasts, and its resolution. Whether the information is presented static or animated also plays a deciding role.

1.1.1 "Normal" visual acuity: 20/20, resp. 1,0

Reference.com http://www.reference.com/browse/wiki/Visual_acuity tells us that *"'normal' visual acuity is frequently considered to be what was defined by Hermann Snellen (1834–1908) (as the ability to recognize an optotype when it subtended 5 MOA (which e.g. would apply to the letter E with even strokes and 'counters' of same width, which – if measured vertically – requires 5 MOA to be seen properly). That is the basis of Snellen's chart according to which 'normal' visual acuity is defined 20/20 feet, 6/6 meter (when visual acuity is measured by ophthalmologists they place the Snellen chart at 20 feet or 6 meters), 1.0 decimal"*

If someone needs to have the standard optotype placed nearer to his/her eyes to decipher it correctly the resulting visual acuity would be a figure below 20 /20, e.g. 10/20 = decimal 0,5. For humans with better eyesight the value would change the other way round.

Again Reference.com: *"In humans, the maximum acuity of a healthy, emmetropic eye (and even ammetropic eyes with correctors) is approximately 20/16 (decimal: 1,25) to 20/12 (decimal: 1,67), so it is inaccurate to refer to 20/20 visual acuity 'perfect' vision. 20/20 is the visual acuity needed to discriminate two points separated by 1 MOA. The significance of the 20/20 standard can best be thought of as the lower limit of normal or as a screening cutoff. When used as a screening test subjects that reach this level need no further investigation, even though the average visual acuity of healthy eyes is 20/16 to 20/12."*

1.1.2 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 requires:

"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."

1.1.3 Visual field, contrast and glare sensitivity are more important than visual acuity – but not applicable to VMS

In the Conclusions of the report of the Eyesight Working Group on "New Standards for the Visual Functions of Drivers" to be considered for an Update of Annex III of Directive 91/439/EEC it was stated:

"... it appears that a variety of parameters of visual function is important for safe driving. This holds true particularly for the visual field. Contrast sensitivity and, perhaps, glare sensitivity are also very important. Visual acuity, especially if only mildly impaired, seems less important, but we note the majority of conditions that lead to decreased visual acuity also lead to decreased contrast sensitivity and increased glare sensitivity."

Contrast sensitivity is defined as the ability to distinguish grey letters on a white background and glare sensitivity as the the sensitivity to glaring light sources such as a setting sun or the headlights of approaching cars.

Neither requirements on the visual field, on contrast and glare sensitivity are critical with regard to information displayed on VMS.

Problems due to possible outshining can be avoided by paying regard to the technical performance requirements and the means of evaluation of conformity to those requirements laid down in EN 12966-1 Vertical road signs – Part 1: Variable message signs.

1.1.4 Physiological requirements on the display of information to be discriminated by drivers with visual acuity of 10/20 resp. 0,5

Research done on numerals and letters confirm that 5 MOA viewing angle should be alright for eyes of "normal acuity" = 20/20 = 1,0.

Since mixed upper and lower case information is better readable than such presented in capital letters only (exceptions will be referred to) the 5 MOA need to relate to those lower case letters which are more detailed than others. Examples: e, a.

A viewing angle of 5 MOA allows to discriminate a character (like an "e") of about 15 mm to be seen from a distance of 10 m.

Consequently the smallest graphical detail (e.g. the "eye" = the white space enclosed by the upper part of an "e") is required to be discriminable under a viewing angle of 1 MOA = about 3 mm seen from a distance of 10 m.

For visual acuity 0,5 the figures must be duplicated.

1.1.5 Physiological criteria to determine the dimensions of VMS

No research could be traced with a focus on preferred overall sizes of VMS and none which would suggest that VMS and information on VMS could be smaller than usually provided. It's rather the contrary: research results indicate that drivers are confronted with too small and too coarse information which therefore is difficult to comprehend.

1.1.5.1 Parameters governing the size of traffic information

The required size of traffic information depends, first of all, on viewing duration.

The more complex the information, the longer it takes drivers to absorb and interprete the information.

Complex information consists of several information elements/units. But what is an information element or information unit?

The "Danish technical handbook for VMS" (a PowerPoint presentation, made available to IIID by Kenneth Kjemtrup, Vejstandardafdelingen, Vejdirektoratet, Copenhagen, DK) speaks of *"symbols and city names"* without specifying their maximum number.

The UNITED NATIONS / Economic and Social Council / Economic Commision for Europe [i)] indicates words and symbols, the number of which should be minimized *"e.g. maximum 7"*

Mare Nostrum considers (unspecified) words and symbols and recommends to minimize their number to a maximum of seven. [ii)]

CEDR in action FIVE. Framework for harmonised Implementation of Variable Message Signs in Europe [iii]), referring to the VAMOS 'White Book', speaks of words with *"accompanying pictograms or not"*, giving the impression that the purpose of the latter is of a dispensible nature which can be left uncounted.
In particular it states that *"the number of words (or information units) in one text message (accompanying pictograms or not) should be limited to 7"* and adds: *"Preferably one message should not contain more than four (unambiguous) words."*

To TROPIC [iv)] in its Final Report, 3.1.5.1 "Information Overload", information elements/units are of textual nature, called *"text information units"*. When traffic is travelling at 100 km/h, their recommended number on one VMS is between three and four. However, to TROPIC, most European motorways have speed limits above 100 km/h. TROPIC therefore does not recommend to display more than four units of information on motorway VMS.
A similar recommendation is to be found in the TROPIC Text and Combined Message Reference Manual [v)] where *"only short messages of up to four units of information"* should be displayed on VMS on roads with speed limits above 110 km/h.

In a study done by Alena Erke, Rolf Hagman and Fridulv Sagberg [vi)] in Norway, text messages (in upper and lower case) containing 4 to 6 information/text elements, 280 mm resp. 9 pixels high, displayed at two VMS, had been investigated. These information/text elements consisted of words and road numbers.

The displayed information was about a closed road section and recommendations for alternative routes. The following statements are taken from the summary and conclusions of the authors:
"Speed measurements showed large speed reductions that can be attributed to the text messages on the VMS."
"The video observations showed that while messages were shown on the VMS there were frequently chain reactions where the braking manoeuvre of one vehicle caused the following vehicles to brake or change lanes. Speed reductions can be indicators of increased attention demands. However, in this study only a proportion of vehicles that reduced speed can be assumed to have done so because of attention demands of the VMS. Many vehicles braked because a vehicle in front braked. It can be assumed that these effects are larger at higher traffic volumes, when the VMS are most likely to be used in order to improve traffic performance."

What is interesting in this study is the fact that where the tests had been done there was a speed limit of 80 km/h. Drivers who drove at a speed of 91,4 km/h (the fastest recorded speed - which is not really fast for motorways but significantly high considering the mentioned speed limit) slowed down to 88,7 km/h.

Disregarding the problem of native language to foreign drivers, the effective presentation of information depends on a mix of its size (touched below and dealt with in “2.1.5.6 Size of symbols/pictograms on VMS as a multiple of corresponding lines of text” and “2.4 Proposal of a European guideline for content structure on VMS”), the resolution and discriminability of its smallest graphical detail (dealt with in “1.3.2 Resolution of the displayed information” and “2.3.1 Determining the absolute size of the “Tern” versions”), the familiarity with the displayed content (dealt with in “1.2 Cognitive requirements with regard to understanding”), the complexity of the information, which relates to the number of employed informations elements, and the viewing duration, which depends on driving speed.

Resolution is crucial and governs discriminability. However, drivers move and experience resolution in dependence of their varying distance to the VMS. At some point the resolution of the information might be optimal, thereafter it’s getting coarser and coarser. With altogether 9 pixels in the vertical dimension, a not atypical situation, there is no chance for easy reading. Text displayed that way might even strain the eyes of drivers in parked vehicles.

When it comes to complexity of the displayed information and viewing duration, the Danish technical handbook for VMS provides the following basic formula:

$$t = 2 + n/3 \text{ seconds}$$

where *t* is the necessary reading time and
n is the number of standard information elements on the sign.

It becomes clear: Driving speed is an important component. The faster one drives, the longer the required distance from where the displayed information must be discriminable.

Based on insights gained from the results of the CST a maximum number of 4 information elements may be assumed. This is in harmony with the above mentioned TROPIC Final Report.

However, whilst the authors of the TROPIC Final Report investigated verbal information units, the Danish technical handbook for VMS considers symbols and city names.

As we know: verbal information units are language dependent. Therefore drivers, unfamiliar with the language used on a given VMS will miss out on such information.
Symbols are language independent. However, not every pictogram that pretends to be a symbol is clearly understood by foreign and local drivers alike.

This deliverable solves the problem by reducing permissible verbal information to “Europeanisms” and by differentiating symbols according to their cognitive value and visual complexity. This is the underlying reasoning which enables the authors of D 2.3 to escape the obsolete notion “a word is a word and a symbol is a symbol and both are equal information units”. By weighing and classifying information units it becomes possible to compose - within defined limits - messages, which do not overburden motorists. See: “2.1.5.5 The classes of information elements as defined for their use on VMS”.

According to the Danish formula, 4 information elements require a necessary viewing time of 3,33 seconds.

Once the time needed for correct interpretation of information displayed on VMS is known, the distance from which drivers must be able to comprehend the displayed information can be calculated. It depends on the speed of the moving vehicle. The “Danish technical handbook for VMS” indicates:

$$D = a + (V \times t)$$

D is the maximum reading distance
a is the distance where reading must stop
V is the driving speed in meters per second
t is the reading time in seconds.

Reading must stop in the point of disappearance of the overhead VMS display, which is when the VMS rises 15° above the normal direction of the central line of vision of the driver.

The central line of vision of the driver has been determined to be 1,1 m above the road surface and the bottom edge of the VMS 5,0 m above the road surface.
The resulting dimension of a = 14,55 m.

Considering the necessary reading time of 3,33 sec. and an assumed driving speed of 100 km/h (most VMS are positioned on motorways with an analogue speed restriction) D has been calculated to be 107,06 m.

The resulting x-height: seen under a viewing angle of 5 MOA (appropriate for visual acuity 20/20 resp. 1,0) is 160,59, which makes roughly 321 mm if doubled for 0,5 visual acuity.

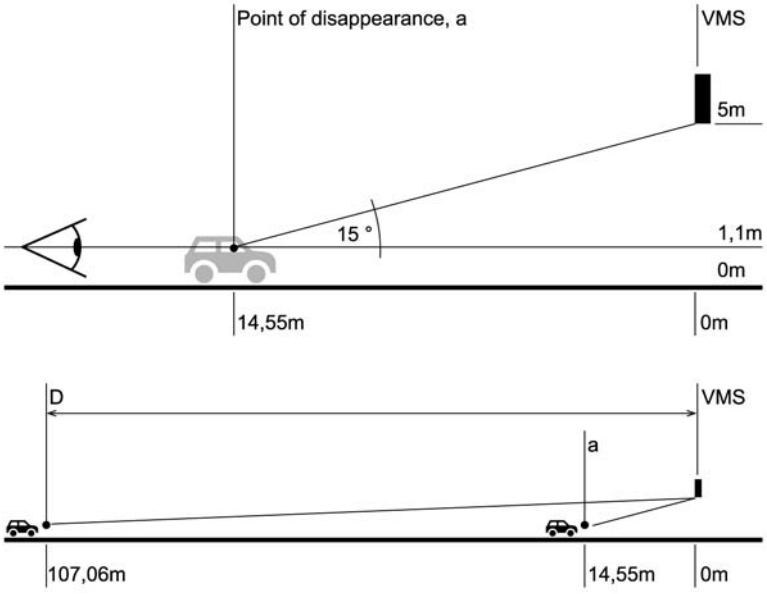

Figure 3: Viewing distance

1.2 Cognitive requirements with regard to understanding

1.2.1 Symbols/Pictograms

Underlying Activity: A2.2 Pictograms substituting verbal messages on VMS (Leader: IIID)

To substitute language dependent verbal information by readily understandable symbols/pictograms a content list of all requested meanings/message elements has been compiled. In case a meaning/message element is shown as a symbol/pictogram it is also called a “referent”. A referent is defined as the “subject represented by a graphical symbol” (ISO 7001:1990 “Public information symbols”), as an “idea or object that the graphical symbol is intended to represent” (ISO 9186:2001

"Test methods for judged comprehensibility and for comprehension") or, in short, "what a symbol/pictogram stands for".

There never was a doubt that the pictograms substituting verbal messages should have the quality of "public information symbols".

"Pictogram" (correct: "pictograph") per definition is a *"visually perceptible figure referring to a 'real object' by resemblance"* [vii]) which attains the quality of a symbol if considered to be backed by a convention. A living convention may be assumed if test results reveal that a visually perceptible figure evokes high enough correct associations in viewers.

In this respect ISO 9186:2001 "Test methods for judged comprehensibility and for comprehension" is the vehicle applied by Consortium partner Danube University Krems in the service of Activity A2.2. Symbols/pictograms attaining a score of 66% correct answers, which is the benchmark for standardization as public information symbols, may also be considered as candidates for use on VMS.

For the given purpose not only "visually perceptible figures referring to a 'real object' by *resemblance*" are considered as pictograms to substitute/optimize (verbal) messages for the TERN. All sorts of visual images are eligible provided they allow for good enough associations of drivers to the denoted referents.

Notwithstanding the above definition further on all pictograms are labeled "symbols/pictograms". The habit of the Vienna Convention to use the word "symbol" for pictograms, which are part of a traffic sign, has contributed to this decision.

Only a few referents regulated by the Vienna Convention have been investigated.

Being the common denominator of traffic legislation in all European member states it was basically assumed that all signs and symbols/pictograms to be used in traffic signs regulated by the Vienna Convention would qualify for undisputed inclusion into the set of symbols/pictograms for use on the TERN. Nevertheless, based on noteworthy arguments, a few Vienna Convention symbols have been checked for correct understanding. Diagnosed shortcomings may stimulate the United Nations to consider amendments of the currently valid Convention.

Irrespective of test results, (nearly) all Vienna Convention signs proposed for use on VMS have been taken on and graphically adjusted to comply with the criteria of discriminability/legibility and the style of rendering supporting these criteria.

1.2.1.1 Symbol/pictogram message elements <u>not</u> regulated by the Vienna Convention

Work started with a list of referents (2nd draft 2005-08-18) compiled from the below mentioned documents. Its structure has been adopted of doc. CEDR - Conference of European Directors of Roads: action FIVE. Framework for harmonised Implementation of Variable Message Signs in Europe. 2004.

List of related/consulted documents

BUREAU MIJKSENAAR: referents for VMS with additional suggestions of IIID. Unpublished / integrated in the below table
Abbreviated in header of table: **MIJKSENAAR**

CEDR - Conference of European Directors of Roads: action FIVE. Framework for harmonised Implementation of Variable Message Signs in Europe, 2004.
Document name: 040318-FIVE_framework_v3-6.pdf
Abbreviated in header of table: **CEDR**

EUROPEAN STANDARD EN 12966-1: Vertical road signs – Part 1: Variable message signs. Submitted to the Formal Vote May 2004.
Document name: EN_12966-1_25052004._E_.pdf

LUOMA, Juha & RÄMÄ, Pirkko. Comprehension of pictograms for variable message signs. VTT Building and Transport, Finland. In: Tec, February 2001.
Document name: Luoma.pdf
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TROPIC - TRaffic OPtimisation by the Intergation of information and Control, Trial Phase: Text and Combined Message Reference Manual. 1998.
Document name: d053i.pdf

UNITED NATIONS. Economic and Social Council. Economic Commision for Europe. Inland Transport Committee, Working Party on Road Traffic Safety, Forty-sixth session, 14-16 March 2005, agenda item 5 (j): Variable Message Signs. 2005.
Document name: TRANS-WP1-2005-06e.pdf
Abbreviated in header of table: **UN**.

Country abbreviations: **D** Germany, **F** France, **NL** The Netherlands

*) The TROPIC Text and Combined Message Reference Manual indicates a need for the message concerned by given country(s).

M E S S A G E T Y P E / **Purpose** / Content	MIJK-SENAAR	UN	LUOMA	CEDR	WHITE BOOK	TROPIC
R E G U L A T O R Y						
Lane allocation						
Lane control signals		*		*		
Available/free lane (TROPIC: green arrow pointing downwards)				*		
Lane closure (TROPIC: red crosses)	*	*		*		F*
Lane change/merge (TROPIC: white/yellow diagonal arrows; flashing or with separate flashers)				*		
Carriageway guidance						
Closure (ahead): - Road - Lane - Pass - Tunnel - Bridge - xxx Exit	*	*		*		F*

M E S S A G E T Y P E / **Purpose** / Content	MIJK-SENAAR	UN	LUOMA	CEDR	WHITE BOOK	TROPIC
Diversion						
Rerouting (Mandatory exit)	*	*		*	*	*
Take next exit	*			*	*	
Speed control						
Speed funneling (chain of speed indications to drop the speed gradually on road section or near junction)				*		
Speed harmonisation (road section) ?				*		
Regulations						
Restrictions of use / Dedicated lanes for target groups: - buses, - lorries, - carpools / HOV (High Occupancy Vehicles) - Emergency vehicles	*			*		
Use / Do not use hard shoulder		*		*		
Clearance xx xx km	*					
Temporary prohibitions e.g. dangerous goods				*		
End of (temporary) restrictions/limitations				*		
D A N G E R W A R N I N G						
Immediate warning for weather conditions **(close ahead)**						
Fog	*	*	*	*	*	D*,NL*
Freezing fog						F*
Snow / Ice	*	*	*	*	*	
High winds				*		
Lane temperature	*					
Immediate warning for traffic status (close ahead)						
Congestion/Queue	*		*	*	*	*
Accident	*	*	*	*	*	D*
Vehicle broken down				*		
Oncoming vehicle/traffic	*	*	*	*		
Pedestrians/persons on the road		*		*		
Slow moving vehicle ahead		*				
I N F O R M A T I V E						
Advance Warning						
Traffic status (further ahead or on another motorway section)				*		
Weather cond. (further ahead)				*		
Speed camera / RADAR (further ahead)	*					
(implicit) Advice						
Suggested route/itinerary (rerouteing)				*		
Suggested/optional exit				*		
Last exit before toll, tunnel, etc.	*					
Network performance after a decision point (travel times or extent of congestion on more than one route after an on-coming junction)				*		
Recommended (max.) speed				*)		
Driver comfort						
Temporary available free lane ahead: - tidal flow lane, - emergency stopping lane				*		

M E S S A G E T Y P E / **Purpose** / Content	MIJK-SENAAR	UN	LUOMA	CEDR	WHITE BOOK	TROPIC
-						
Services: - parking facilities, - P+R, - public transport, - fairs, - sport events, - ferries				*		
Parking space available	*			*)	*	
Motorway section performance (travel time to next exits)				*		
Miscellaneous						
Control point						
Direction						NL*
Follow						NL*
Reachable						NL*
Fines doubled in all work zones	*					
Switch off engine if congestion persits				*		
Switch on hazard warning lights				*		

Table 4: First list of referents/meanings

Furthermore, with the assistance of ASFINAG, ASECAP members and, with the support of the BMVIT Austrian Federal Ministry for Transport, Innovation and Technology, all other Transport Ministries of EU member states had been invited to propose additionally needed messages. The resulting definite list of messages became the basis of the documented outcomes.

The value of visualizing many of the listed referents for display on VMS is based on a statement taken from the TROPIC Text and Combined Message Reference Manual [viii]: *"It was found that mandatory speed limits were generally more effective when additional information justifying the reason for the restriction was given."* The same was thought to be valid for other indicative information displayed together with prohibitory, restrictive and mandatory signs.

Subsequently the involved consortium members started to collect already existing symbols/ pictograms. A compilation which included the newly designed symbols/pictograms was evaluated at a Technical Meeting (Wien/Vienna, 7/8.10.2005). For the definite collection see Annex 1.

Over the full development period of the project altogether 2977 (documented) symbols/pictograms were designed and tested according to a two-stage test procedure defined by ISO 9186:2001 "Test methods for judged comprehensibility and for comprehension".

The Comprehensibility Judgement Test (CJT, Annex 4) was conducted in the Czech Republic, in Hungary, Spain and Austria by CDV, KTI, INTRAS Road Safety & Traffic Institute (Universitat de València) and DUK (coordinator).

ISO 9186 recommends: "If there are four or more variants for a particular referent, conduct a comprehensibility judgement test in at least two countries in order to determine the variants judged highest on comprehensibility."

Respondents are to be told to judge the comprehensibility of each variant by following this instruction: "Each symbol is supposed to mean (provide the intended meaning). Please write the percentage of the population that you expect would understand this meaning."

Based on insights, that the most comprehensible variant will be one of those judged most comprehensible, variants with low potential were sorted out at an early stage. A few variants with highest scores were considered fit for use without further testing.

The subsequent Comprehension Test (CT, Annex 5) was conducted in the Czech Republic, in Hungary and in Austria.

According to ISO 9186 a set of test sheets for each referent had to be made, whereas each sheet showed one of the graphical symbol variants to be tested with a line below for the subject's response. Respondents were instructed to write down their answer to the question: "What do you think this symbol means?"

To determine the most comprehensible variant the combined data from all participating countries were considered. "The variant with the highest overall score is the most comprehensible variant."

Based on the test results a number of symbols/pictograms had been found good enough for being recommended for use, others were modified for improvement. To evaluate the modifications a previously unintended 2nd Comprehension Test (2ndCT, Annex 6) was conducted in the Czech Republic and in Austria.

Animated versions of specific symbols/pictograms were elaborated and submitted to the subsequent test which was a Comprehension Test on Animated Pictograms (CAT, Annex 7), conducted in the Czech Republic and in Austria.

Whilst the preceding tests were paper & pencil tests, the images to be interpreted in the CAT were presented screen projection.

Insights gained from this test are dealt with in the next chapter: "1.2.1.2 Developing and evaluating animated symbols/pictograms"

Finally symbols/pictograms, Vienna Convention traffic signs and textual information were combined and were subdued a (VMS) Content Structure Test (CST, Annex 10).

The results of this test are dealt with under "1.2.3 Cognitive requirements on content structure"

1.2.1.2 Developing and evaluating animated symbols/pictograms

With a focus on static information the optimization process of symbols/pictograms could have been concluded after the Comprehension Test (CT). Freely programmable LED based VMS ("graphical VMS"), however, pose a challenge to designers due to their capability to also show information in animated mode.

The team responsible for conducting the tasks of WP2 investigated the potential of animated information for faster recognition and better understanding. Such certainly could not be expected of symbols/pictograms for stationary, self-contained referents/meanings. However, it was felt, that referents/meanings indicating objects/concepts in motion, like "wrong way driver" and such referring to an activity like "switch off engine if congestion persists" might profit.

Another aspect which had to be investigated was the notion of pulsating/flashing signals, which are traditionally used to raise attention.

Danger warning signs for matrix displays

The design of danger warning signs is governed by conflicting needs:

Need 1:
- to comply with the Vienna Convention requesting symbols/pictograms to be shown within red bordered triangles.

Reducing the size of a symbol/pictogram to make it fit into the small area within a red bordered triangle means reducing its conspicuity and discriminability.

Need 2:
- to display the danger warning symbols/pictograms as big as possible to increase conspicuity and discriminability.

If the usually square backgrounds provided for symbols/pictograms is used to show symbols/pictograms full size there is no space left for a red bordered triangle.

It became clear that the design of danger warning signs for VMS would need to bypass Vienna Convention requirements by finding solutions beyond the realm of traditional sign making. Such have not really investigated yet as can be seen from the comments given at the European VMS Platform Düsseldorf Workshop in June 2003 [ix]. At that time, flashing signs/messages/VMS were only used in England, Scotland, Wales, France and Italy. Comments indicated the use of flashing signs to attract driver's attention on more severe situations, for very unusual events, emergencies, and when an immediate action of drivers is needed. However, no research evidence to show benefits or drawbacks was reported.

Investigating danger warning elements

To investigate the effectiveness of potential danger warning elements for use on VMS a number of possibilities were examined in a special test: Evaluation of Warning Elements for Matrix Displays (WET, Annex 8) conducted in addition to the proposed ISO test procedure.

Being aware of the possibility to enhance the message to be conveyed by traffic signs by adding one single amber flashing light or two amber lights flashing alternately [x] a third possibility, namely amber flashing lights positioned at every corner of a rectangular information carrier with a danger warning sign on it was considered. Warnings of this kind are used e.g. in Great Britain together with indications of advised temporary maximum speeds, changed directions, or risk of fog ahead. [xi]
Moreover a possibility, which can be realized only on VMS, namely a danger specific symbol with superimposed flashing warning element was conceived.

Finally the following danger warning elements were tested:

- Pictogram/symbol within a warning triangle (traditional display)
- Symbol with two alternately flashing amber lights above
- Symbol surrounded with four simultaneously flashing amber lights, one at each corner
- Red warning triangle presented left of symbol
- Flashing smaller red triangle presented at right edge of matrix
- Symbol with superimposed full-size flashing warning triangle.

The last version demonstrated: what on static signs is displayed inseparably (symbol/pictogram with surrounding triangle) can be separated and shown in a way that allows for a symbol displayed in maximum size and a temporarily superimposed categorizing element, e.g. a danger warning element.

Results of the WET have proved that flashing lights are somehow less effective than a triangle, shown in flashing mode, superimposed a symbol/pictogram.

Nevertheless, in the "Discussion of the findings" C. Brugger, who had conceived and conducted the test on behalf of Danube University Krems, states: *"Based on rating results, the forms of displayed warning elements show only minor differences. Compared to these differences, the individual pictogram variants tested had a much stronger influence on the ratings concerning the warning of danger."*

C. Brugger also said: *"Furthermore the effect of using flashing warning elements on the amount of attention given to all other static warning signs has to be observed closely. The possibility of creating two categories of warning signs and its consequences as pointed out by Lucas [xii] should not be ignored."*

Principles for animation

Consequently two types of animated symbols/pictograms were conceived, designed and evaluated:

- Symbols/pictograms with a superimposed categorizing sign (indicating danger warning or "out of order") in flashing mode

- Symbols/pictograms WITH ANIMATED CONTENT, WITH OR WITHOUT a superimposed flashing categorizing sign.

The results of the Comprehension Test on Animated Pictograms (CAT) indicate:

Improvements in comprehension of a few symbols/pictograms were attained compared with the results of the (paper and pencil) Comprehension Test by which the same information - presented static - had been evaluated.

Noticable improvements of comprehension can be reported of the following referents/meanings:

- Wrong way driver, Referent iD 2.3.4 (ANIMATED CONTENT: combination of danger warning triangle with animated oncoming passenger car)
- Vehicle broken down, Referent iD 2.3.3 (static content with superimposed flashing triangle)
- Switch off engine if congestion persists, Referent iD 4.5 (animated content, no triangle).

In comparison with the static symbol/pictogram the one with animated content indicating “Wrong way driver” improved by 100%: Score 20,0 (CT), 40,55 (CAT). In the Content Structure Test (CST) it improved again to 59,8. According to ISO 9186 priniples (which propose a benchmark of 66%), it nevertheless failed to score high enough to allow for an unrestricted recommendation for use – this symbol/pictogram needs to be promoted widely in addition.

“Vehicle broken down”: the improvement of this symbol/pictogram from score 44,5 (CT) to 73,31 (2ndCT and CAT) to 86,2 (CST) can possibly be also attributed to “action lines” (indicating a boiling engine), which had been added on the advice of an expert in the field of comics which lead contractor IIID had invited to participate in one of the Technical Meetings of WP2.

“Switch off engine if congestion persists”: the animation of this symbol/pictogram when tested in a laboratory situation yielded unsatisfactory results: Score 50,75 (CAT). However, when shown in context, its performance increased considerably: Score 77,2 (CST). Thus, the animated symbol/pictogram is recommended for use: drivers in queuing vehicles will have plenty of time to estimate the meaning of the symbol/pictogram and to draw the right conclusions from its meaning.

The following conclusions have been drawn:

Animated content heightens alertness. In rare cases it can facilitate the correct comprehension of symbols/pictograms. More often animation may cause irritations and distraction from other information of possibly higher importance.

The use of animated symbols/pictograms therefore cannot be generally supported. Only in cases, when test results hit the defined benchmark and show a significant improvement over static versions (also when presented in context with other related information), animated symbols/pictograms instead of static ones may be considered for use.

Static symbols/pictograms, however, with a superimposed categorizing sign in flashing mode (indicating danger warning or “out of order”) square the circle by allowing for both the indicated higher-ranking category of meaning and the symbols/pictograms to be shown full size.

1.2.2 Verbal information

Underlying Activity: A2.3 Key meanings and bilingual messages in VMS (Leader: INFOTERM)

1.2.2.1 Key meanings

Notwithstanding the prime purpose of the project to substitute verbal messages through well understood symbols/pictograms it was expected that it would not be possible to design effective visualizations of key meanings with underlying concepts of an all too general or abstract nature.

Consequently A2.3 was based on the premise: Verbal representations (in the form of terms, facts, statements, indications, requests, demands etc.) can occur in combination with or in addition to or independently from traffic signs.

INFOTERM took on the task to do an investigation into language based information, covering both full referents and information elements needed to complement symbol/pictogram messages.

A basic list of verbal messages, which presumably never will be substituted by symbols/pictograms, help to narrow down the task:

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 in one unabbreviated term in lower case letters only [xiii)]
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).

Table 5: Basic list of verbal messages

Like abbreviations of SI units other information can also be communicated through text:
INFOTERM in Activity A2.3 has developed a methodology of “Key meanings and bilingual messages in VMS” (Annex 12) and investigated the comprehensibility of selected verbal information via an enquiry done across Europe (Annex 13). It calls the verified verbal expressions “Europeanisms”. Subsequently 35 “keywords” have been suggested to be used to indicate referents/meanings which could occur in traffic relevant communication. Some of these “keywords” could equally well be perceived as symbols/pictograms.
See “2.2.1 Europeanisms”

1.2.2.2 Discriminability requirements to safeguard easy reading of a typeface for VMS and static applications

Part of the work which had to be undertaken was the development of a highway alphabet, suitable for both VMS and static applications. The new typeface “Tern” was requested to be designed in Latin and Greek fonts for various sizes as required by the envisaged content structure, optimized for freely programmable VMS. Moreover, to facilitate comparison tests with the fonts currently used on many LED based VMS and to allow for their immediate substitution, if deemed appropriate, the additional need of a 24 pixel sized typeface was established.

Once typefaces as used on traffic signs in various European countries had been collected it became evident, that those ones which were designed for traditional ways of reproduction like printing and plotting would not be of value for the task ahead. Consequently IIID decided to develop and test the new universal highway alphabet only in comparison to those typefaces also designed for the display on VMS (see Figure 8), which are:

- DIN (Germany)
- Transport (Great Britain)
- RWS (The Netherlands)

The test that has been conceived to evaluate the legibility of the Latin typefaces (under normal and simulated impaired visibility conditions) was developed and conducted by DUK – Danube University Krems – in close collaboration with IIID.

The outcome of the test indicated the superior discriminability of the British “Transport” due to its wide characters.

However, neither the Transport, the DIN and RWS meet the requirements of structured information with regard to sizes and the official EU languages as defined in this project. With regard to legibility the DIN and RWS also compare unfavourably with the newly designed font, called “Tern” (for “Trans-European Road Network”).

Special attention had to be given to clearly analyse those letters and numerals which are known for being easily confused. The results were needed to understand how the discriminability of critical letters and numerals of the Tern could be further improved which was achieved by redesigning the respective characters.

Normal and impaired visibility were simulated through PC screen display of the characters to be tested in conformity with visual acuity of 1,0, 0,65 and 0,5.

To facilitate comparisons the typefaces had been tested

- with same overall height (bottom of descender to top of capital letter): for normal display (e.g. for printed or plotted applications)
- with same height of lower case letters (descenders excluded) = “x-height”: for bitmap displays (e.g. for VMS applications).

Impaired Visibility Typeface Test (IVT) Report: Annex 11

The test results enabled Prof. Spiekermann to improve the “Tern” for optimal legibility. A vector based version and several pixelled variants of the Latin and Greek alphabets were designed. They are now available in OTF format:

- Tern – suitable for any size of traditional reproduction (see Figure 9)
- TernVMSonefour – bitmap version for body height = 14 pixels (see Figure 10)
- TernVMStwozero – bitmap version for body height = 20 pixels (see Figure 11)
- TernVMStwofour – bitmap version for body height = 24 pixels (see Figure 13)
- TernVMSthreeone – bitmap version for body height = 31 pixels. (see Figure 12)

Due to budget limitations it was not possible to once more test the final version(s) of the typeface – after improving its design – in comparison to its draft version and the other digital highway alphabets. It might pay off to make good for this at a later stage should arguments be needed to support the attained quality of the “Tern” with further statistical data.

1.2.3 Cognitive requirements on content structure

For testing the content structure of information to be displayed on VMS, the information had to be simulated as if it were real. Selected pictogram/pictogram and pictogram/text combinations were shown, popping up far away (very small, equalling the size of lower case letters, descenders excluded, seen under 5 MOA), growing bigger and bigger and getting out of sight overhead in the “point of disappearance”. The time allocated for the test was based on the assumption that the addressees of the information would drive at a speed of 100 km/h.

Whenever it was thought appropriate to combine symbols/pictograms with place names the latter were fictitious. Real place names would have provided an advantage to subjects familiar with them.

Subjects of the 3 test series had to imagine being on a journey

- to a distant capital city Mels, reachable via “Sonbor” and “Galno” respectively
- for a skiing holiday to a place called “Sonbor” with a stop at “Galno”.
- to a Champions League football match via “Galno” and “Mels”.

The purpose of the CST Content Structure Test was manyfold:
To get insights on

- the maximum number of permissible information elements to be displayed the performance of newly designed symbols/pictograms, in particular animated ones, shown in context with Vienna Convention symbols
- the most appropriate positioning of direction dependent symbols/pictograms
- the positioning of length/distance indications on the side of a symbol/pictogram vs. its display below the symbol/pictogram
- the validity of the assumption of a standard letter size allowing for three lines of text besides of a symbol/pictogram in comparison with place names shown in reduced size resulting in a maximum of four lines of text
- the possibility of displaying indications of length in two lines (staggered) vs. the traditional way in just one line.

As all messages contained pixelled information, the projected simulations were impaired due to the fact that the computing infrastructure’ display capabilities was challenged to its limits.

The first test-examples of the simulations showed combinations of only two pieces of information. During the test run the displayed information was increased in complexity. One of the most complex displays showed a combination of four concepts: Road works, speed restriction, radar (speed camera), fines doubled.

Some other complex messages contained place names which were of no relevance to the test persons. The relevant information elements, however, never went beyond a maximum of four.

Information was displayed centered. On two comparable occasions it was aligned left.

Two examples showed lane-related information (different speed limits for each of the lanes). The assumption was that this might occur on motorways of three (or more) lanes, especially in situations with a separate exit lane.

Test report: see Annex 10

1.3 Technical requirements with regard to the presentation of the information

1.3.1 Contrast reversion

Paragraph 1. bis of Article 8 of Amendment 1 of the Vienna Convention (entered into force on 30 November 1995) allows to present information on VMS with converted contrast. Thus dark-coloured signs or symbols may appear in a light colour, light-coloured backgrounds then being replaced by dark backgrounds. The referred to Amendment requests that the red colour of the symbol of a sign and its border shall not be changed.

1.3.2 Resolution of the displayed information

As explained in 2.3.1, the resolution of VMS must allow for the discriminability of the smallest graphical detail of the characters and symbols/pictograms to be displayed.

Considering that the smallest graphical detail is required to be discriminable by eyes of “normal” visual acuity under a viewing angle of 1 MOA = about 3 mm seen from a distance of 10 m, the 3 mm becomes 4,11 mm for eyes of visual acuity 0,73.

With regard to the distance of 107,06 m from where the VMS information must be perceivable and comprehensible (see “2.3.1 Determining the absolute size of the “Tern” versions”), the smallest graphical detail for eyes of visual acuity 0,73 needs to be about 44 mm in size.

This figure translates to multiples of 22 mm as the basic increments of the grid underlying the positioning of the LEDs on VMS.

Increments of 22 mm are close to many newly manufactured VMS. 22 mm also seems to be a good compromise between other practices which range from 15 mm up to 25, 30 and even 60 mm.

Grid increments of 22 mm also compare favourably with a daily life experience:
Considering a viewing distance of 14,55 m (distance between the point of disappearance and the VMS) set in relation to the viewing distance for reading a newspaper, the resulting resolution turns out to be 20 lines/cm = 51 lines/inch.
The resolution of pictures on low grade newsprint of 22 lines/cm = 55 lines/inch, common at the time after the second world war, corresponds with a viewing distance of 14,55 m before the point of disappearance. The further away the position of the vehicle, the finer the resolution.

1.3.3 Colour

RGB based, freely programmable VMS may display up to 16.777.216 colours of which discrete combinations of hue, saturation, and lightness can be specified. By adjusting the colours defined in the Vienna Convention minor deviations may occur but will not cause concerns.

The following colours are needed on VMS:

- white
- yellow
- red
- green
- blue
- amber (for the rerouting/“delestage” arrow).

Technical requirements are laid down in para. 9.3.5 Colour of EN 12966-1 Vertical road signs—Part 1: Variable message signs.

2 Results

The elaborated symbols/pictograms, together with Vienna Convention traffic signs, suitable for application on VMS, static signs and in-car navigation displays meet all documented requirements. So does the complementing Latin and Greek “Tern” alphabet versions which have already been used for text elements in the renderings of the newly designed symbols/pictograms and the modified Vienna Convention traffic signs required on motorways.

Apart from verbal message elements like place names, specific words and abbreviations have been identified as “Europeanisms”, suitable for communication across language barrieres.

2.1 Proposal of a European guideline on pictograms for static and variable message signs

A few referents of the list of “1.2.1.1 Symbol/pictogram message elements not regulated by the Vienna Convention” were abandoned, due to their unspecific or all too general meanings (as with “Traffic status”), their cognitive closeness to and therefore likelihood of confusions with other referents (as with ”High probability of accidents” which gets easily confused with “Accident has happened”), the possibility to employ other means to communicate the requested message (as with “Use hard shoulder”), or the difficulty to correctly communicate concrete information within an indicated category (as with “Traffic status”).

A number of safety enhancing and/or eco-friendly referents, deemed to be of relevance, have been added.

All symbols/pictograms were designed in a vector graphics based format for general use (e.g. for printing and plotting).

Of those symbols/pictograms which are needed for VMS, a bitmap version (64 pixels high) has been elaborated. For occasional use of some specific symbols/pictograms a smaller size (46 pixels high) has also been made available.

In a few cases some more sizes, harmonized with VMS letter sizes, have been added.

How the symbol/pictogram sizes have been determined is explained in “2.1.5.6 Size of symbols/pictograms on VMS as a multiple of corresponding lines of text” and “2.4 Proposal of a European guideline for content structure on VMS”.

Vienna Convention symbols defined for use on VMS have been adapted on an underlying square background. Square backgrounds have also been used for most of the other symbols/pictograms. However, on some occasions it was felt that a rectangular (landscape) background would be more appropriate. The freely programmable concept of full graphical displays allows to mix symbols/pictograms of differing widths much as it allows the proportional display of typographic characters.

2.1.1 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

Table 6: Final list of pictogram referents

2.1.2 Optimizing the combination of background shapes and symbols/pictograms

Symbols/pictograms communicate concrete meanings whilst the geometric shapes of traffic signs determines the category of the meaning which can be mandatory, danger warning or informative.

All mandatory, danger warning, and informative signs for static use are laid down in the Vienna Convention.

The development of warning and informative signs for temporary use – as on VMS – has been defined as one of the prime concerns of IN-SAFETY Activity A2.2.

The conclusions from “1.2.1.2 Developing and evaluating animated symbols/pictograms” show the way to proceed:

“Static symbols/pictograms with a superimposed categorizing sign in flashing mode (indicating danger warning or “out of order/not acessible/not available”) square the circle by allowing for both the indicated higher-ranking category of meaning and the symbols/pictograms to be shown full size.”

Whenever a symbol/pictogram is presented with superimposed triangle or diagonal cross indicating prohibition or “out of order/not acessible/not available” these graphical elements are shown 3 tenths of a second in intervals of 8 tenths of a second. (See Figure 32 and Figure 23)

2.1.3 Design Procedure

Pictograms rendered as vector graphic images, considering principles of pictogram design under special consideration of the requirements governing the clearly discriminable display of the minimum graphical details, while adhering to bitmap design rules, defined by Bureau Mijksenaar (Annex 3). Example: Elk/Reindeer on the road (Referent iD 2.3.8.1), next page.

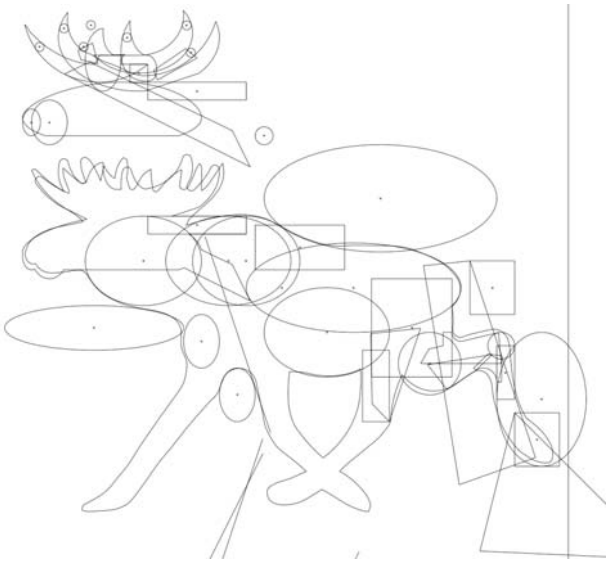


Figure 4: Designing (VMS) pictograms in vectors, by adhering to pixel-requirements/restrictions (1)

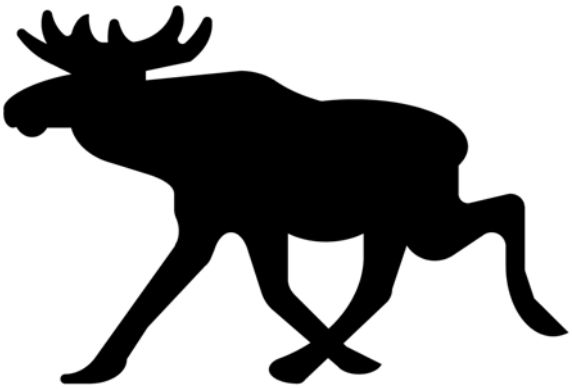


Figure 5: Vector based pictogram for conventional road signage (2)

Figure 6: Converting vector based pictograms to pixels (3)

2.1.4 Tern Symbols- Complete list of symbols/pictograms elaborated in the project

The structure of the table compares with the one of the initially compiled list of referents based on doc. CEDR - Conference of European Directors of Roads: action FIVE. Framework for harmonised Implementation of Variable Message Signs in Europe. 2004.
See "1.2.1.1 Symbol/pictogram message elements not regulated by the Vienna Convention"

Note: A few denotations (names) of referents/meanings, which had turned out to be inappropriate, have been modified.

References to the Vienna Convention, Annex 1 have been added, and so have been class indications, directional dependencies and whether a pictogram is available in animated mode.

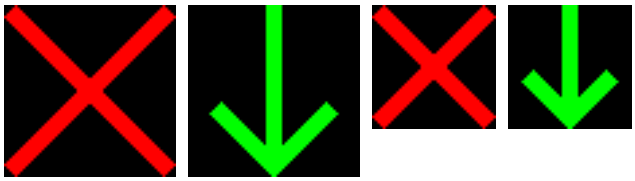
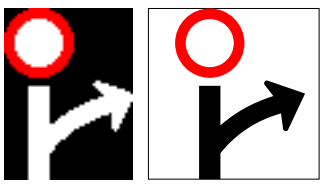
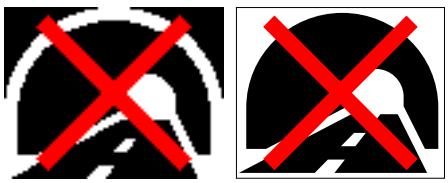
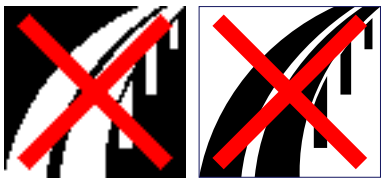
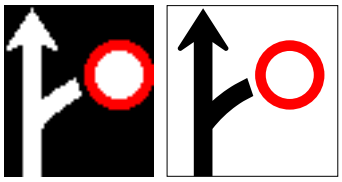
Class indications are explained in chapter "2.1.5.5 The classes of information elements as defined for their use on VMS"

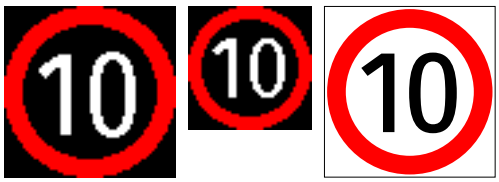
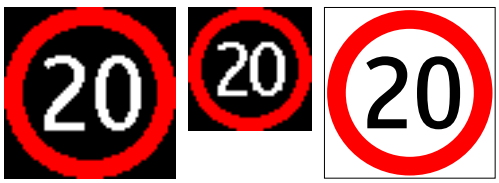
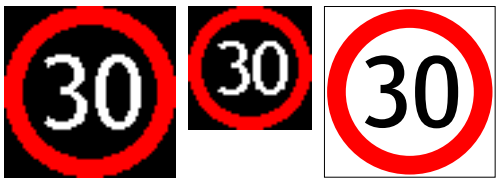
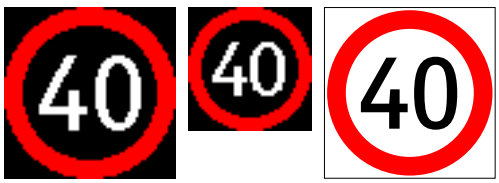
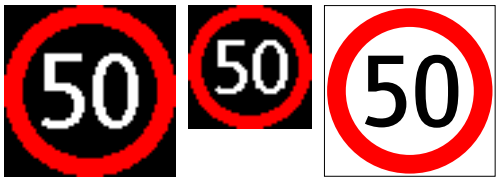
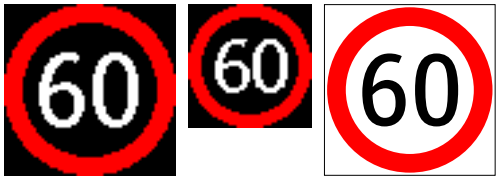
Explanation:

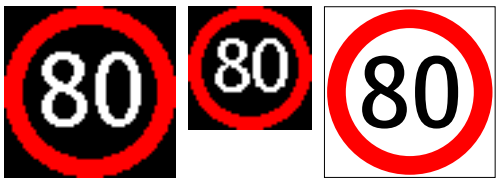
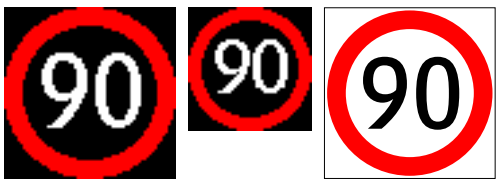
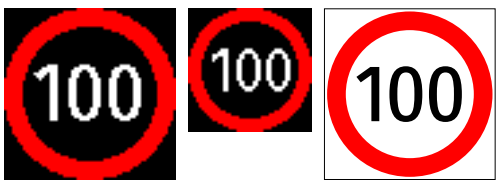
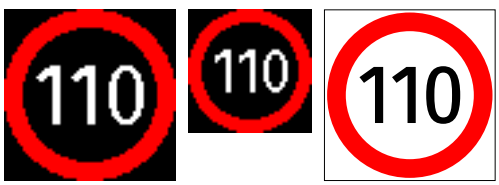
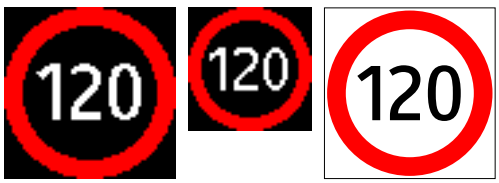
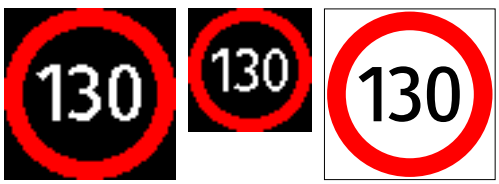
Whenever applicable, both the VMS version (easily indentified white on black and a rugged – pixelled – appearance) of a pictogram/symbol and its counterpart for conventional road signage (sharp edges) will be shown. In several cases, smaller versions of VMS pictograms are available, to allow for applications combined with textual information underneath.

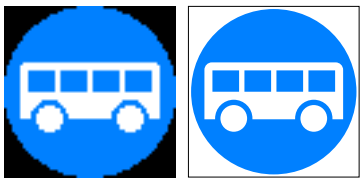
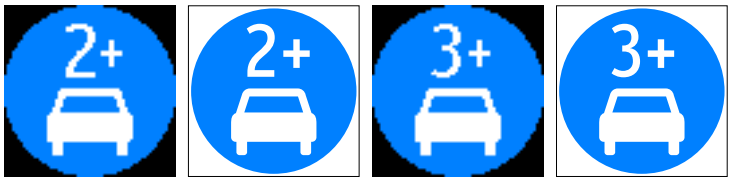
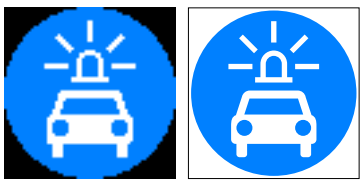
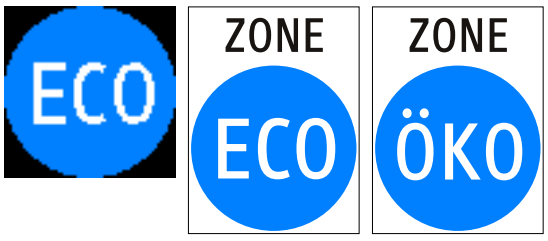
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
Tern Symbol iD number	Pictogram name	Relation to Vienna Convention Symbol(s)	Governs terms of use of the pictogram	whether the VMS pictogram is animated (by superimposition of warning triange, "out of order"-cross or other means	"DD": implied directional dependency of the pictogram

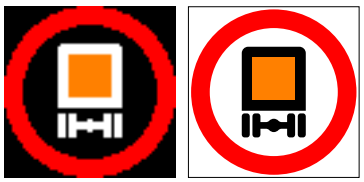
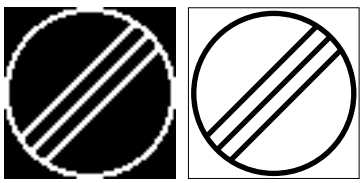
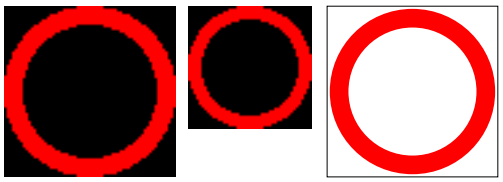
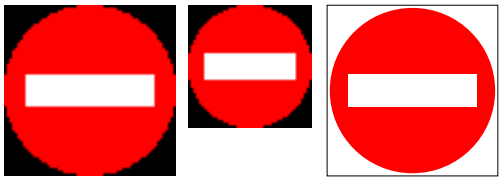
Figure 7: Depiction of elaborated pictograms (following pages)

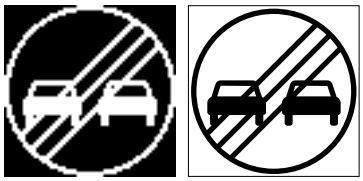
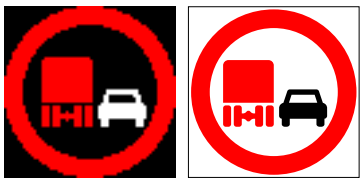
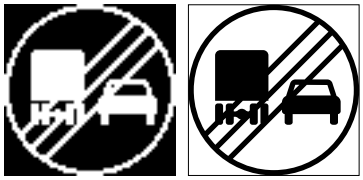
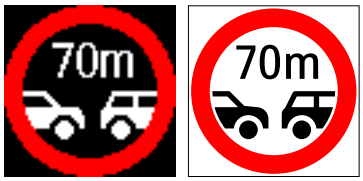
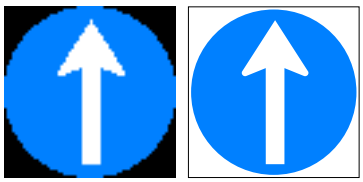
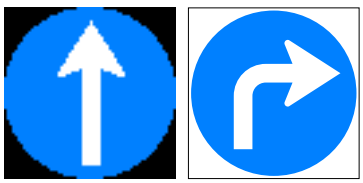
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1	**Regulatory**				
1.1	**Lane Allocations**				
1.1.1	Lane control signals 	—	1	—	—
1.1.2	Lane indication 	*Accord. to E, 4*	1	—	—
	When needed, lane dedicated siganlling can be provided by displaying broken lines in parallel with the road markings on the below motorway.				
1.2	**Carriageway Guidance**				
1.2.1	Closure ahead				
1.2.1.1	Road ahead closed/Take next exit 	—	2	—	—
1.2.1.2	Pass/Mountain road ahead closed 	—	3 –	—	—
1.2.1.3	Tunnel ahead closed 	—	3 –	—	—
1.2.1.4	Bridge ahead closed 	—	3 –	—	DD non-VMS
	DD only for non-VMS display: shown (standard-) symbol applies to straight and/or bridges curved to the right. Bridges bent to the left to be signalled by a turned symbol.				
1.2.1.5	Exit ahead closed 	—	3	—	—

Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1.2.2	Take next exit (= 1.2.1.1)	—	—	—	—
1.2.3	Lane Closure ahead 	G, 12a	1	—	—
1.3	**Speed control**				
1.3.1	Speed funneling Abandoned	—	—	—	—
1.3.2	Speed harmonisation Abandoned	—	—	—	—
1.3.3	Speed limit 10 km/h 	*C, 14*	1	—	—
1.3.4	Speed limit 20 km/h 	*C, 14*	1	—	—
1.3.5	Speed limit 30 km/h 	*C, 14*	1	—	—
1.3.6	Speed limit 40 km/h 	*C, 14*	1	—	—
1.3.7	Speed limit 50 km/h 	*C, 14*	1	—	—
1.3.8	Speed limit 60 km/h 	*C, 14*	1	—	—

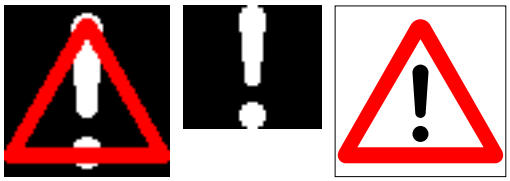
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1.3.9	Speed limit 70 km/h 	*C, 14*	1	—	—
1.3.10	Speed limit 80 km/h 	*C, 14*	1	—	—
1.3.11	Speed limit 90 km/h 	*C, 14*	1	—	—
1.3.12	Speed limit 100 km/h 	*C, 14*	1	—	—
1.3.13	Speed limit 110 km/h 	*C, 14*	1	—	—
1.3.14	Speed limit 120 km/h 	*C, 14*	1	—	—
1.3.15	Speed limit 130 km/h 	*C, 14*	1	—	—

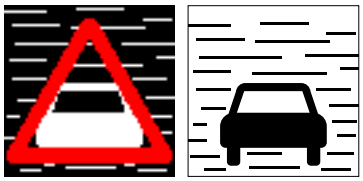
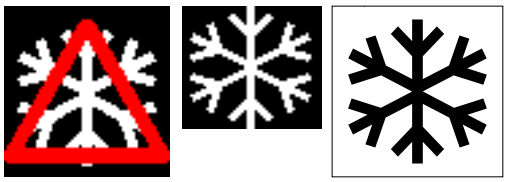
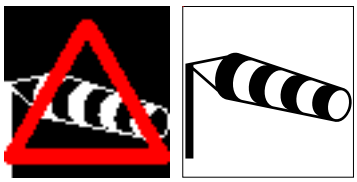
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1.4	**Regulations**				
1.4.1	Regulations of use/Dedicated lanes for target groups				
1.4.1.1	Lane dedicated for busses 	*Acc. to Sec. D*	1	—	—
1.4.1.2	Lane dedicated for lorries 	*Acc. to Sec. D*	1	—	—
1.4.1.3	Car sharing lane; Lane dedicated for HOVs 	*Acc. to Sec. D*	3 –	—	—
1.4.1.4	Lane dedicated for taxis 	*Annex 2, IV, 40c*	1	—	—
1.4.1.5	Lane dedicated for emergency vehicles 	*Acc. to Sec. D*	3 –	—	—
	Emergency vehicles are allowed to approach from a direction opposite to the direction of traffic on motorways. To be considered in further research.				
1.4.2	SMOG/Inversion weather/Environmental zone 	—	3 –	—	—
	Eco could become a Europeanism: GB: ecological, NL: ecologisch, DE: ökologisch, FR: écologique, GR: (oikologikos), PT: ecological, ES: ecológico This sign, accompanied with “Zone” might be used for Environmental Zone regulations, where eg the use of an Euro 4 catalysator is compulsory. Legislation might differ in applying countries which should be harmonized. SMOG, if required, to be displayed below as Vienna Conv. additional panel)				
1.4.3	No lorries at night 	*C, 3e*	1	—	—
	Combined with E, 9b: Suggested amendment of Vienna Convention: use standard time indication as proposed by ISO 8601- : to seperatee hours from minutes, “h” for hour to be omitted				

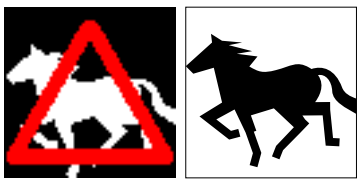
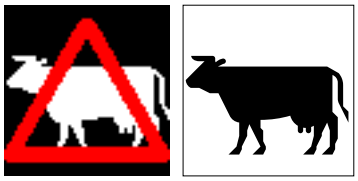
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1.4.4	No vehicles over xx tonnes 	*C, 7*	1	—	—
1.4.5	No entry for vehicles carrying dangerous goods 	*C, 3h*	1	—	—
1.4.6	End of restrictions/limitations 	*C, 17a*	1	—	—
1.4.7	Use/dont use hard sholder (see 1.1.1 Lane control signals)	—	—	—	—
1.4.8	Clearance xx km Unclear/unspecific referent, abandoned	—	—	—	—
1.4.9	No entry for vehicles having a mass exceeding ... tonnes on one axle 	*C, 8*	1	—	—
1.4.10	Prohibited vehicular traffic in both directions 	*C, 2*	1	—	—
1.4.11	No entry 	*C 1a*	1	—	—
1.4.12	Overtaking prohibited 	*C, 13aa*	1	—	—

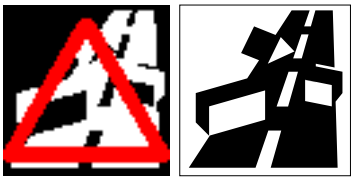
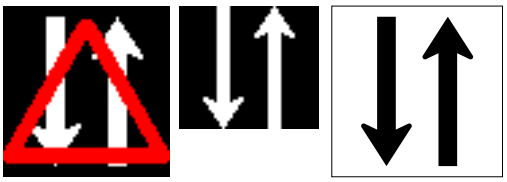
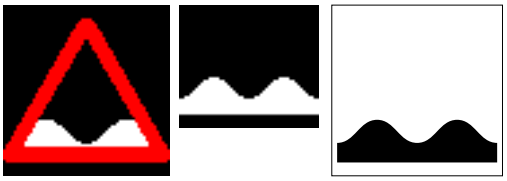
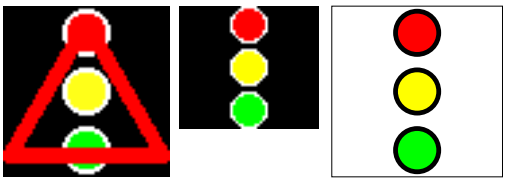
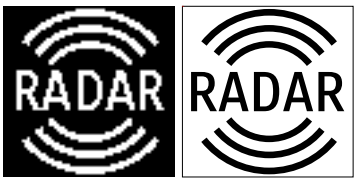
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
1.4.13	End of prohibition of overtaking 	*C, 17c*	1	—	—
1.4.14	Overtaking prohibited for goods vehicles 	*C, 13ba*	1	—	—
1.4.15	End of prohibition of overtaking by goods vehicles 	*C, 17d*	1	—	—
1.4.16	Driving less than x metres apart prohibited 	*C, 10*	1	—	—
1.4.17	Direction to be followed 	*D, 1a*	1	—	—
1.4.18	Direction to be followed 	*D, 1a*	1	—	—

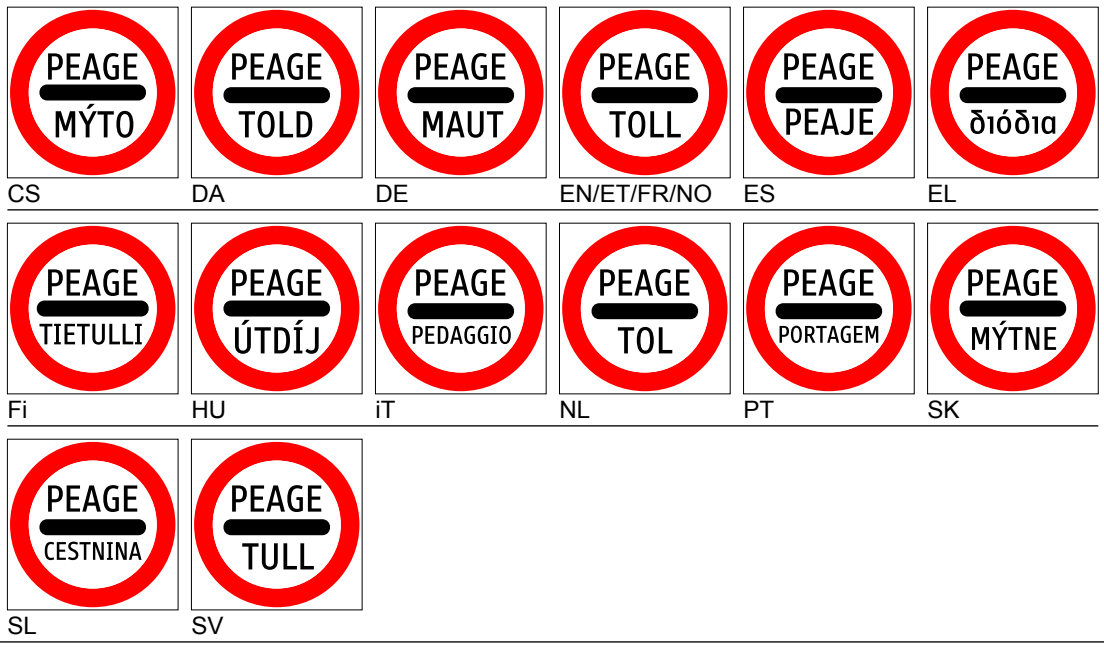
2 Danger warning

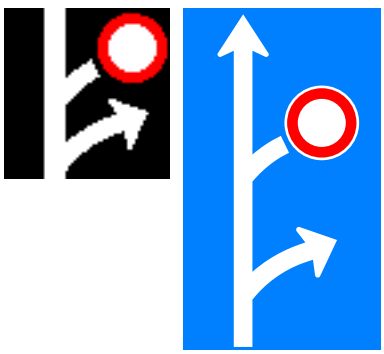
2.1	Danger warning (general) 	*A, 32*	1	*Animation*	—

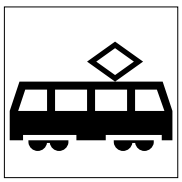
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
2.2	**Immediate warning on weather conditions (close ahead)**				
2.2.1	Flooded road 	—	3	*Animation*	—
2.2.2	Fog 	—	2	*Animation*	—
2.2.3	Freezing Fog 	—	3	*Animation*	—
2.2.4	Snow/Ice 	*H, 9*	1	*Animation*	—
2.2.5	Cross-wind  DD: Symbol to be shown according to direction of wind	*A, 31*	1	*Animation*	DD
2.2.6	Road surface temperature 	—	1	—	—
2.2.7	Slippery road 	*A, 9*	1	*Animation*	—
2.3	**Immediate warning on traffic status (close ahead)**				
2.3.1	Traffic congestion/Queue 	*A, 24*	1	*Animation*	—

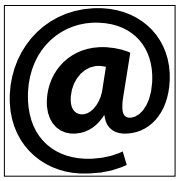
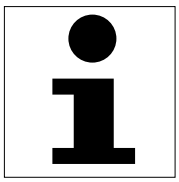
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
2.3.2	Accident (has happened) 	—	3	*Animation*	—
2.3.3	Vehicle broken down 	—	3	*Animation*	—
2.3.4	Oncoming illegal traffic/Wrong way driver 	—	3 –	*Animation*	—
2.3.5	Pedestrian(s) on the road 	—	1	*Animation*	—
2.3.6	Horse on the road 	—	1	*Animation*	—
2.3.7	Cattle on the road 	*A, 15a*	1	*Animation*	—
2.3.8	Deer on the road 	*A, 15b*	1	*Animation*	—
2.3.8.1	Elk/Reindeer on the road 	—	3 – (2: Scandinavia)	*Animation*	—
2.3.9	Slow moving machine ahead Abandoned. 2.1 Danger Warning to be mounted directly and clearly visible on the rear of the vehicle.	—	—		—

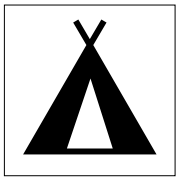
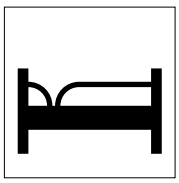
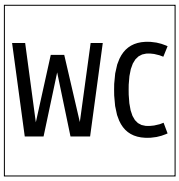
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
2.3.10	High probability of accidents Not a referent for VMS, abandoned	—	—		
2.3.11	Objects/Obstacles on the road	—	3	*Animation*	—
					
2.3.12	Two way traffic	*A, 23*	1	*Animation*	—
					
2.3.13	Road uneven	*A, 7a*	1	*Animation*	—
					
2.3.14	Light signals	*A, 17a*	1	*Animation*	—
					
2.3.15	Road works	*A, 16*	1	*Animation*	—
					
2.3.16	Swing bridge	*A, 5*	1	*Animation*	—
					
3	**Informative**				
3.1	**Advance warning**				
3.1.1	Traffic status Unclear/unspecific referent, abandoned	—	—	—	—
3.1.2	Weather condition (see paragraph 2.2)	—	—	—	—
3.1.3	Speed camera	—	1	*Animation*	—
					

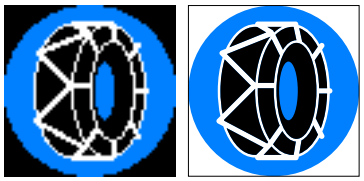
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.2	**(Implicid) advice**				
3.2.1	Rerouting arrow (Delestage arrow)  For 2 destinations and large typeface (TernVMSthreeone)  For 3 destinations and medium sized typeface (TernVMStwozero)	—	3 – 	—	DD
3.2.2	**Last exit before**				
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 	—	—	—	—

Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.2.2.3	Last exit before tunnel 	—	—	—	—
3.2.2.4	Last exit before temporarily closed tunnel 	—	—	—	—
3.2.2.5	Last exit before bridge 	—	—	—	—
3.2.3	Exit after next exit closed 	—	2	—	—

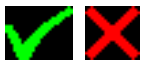
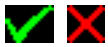
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.2.4	Fog speed control 	—	—	—	—
3.2.5	Filling station (ISO 7001)  Last filing station before xx – proposed for further research	*F, 4*	1	—	—
3.3	**Driver comfort**				
3.3.1	Temporarily free lane ahead: Tidal free lane/Emergency stopping lane (see 1.1.1 Lane control signals)	—	—	—	—
3.3.2	Services				
3.3.2.1	Parking facilities 	*E, 14a*	1	—	—
3.3.2.2	Park and ride   Class 1 in applying countries only, otherwise Class 3– (OeNorm 3011).	*E, 14b / E, 14c*	1	—	—
	 Local Metro carrier logo to be shown (here: “U”, together with explanatory text “Metro”  P+ generic Rail bound vehicle to communicate P+R according to Vienna Convention principles. Further design research on vehicle advised.	—	3 –	—	—
3.3.2.3	Public transport: Tram 	*E, 16*	1	—	—

Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.3.2.4	Ferry/Boat 	—	1	—	DD
3.3.2.5	Sports events Use logo of event	—	2	—	—
3.3.2.6	Fair Use logo of event	—	2		
3.3.2.7	Picnic site/Rest area (ISO 7001) 	*F, 8*	—	—	—
3.3.2.8	Childrens playground/Play area (ISO 7001) 	—	—	—	—
3.3.2.9	Internet 	—	—	—	—
3.3.2.10	Caravan site 	*F, 11*	—	—	DD
3.3.2.11	Mobile home 	—	—	—	DD
3.3.2.12	Information (ISO 7001) 	—	—	—	—

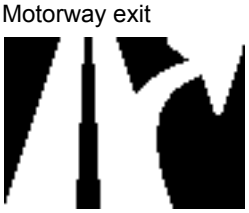
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.3.2.13	Camping site (*ISO 7001)* 	*F, 10*	—	—	—
3.3.2.14	Refreshments or cafeteria (*ISO 7001)* 	*F, 7*	—	—	—
3.3.2.15	Hotel or motel (OeNorm3011) 	*F, 5*	—	—	—
3.3.2.16	Drinking water (ISO 7001) 	—	—	—	—
3.3.2.17	Full accessibility / Toilets accessible (ISO 7001) 	*H, 7*	—	—	DD
3.3.2.18	Hospital 	*E, 13b*	—	—	—
3.3.2.19	Restaurant 	*F, 6*	—	—	—
3.3.2.20	WC / Toilet 	—	—	—	—

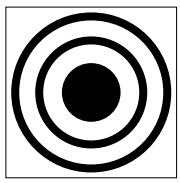
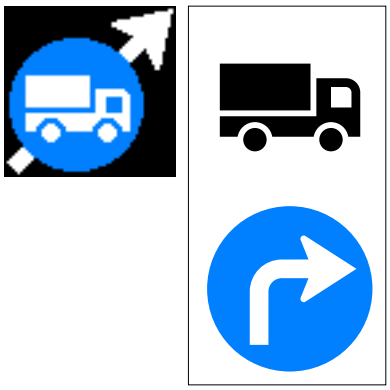
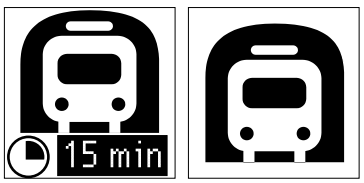
Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
3.3.3	Available parking spaces	—	—	—	—
					
3.3.4	Emergency phone	—	—	—	—
					
3.3.5	Emergency phone number	—	—	—	—
					
3.3.6	Snow chains mounting area	*D, 9/E, 14a*	3	—	—
	 				
3.3.6.1	Snow chains compulsory	*D, 9*	1	—	—
					
3.3.7	Length/Distance	*H, 2/H, 1*	1	—	—
					
	Length by place names	—	3	—	—
					
	Lenght, beginning and end specified by place names				

Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
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/Not reachable	—	3 –	—	—
4.4	Fines doubled	—	—	—	—
4.5	Switch off engine if congestion persists	—	1	*Animation*	—
4.6	Switch on hazard warning lights	—	3 –	—	—
4.7	Motorway entry ramp/junction	—	3	—	—
4.8	Motorway exit	—	2	—	—
4.9	Height control	*C, 6*	1	—	—


for large typeface (TernVMSthreeone)

for medium sized typeface (TernVMStwozero)

for small typeface (TernVMSonefour)



Referent	Name	*Vienna Conv. Annex 1*	Class	*Animation*	Directional Dependency
4.10	Truck-to-rail terminal 	—	3 –	—	DD
4.11	Motorail station 	—	3	—	DD
4.12	City centre  for large typeface (TernVMSthreeone)  for medium sized typeface (TernVMStwozero)  for small typeface (TernVMSonefour)  	—	3 –	—	—
4.13	Compulsory direction for lorries to check point 	*Acc. to D, 10c*	1	—	—
4.14	Peage/Toll (= 3.2.2.1.1)	—	—	—	—
4.15	Underground trains depart every x minutes 	—	3 –	—	—
4.16	Road restricted to particular users Proposed to be subject of further research: Pictograms of vehicles to be harmonized with corresponding symbol in driver´s licence.	*H, 5a*	—	—	—
4.17	Road restricted to particular users Proposed to be subject of further research: Pictograms of vehicles to be harmonized with corresponding symbol in driver´s licence.	*H, 5b*	—	—	—

2.1.5 Recommendations with regard to Vienna Convention signs

The following Vienna Convention traffic signs have been borrowed for integration into the set of symbols/pictograms to be used on the TERN. The selection is based on document UNITED NATIONS. Economic and Social Council. Economic Commision for Europe. Inland Transport Committee, Working Party on Road Traffic Safety, Forty-sixth session, 14-16 March 2005, agenda item 5 (j): Variable Message Signs. 2005. Document name: TRANS-WP1-2005-06e.pdf

In some cases graphical adjustments of the picture content have been made to comply with the criteria of discriminability/legibility and the style of rendering supporting these criteria.

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.

Note:
Symbols contained in Annex 1 of the Vienna Convention are considered to be guideline examples the image content of which is binding. Otherwise traffic signs in most European countries which show re-designed images, would be illegal: as many of the symbols depicted in the quoted Annex 1 do not relate to the appearance of nowadays vehicles, facilities, equipment, most traffic authorities found it appropriate to adapt the style of the Vienna Convention symbols to make them look contemporary. A compilation of Vienna Convention symbols in use shows the diversity of applied interpretations: Annex 2.

To alert drivers to a rapidly approaching danger or an untypical road condition it is suggested to superimpose a flashing triangle resp. other graphical element onto the symbol/pictogram.

Thus there will be two kinds/states of warnings against danger and atypical road conditions:

- full size static symbol/pictogram
- full size static symbol/pictogram with superimposed flashing triangle or other graphical element, e.g. an “X”, to indicate an impassable facility.

To additionally facilitate the need of signalling warning on an oncoming vehicle, approaching against the carriageway´s movement of traffic (wrong way driver), it was decided to animate the symbol itself, while displaying the triangle in stasis.

It is not recommended to combine animated symbols/pictograms with a flashing categorizing element since this impairs comprehension.

2.1.5.1 Symbols/pictograms listed below are suggested to substitute the current ones on the occasion of the next revision of the Vienna Convention:

Below listing of the symbols/pictograms:
DD (Directional Dependency): if indicated, DD refers to an implied directional dependency of the symbol/pictogram; if applied in connection with a directional indication, e.g. an arrow, to support the direction of a course to be taken, it needs to be checked, whether the symbol/pictogram can be used as depicted or whether it needs to be shown reversed)
All images are also available for countries where traffic keeps to the left.

Vienna Convention, Annex 1
Section A, DANGER WARNING SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
II. / 5.(a)	A, 5	Swing bridge	2.3.16	Swing bridge [Δ)]
II. / 7.	A, 7a	Uneven road	2.3.13	Uneven road [Δ)]

II. / 9.	A, 9	Slippery road	2.2.7	Slippery road [*)]
II. / 15.	A, 15a	Domestic animals crossing	2.3.7	Cattle on the road [Δ)]
II. / 15.	A, 15b	Wild animals crossing the road	2.3.8	Deer on the road [Δ)]
II. / 16.	A, 15	Road works	2.3.15	Road works [Δ)]
II. / 17.(a)	A, 17a	Light signals	2.3.14	Light signals [Δ)]
II. / 23.	A 23	Two way traffic	2.3.12	Two way traffic [Δ)]
II. / 24.	A, 24	Traffic congestion	2.3.1	Traffic congestion [Δ)]
II. / 27.	A, 27	Intersection with a tramway line	3.3.2.3	Public transport: Tram [*)]
II. / 31.	A, 31	Cross-wind	2.2.5	Cross-wind [Δ) DD)]
II. / 32.	A, 32	Other dangers	2.1	Other dangers [Δ)]

[Δ)] Superimposed flashing triangle possible on VMS
[*)] Static use only
[DD)] Directional dependency

Table 7: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section A

Vienna Convention, Annex 1
Section B, PRIORITY SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	–	–

Table 8: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section B

Vienna Convention, Annex 1
Section C, PROHIBITORY OR RESTRICTIVE SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
II. / 1.(a)	C, 1a	Prohibited entry for all vehicles	1.4.11	Prohibited entry for all vehicles
II. / 1.(b)	C, 2	Prohibited vehicular traffic in both directions	1.4.10	Prohibited vehicular traffic in both directions
II. / 1.(c)	C, 3h	No entry for vehicles carrying dangerous goods for which special sign plating is prescribed	1.4.5	No entry for vehicles carrying dangerous goods
II. / 1.(e)	C, 6	No entry for vehicles having an overall height exceeding ... metres	4.9	Height control
II. / 1.(e)	C, 7	No entry for vehicles exceeding ... tonnes laden mass	1.4.4	No lorries over ... tonnes Weight indicated in SI units, as required; characters of equal height
II. / 1.(e)	C, 8	No entry for vehicles having a mass exceeding ... tonnes on one axle	1.4.9	No entry for vehicles having a mass exceeding ... tonnes on one axle
II. / 1.(f)	C, 10	Driving of vehicles less than ... metres apart prohibited	1.4.16	Driving of vehicles less than ... metres apart prohibited
II. / 4.(a)	C, 13aa	Overtaking prohibited	1.4.12	Overtaking prohibited
II. / 4.(b)	C, 13b	Overtaking by goods vehicles prohibited	1.4.14	Overtaking by goods vehicles prohibited
II. / 5.(a)	C, 14	Maximum speed limited to the figure indicated	1.3.3 – 1.3.15	Maximum speed limited to the figure indicated
II. / 7.(b)	C, 16	Passing without stopping prohibited	3.2.2.1.1	Toll road ahead
II. / 8.(a)	C, 17a	End of all local prohibitions imposed on moving vehicles	1.4.6	End of all local prohibitions imposed on moving vehicles

Table 9: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section C

Vienna Convention, Annex 1
Section D, MANDATORY SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
II. / 1.	D, 1a	Direction to be followed	1.4.17, 1.4.18	Direction to be followed

II. / 9.	D, 9	3.3.6	3.3.6	Snow chains mounting area
II. / 9.	D, 9	Snow chains compulsory	3.3.6.1	Snow chains

Table 10: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section D

Vienna Convention, Annex 1
Section E, SPECIAL REGULATION SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
II. / 2.	E, 2a	Position of the lane reserved for buses in accordance with Vienna Convention Article 26 bis, paragraph 2.	1.4.1.1	Lane dedicated for busses *Note:* The bus is depicted non-directional for ease of application according to ISO 7001:1990 “Public information symbols”, Sheet No. 005 resp. ISO 7001:2007 “Graphical symbols — Public information symbols“ with Reference No. PI TF 006 and Meaning ”Bus station or bus stop or buses“ (seen from a distance it would be difficult to distinguish the front and rear of a bus, even if correctly depicted; since it is the overall shape which matters, a symbol/pictogram showing a non-directional bus is deemed acceptable and easier to handle than showing a directional bus)
II. / 4.	E, 4	Lane indications	1.1.2	Lane indication *Note:* The bus is depicted non-directional for ease of application according to ISO 7001:1990 “Public information symbols”, Sheet No. 005 resp. ISO 7001:2007 “Graphical symbols — Public information symbols“ with Reference No. PI TF 006 and Meaning “Bus station or bus stop or buses” (seen from a distance it would be difficult to distinguish the front and rear of a bus, even if correctly depicted; since it is the overall shape which matters, a symbol/pictogram showing a non-directional bus is deemed acceptable and easier to handle than showing a directional bus)
II. / 11.	E, 13b	Hospital	3.3.2.18	Hospital *Note:* The red cross may be replaced by one of the symbols referred to in Section F, Subsection II, Para. 1.
II. / 12.(a)	E, 14a	Parking	3.3.2.1	Parking
II. / 12.(b)	E, 14b and E, 14c	Parking for vehicles whose drivers wish to use a means of public transport	3.3.2.2	METRO, Tramway, Rapid urban rail system, and indication of local carrier emblem of METRO (e.g. “U” for Underground). *)
*) Static use only				

Table 11: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section E

Vienna Convention, Annex 1
Section F, INFORMATION, FACILITIES OR SERVICE SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
II. / 2.	F, 4	Filling station	3.2.5	Filling station in accordance with ISO 7001:2007, Refr. no. PI CF 009 “Filling station” *)
II. / 2.	F, 5	Hotel or motel	3.3.2.15	Hotel or motel *)
II. / 2.	F, 6	Restaurant	3.3.2.19	Restaurant *)
II. / 2.	F, 7	Refreshments or cafeteria	3.3.2.14	Refreshments or cafeteria in accordance with ISO 7001:2007, Refr. no. PI CF 002 “Refreshments – coffee shop or café or buffet” *)
II. / 2.	F, 8	Picnic Site	3.3.2.7	Picnic Site

				adapted from ISO 7001:2007, Refr. no. PI TC 004 “Picnic area” *)
II. / 2.	F, 10	Camping site	3.3.2.13	Camping site in partial accordance with ISO 7001:2007, Refr. no. PI TC 002 ”Campsite or camping” *)
II. / 2.	F, 11	Caravan site	3.3.2.10	Caravan site in partial accordance with ISO 7001:2007, Refr. no. PI TC 003 ”Caravan park or caravans” DD)
*) Static use only DD) Directional dependency				

Table 12: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section F

Vienna Convention, Annex 1
Section G, DIRECTION, POSITION OR INDICATION SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	–	–

Table 13: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section G

Vienna Convention, Annex 1
Section H, ADDITIONAL PANELS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / 2.(a)	H, 1	Distance	3.3.7	Distance indicating the distance from a sign to the beginning of the dangerous section of road or of the zone to which the regulation applies
– / 2.(b)	H, 2	Length	3.3.7	Length indicating the length of the dangerous section of road or of the zone to which the regulation applies
– / 2.(b)	H, 2	Length	3.3.7	indicating the length of the dangerous section of road or of the zone to which the regulation applies, specifying beginning and end by place names *Note:* Place names with arrow in between must not be shown staggered
– / 5.	H, 7	Parking for handicapped persons	3.3.2.17	Parking for handicapped persons in accordance with ISO 7001:2007, Ref. no. PI PF 006 “Full accessibility / Toilets – accessible” *Note:* Also to be used as an autonomous sign according to Section F, black on white to indicate fully accessible facilities, e.g. of restaurant, toilets, etc. *) DD)
– / 7.	H, 9	To indicate that the section of road ahead is slippery because of ice or snow	2.2.4	Snow/Ice *Note:* On VMS to be used as an autonomous traffic sign according to Section A, DANGER WARNING SIGNS
*) Static use only DD) Directional dependency				

Table 14: Referents to substitute current symbols in the Vienna Convention, Annex 1, Section H

2.1.5.2 Suggestions on how to adjust the not yet reworked Vienna Convention traffic signs

It is suggested that the United Nations consider harmonizing the remaining Vienna Convention traffic signs with the reworked ones listed under "2.1.5.1 Symbols/pictograms listed below are suggested to substitute the current ones on the occasion of the next revision of the Vienna Convention:"

The following requirements should be complied with:

- Graphical elements with the same meaning shown in different traffic signs should be identical; currently some traffic signs listed in Annex 3 of the Vienna Convention depict different images of cars, buses, lorries, etc..
- A more schematic rendering of the symbols – following a general tendency towards economic sign systems – should be attained by not disregarding the need to conserve enough realistic features in the symbols to differentiate one from the other. [xiv)]
- Traffic signs depending on orientation should show their graphic picture content in relation to the intended movement or, should such not be applicable, in reading order to allow the viewer to identify himself/herself with the meaning of the symbol/pictogram. Example: a symbol/pictogram requesting "lorries must leave the motorway"; it should show a lorry as moving from left to right. In countries where traffic keeps to the left, the depicted lorry would have to be reversed.
  In cases indicating an endangering moving object/subject the orientation of the symbol/pictogram should be in reversed reading order (Example: "animal on the road").
  Note: The Vienna Convention explicitly allows for reversed depiction.
- White, shiny, translucent and light elements of symbols/pictograms on traditional traffic signs (not VMS) to be shown outline [xv)].
- Symbols of SI units indicating length and weight to be shown in lower case (Example: Kilometres to be indicated by "km" instead of "Km", as occasionally found, tons to be indicated by "t" instead of currently "T").
- Symbols and fractions of SI units to be shown same size as full SI units (Example: 3,6t and not 3,6 t)

2.1.5.3 Symbols/pictograms depicting the following referents are suggested to be included in the Vienna Convention on the occasion of its next revision

Below listing of the symbols/pictograms:

DD (Directional Dependency): if indicated, DD refers to an implied directional dependency of the symbol/pictogram; if applied in connection with a directional indication, e.g. an arrow, it needs to be checked, whether the symbol/pictogram can be used as depicted or whether it needs to be shown reversed to support the direction of a course to be taken)

Vienna Convention, Annex 1
Section A, DANGER WARNING SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
Analogue to 12.	A, 12a and A, 12b	–	2.3.5	Pedestrian on the road [Δ)]
Analogue to 26.	A, 26a	Other level-crossings	3.3.2.2	resp. ISO 7001:2007, Ref. no. PI TF 002 Symbol/pictogram to indicate "Rapid urban rail transport system" resp. "Railway station or railways or trains" [*)]
– / –	–	–	2.2.1	Fooded road [Δ)]

– / –	–	–	2.2.2	Fog [Δ)]
– / –	–	–	2.2.3	Freezing fog [Δ)]
– / –	–	–	2.2.6	Road surface temperature
– / –	–	–	2.3.2	Accident (has happened) [Δ)]
– / –	–	–	2.3.3	Vehicle broken down [Δ)]
– / –	–	–	2.3.4	Oncoming illegal traffic / Wrong way driver (Animated) *Note:* Needs strong advertising prior to introduction
– / –	–	–	2.3.5	Pedestrian(s) on the road [Δ)]
– / –	–	–	2.3.6	Horse on the road [Δ)]
– / –	–	–	2.3.8.1	Elk/Reindeer on the road [Δ)]
– / –	–	–	2.3.11	Objects/Obstacles on the road [Δ)]
– / –	–	–	3.3.2.4	Ferry/Boat [DD)]

[Δ)] Superimposed flashing triangle possible on VMS
[*)] Static use only
[DD)] Directional dependency

Table 15: Referents to be included in the Vienna Convention, Annex 1, Section A

Vienna Convention, Annex 1
Section B, PRIORITY SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	–	–

Table 16: Referents to be included in the Vienna Convention, Annex 1, Section B

Vienna Convention, Annex 1
Section C, PROHIBITORY OR RESTRICTIVE SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
Analogue to 1.(c)	C, 3e	–	1.4.1.2	Lane dedicated for lorries

Table 17: Referents to be included in the Vienna Convention, Annex 1, Section C

Vienna Convention, Annex 1
Section D, MANDATORY SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	1.1.1	Lane control signals
– / –	–	–	1.4.1.3	HOV (High Occupancy Vehicle) lane *Note:* Needs legal basis and strong advertising prior to introduction – unless already adopted
– / –	–	–	1.4.1.4	Lane dedicated for taxis
– / –	–	–	1.4.1.5	Lane dedicated to emergency vehicles
Analogue to 10. / D	–	–	4.13	Mandatory direction for lorries (to check-point)

Table 18: Referents to be included in the Vienna Convention, Annex 1, Section D

Vienna Convention, Annex 1
Section E, SPECIAL REGULATION SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	1.2.1.1	Road ahead closed / Take next exit
– / –	–	–	1.2.1.2	Pass/Mountain road ahead closed [X)] *Note:* The symbol/pictogram with a focus on “mountain road” is based on a tested variant which had prioritised the notion of

				"pass"
– / –	–	–	1.2.1.3	Tunnel ahead closed [X)] *Note:* Tunnel symbol/pictogram as suggested for motorways (compare with 8.(a) / E, 11a) Note: The current Vienna Convention tunnel according to CT results indicates "narrow and/or low tunnel" and therefore should be restricted to tunnels other than of motorways.
– / –	–	–	1.2.1.4	Bridge ahead closed [DD) -static only, X)] Note: Bridge symbol/pictogram is best practice in Bavaria, Germany
– / –	–	–	1.2.1.5	Exit ahead closed
– / –	–	–	1.2.3	Lane Closure ahead
– / –	–	–	1.4.2	Environmental zone *Note:* The symbol/pictogram has been conceived after the execution of the CT Would need legal basis and strong advertising prior to introduction
– / –	–	–	1.4.3	No lorries at night in analogy to II / 8.(a) (ii) / E, 9b Applicable time indicated according to ISO 8601
– / –	–	–	3.3.3	Available parking spaces to be indicated in white numerals on green background, red background when zero spaces available VMS application only (Example)
– / –	–	–	4.5	Switch off engine if congestion persits (Animated)
– / –	–	–	4.6	Switch on hazard warning lights
– / –	–	–	4.7	Motorway entry ramp / junction
– / –	–	–	4.5	Motorway exit
– / –	–	–	4.15	Underground trains depart every x minutes Static use with inbuilt VMS display to indicate minutes
[X)] Closed situation indicated by superimposed flashing "X" in red [DD)] Directional dependency				

Table 19: Referents to be included in the Vienna Convention, Annex 1, Section E

Vienna Convention, Annex 1
Section F, INFORMATION, FACILITIES OR SERVICE SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	3.1.3	Speed camera Animated; to be used static in case another more important symbol/pictogram on the same VMS is shown animated or with superimposed flashing element
– / –	–	–	3.3.2.8	Childrens playground in accordance with ISO 7001:2007, Refr. no. PI TC 005 "Play area" [*)]
– / –	–	–	3.3.2.9	Internet [*)]
– / –	–	–	3.3.2.11	Mobile home [*) DD)]
– / –	–	–	3.3.2.12	Information in accordance with ISO 7001:2007, Refr. no. PI PF 001 "Information" [*)]
– / –	–	–	3.3.2.16	Drinking water in accordance with ISO 7001:2007, Refr. no. PI PF 007 "Drinking water" [*)]
– / –	–	–	3.3.2.20	WC / Toilet [*)]
– / –	–	–	3.3.4	Emergency phone [*)]
– / –	–	–	3.3.5	Emergency phone number [*)]
[*)] Static use only [DD)] Directional dependency				

Table 20: Referents to be included in the Vienna Convention, Annex 1, Section F

Vienna Convention, Annex 1
Section G, DIRECTION, POSITION OR INDICATION SIGNS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	3.2.1	Rerouting arrow (“Delestage arrow”) DD) *Note:* Examples show applications with single digit rerouting numbers Needs legal basis and strong advertising prior to introduction – unless already adopted
– / –	–	–	3.2.2.1	Last exit before toll station *) Concept based on regulations defined in Section C, para. 7 (Prohibition of passing without stopping) and Section E, para. 1 (Signs indicating a regulation or danger warning applying to one or more traffic lanes) *Note:* In countries where traffic keeps to the left to be shown reversed
– / –	–	–	3.2.2.1.1	Toll road ahead *) Concept based on regulations defined in Section C, para. 7 (Prohibition of passing without stopping)
– / –	–	–	3.2.2.2	Last exit before pass/mountain road *) Concept based on Section E, para. 1 (Signs indicating a regulation or danger warning applying to one or more traffic lanes) and 2 (Signs indicating lanes reserved for buses) The symbol/pictogram with a focus on “mountain road” is based on a tested variant which had priorytised the notion of “pass”
– / –	–	–	3.2.2.3	Last exit before tunnel *) Concept based on Section E, para. 1 (Signs indicating a regulation or danger warning applying to one or more traffic lanes) and 2 (Signs indicating lanes reserved for buses)
– / –	–	–	3.2.2.4	Last exit before before temporarily closed tunnel *)
– / –	–	–	3.2.2.5	Last exit before bridge *)
– / –	–	–	3.2.3	Exit after next exit closed
– / –	–	–	3.2.4	Fog speed control *) *Note:* Requires that in districts of frequently occurring fog white dots are painted in appropriate intervals on the side of the motorway. The proposed traffic signs are based on similar ones implemented in Austria. They have have been conceived after the execution of the CT.
– / –	–	–	4.3	Reachable/ Not reachable Reachable places to be indicated by adding a check mark in green Not reachable places to be indicated by adding a red “X”
– / –	–	–	4.4	Fines doubled *Note:* Needs legal basis and strong advertising prior to introduction
– / –	–	–	4.10	Truck-to-rail-terminal DD)
– / –	–	–	4.11	Motorail station DD)
– / –	–	–	4.12	City centre
*) Static use only DD) Directional dependency				

Table 21: Referents to be included in the Vienna Convention, Annex 1, Section G

Vienna Convention, Annex 1 Section H, ADDITIONAL PANELS

Vienna Convention Signs/Symbols			**Tern Symbols**, Activities A2.2 & A2.4	
Subsection/ Paragraph	iD	Name	iD	Name
– / –	–	–	–	–

Table 22: Referents to be included in the Vienna Convention, Annex 1, Section H

2.1.5.4 Referents/meanings, not yet generally introduced in the EU

Those referents/meanings, not yet known in the EU or only known in some EU member states, are suggested for use on the provision that they are developed in a harmonized way across Europe and that they are effectively explained to drivers in connection with their eventual introduction:

iD	Name	Description
4.4	Fines doubled	to alert drivers to be particularly cautious e.g. in zones of road works to avoid falling prey to tightened law enforcement. Examples to be found in the USA.
1.4.2	ECO / ÖKO	to indicate an environmental (protection) zone in which special legislation applies. Environmental (protection) zones are just about to be introduced, e.g. by the Municipalits of Copenhagen and Stuttgart.
3.2.4	Fog speed control	through information given on boards positioned along the motorway, suggesting speed adjustment in foggy conditions according to white dots painted in appropriate intervals on the side of the motorway. If two dots can be seen at the same time a recommended speed reduction to 80 km/h is advised, if only one dot can be seen drivers are advised to reduce the speed to a max. of 40 km/h. Requires that in districts of frequently occurring fog white dots are painted in appropriate intervals on the side of the motorway. Examples to be found along Austrian motorways.
1.4.1.3	HOV (High Occupancy Vehicle)	to indicate a lane for vehicles with at last two (or three) people in them. Example to be found in Madrid.
3.3.2.2	P+R (Park and Ride)	to indicate a parking facility at intersections with means of public transport serving city centers. Examples to be found in Germany
3.2.1	Rerouting (“Delestage arrow”)	to be used in case a stretch of a motorway becomes impassable to indicate a proposed alternative route to a given destination. Examples to be found in Germany. Suggested by IIID for use because of its specific shape which differentiates it from any other arrows, thus accounting for heightened conspicuity and ease of learnability.
1.4.2	SMOG (Inversion weather)	
–	Congestion Charge	

Table 23: Referents/meanings not yet generally introduced in the EU

2.1.5.5 The classes of information elements as defined for their use on VMS

Considering the many conditions governing the quick discriminability and correct comprehension of symbols/pictograms, test results indicate correlations between

- the degree, to which a symbol/pictogram relates to already learnt information (traffic signs usually have an advantage over newly introduced symbols/pictograms)
- the complexity of the symbol/pictogram (clear and simple images can be comprehended quicker than detailed ones).

These two factors were considered in the elaboration of a concept aiming at weighing symbols/pictograms for their use on VMS to safeguard comprehensible combinations of information elements which do not overburden motorists.

Three classes of symbols/pictograms were defined:

Class 1	Symbols/pictograms in Class 1 comprise
	all Vienna Convention signs required for messages on VMS, unless tested for comprehension with scores of correct understanding below 88% It may be assumed that all Vienna Convention signs are well understood. After all, drivers have to learn them at driving school
	symbols/pictograms not regulated by the Vienna Convention, that have yielded comprehension scores of correct understanding above 88%.
	Europeanisms, as defined by INFOTERM.
	One place name shown is to be considered Class 1

Class 2	Symbols/pictograms in Class 2 comprise
	Vienna Convention signs tested for comprehension with scores of correct understanding between 77% and 88%.
	symbols/pictograms not regulated by the Vienna Convention, that either have been accepted after

	convincing scores when tested for judged comprehensibility or yielded comprehension scores between 77% and 88%.

Class 3	Symbols/pictograms in Class 3 comprise
	Vienna Convention signs tested for comprehension with scores of correct understanding between 66% and 77%.
	symbols/pictograms not regulated by the Vienna Convention, that have yielded comprehension scores between 66% and 77%. Some of these symbols/pictograms are considered on the provision that they get regulated, subsequently learnt in diving schools and advertised widely to induce a learning process among drivers.

Table 24: Classes of information elements

2.1.5.6 Size of symbols/pictograms on VMS as a multiple of corresponding lines of text

For relating text to symbols/pictograms and vice versa a modular approach requires that multiple lines of text correspond with the height of a symbol/pictogram. The optimal relationship is established when symbol/pictogram and text of comparable visual complexity are aligned. This is the case when the smallest graphical details of symbols/pictograms are about the same as the smallest graphical details of accompanying text.

The meaning of a standard traffic sign is composed of a symbol/pictogram and a background shape, often dyed and reinforced by a coloured border.

For the purpose of this project numerals (as in speed restrictions) may be treated like symbols/pictograms.

Speed restricting images (= large numerals on circular areas) stick out. Large words, indicating high importance of the underlying meaning, likewise draw attention: the modular concept needs to provide a standard, at the same time it must concede rightful deviations.

In most cases symbols/pictograms utilize the full height of a VMS. Smaller symbols/pictograms with related text below the symbol/pictogram (e.g. numerals indicating a length or a distance) require the modular concept to allow for combinations of different sizes of text and symbols/pictograms.

From these considerations a basic grid was developed for the design of composite messages for VMS. See: “2.4 Proposal of a European guideline for content structure on VMS”

2.2 “Keywords”

In contrast to the abbreviated SI units and certain exceptions (e.g. “via”) the listed “keywords” (Table 25) are to be shown throughout in capital letters.

2.2.1 Europeanisms

“Europeanisms”, (traffic relevant vocabulary identified and investigated by INFOTERM for understanding throughout Europe) presented as “keywords”, can be vocalized. Exception: Abbreviated SI units (they cannot be vocalized). However, they have a clear verbal equivalent. This facilitates verbal communication as needed by text based systems (like RDS) and voice supported (in-car navigation) systems.

Europeanisms as proposed by INFOTERM for use on VMS:

Recommendations

2.2.1.1 Verbal messages to be harmonized

(short) Verbal messages and fundamental verbal message elements to be harmonised (also on [road-] maps) or considered for Europe-wide harmonization (e.g. according to number of letters):

Letter sign	Meaning represented	Existing standards/rules/ conventions/applications	Harmonization
@	Internet access available		– to be harmonised
h	hour	DIN 1355, ISO/R2015-1971	– as in given standards
H / HALT	halt (bus, tram etc. stop)	H=hospital in VC, or H= heli-copter landing in the UK, which, however, is not an issue for road scenarios	– according to VC: employment of vehicular symbol instead of "H" (as Tern Symbols for Bus [also ISO], Tram (Tern Symbol 3.3.2.3), ...
i/ INFO	information (point/available/…)	Symbol: ISO 7001	– as in Tern Symbol 3.3.2.12
m	metre/meter	SI, ISO and VC	– as “m” in lower case letters only, acc. to given standards
METRO	metro, underground	VC	– not possible, show local carrier logo combined with METRO as in Tern Symbol 3.3.2.2
P / PARKING	parking (area/building/…)	VC	– is given
t	ton (weight limit)		– as in SI, “t” in lower case letters
km	kilometre (per hour etc.)	SI, ISO and VC	– as in SI, “km” in lower case letters
NO	not permitted, not allowed, denied	as symbols in VC Annex 1, Chapter C	To be harmonized for provisions not touching VC Chaper C – as Tern Symbol 4.3, a red “x”
OK	permitted/allowed	Other provisions in VC	– as Tern Symbol 4.3, a green “tick”
WC	toilet (available…)	Austrian Standard (Önorm)	– as Tern Symbol 3.3.2.20
P+R	park-and-ride	confirmed countries: A, D, DK, FI, HU, NL, SE, UK	– as Tern Symbol 3.3.2.2 (acc. to VC)
min	minute	ISO 31 (series) confusion with min.=minimum must be avoided	– confusion with min.=minimum must be avoided
BUS	bus	VC, ISO	– as Tern Symbol element 1.4.1.1 (acc. to ISO 7001)
TEL	telephone	VC, ISO	– as Tern Symbol element 3.3.4
POL / POLICE	police		– to be considered
SOS	emergency (telephone, vehicle, …)	Antiquated sea distress signal since GMDSS (1999)	– should be harmonised
via	Reach location A via location B		– “via” in lower case letters only
EXIT	Exit from highway, building…	Symbol for “exit” on motorways in confirmed countries: A, D, CZ, ES, F	– as Tern Symbol 4.8
FULL	e.g. parking area full		– should be considered
HALT / H	See “H”		
INFO / i	See “i”		
SMOG	Polluted air	antquated type of pollution	– should be considered
STOP	“stop” sign	VC	– is given, however, variations in size, etc. should be harmonized
TAXI	e.g. for taxis only	Verbal: VC, Symbol ISO 7001	– “TAXI” in upper case letters (slight variation according to national orthography could be considered as acceptable)
TRAM	Tram/Tram stop	VC, ISO 7001	– as Tern Symbol 3.3.2.3
ZONE	e.g. parking zone	VC	– as in VC in upper case “ZONE”
ENTRY	Entry to a building		– should be considered
GRATIS	Access/use etc. free of charge		– should be considered
RADAR	radar (control)		– as Tern Symbol 3.1.3
RADIO	Traffic broadcast +		– should be considered

Letter sign	Meaning represented	Existing standards/rules/ conventions/applications	Harmonization
	frequency		
TRAIN	Train (crossing…)	VC, ISO 7001	– should be considered
TRUCK	Lorry, truck		– as Tern Symbol element 1.4.1.2
POLICE / POL	See “POL”		
CENTRE / CENTER	(city) centre		– as Tern Symbol 4.12 (slight variation according to national orthography could be considered as acceptable)
EXCEPT	Except for …	VC	– as Tern Symbol 4.3, a green “tick”
CARAVAN	caravan	VC, ISO 7001	– as Tern Symbol 3.3.2.10
CONTROL	Control		– should be considered;
PARKING / P	See “P”		
OIL	Slippery road due to trail of oil		– to be harmonised

Table 25: Europeanisms

2.2.1.2 Verbal messages to be studied for harmonization

(short) Verbal messages and fundamental verbal message elements which need further investigation especially if occurring in clusters of related messages before they can be considered for Europe-wide harmonization (according to number of letters):

Letter sign	Meaning represented	Remarks
FOG	Fog warning	
GAS	Gasoline, Petrol, Benzin, Filling station (VC)	LPG = Liquified/Liquefied Propane/Petroleum Gas is used for gas (not: gasoline) driven vehicles
HOV	High occupancy vehicles	In some countries called “Car sharing lane” or “Car pools”, IIID suggest Tern Symbol 1.4.1.3
CASH	Dues/fees to be paid in cash	
FAIR	(trade) fair	To be signalled by displaying logo of event
TOLL	Toll road ahead	National verbal equivalent to be shown under “PEAGE”, according to VC, Annex 1, C, 16
OPENING	Opening of an event, a fair…	To be signalled by displaying logo of event

2.2.1.3 Systematization of the syntax of certain verbal message and symbol clusters

Certain combination clusters may have several complexity dimensions – e.g. co-occurring signs, graphical symbols and verbal messages/verbal message elements – and should be further investigated with the aim to systematize and simplify (across language boundaries). Information on PARKING for example belongs to one or more such clusters.

Base symbol	Extension level 1	Extension level 2 plus indication of	Extension level 3 plus indication of
P	for passenger cars (&number)	distance	time
	for buses (&number)	direction	WC
	for trucks (&number)		handicapped WC
	for caravans (&number)		drinks, restaurant…
	for xxx (&number)		other
P+(R)	+R (park-and-ride)	distance	time
	+BUS	direction	frequency
	+METRO		capacity
	+TRAIN		name (of location)
	+TRAM		other
	+xxx		

2.2.1.4 Measures, units, quantities

Measures, units or quantities occur (less in than around) traffic signs – e.g. in additional panels and verbal messages for information purposes. They may indicate:

- a fact – e.g. 15% gradient road
- a minimum: minimum number of passengers 2+ for HOV
- a maximum – e.g. 60 (= speed limit 60 km/h)

a range of:
- time: from 10h to 15h
- time: “Sundays and holidays, 20:00–06:00”, etc.
- distance: in 2km from here
- a frequency: e.g. every 15min (e.g. trains leaving from P+R)

in combination with numbers. Sometimes arrows are used to indicate a range.

Measures, units and quantities often occur in combination with numbers (integers or decimals – sometimes negative) and other kinds of information:

Distances:
- (length:) =stretch of road from here to…: /arrow up/ 500m /arrow up/,/arrow up/ 5km /arrow up/, etc.
- distance (=in… m): 100m (e.g. railway crossing), give way 50ys, etc.

Other measurements:
- 5,5t (gross weight), 8t (axle weight), etc.;
- 2m (width), 3.8m (height), 10m (length), 3km (distance), …;
- (Speed:) 80 (= 80km/h) + time (period) indication on additional sign
- (Degree:) 10% (gradient road, dangerous hill), 0° (= 0°C. temperature), etc.

Concerning the numbers the following considerations have to be made with respect to a systematization and harmonization on roads across Europe:

- decision on font: numeral fonts today are often different for indicating speed limits, distances, times, radio frequencies, etc. and should be harmonised as proposed by IIID employing typeface “Tern”
- decision on position and size: such as smaller 5 in 3.5t and other ways of writing should be harmonized in such a way that all numerals (before and after decimal point) should have the same size
- decision on proportion in relation to the sign or message;
- decision on dot or comma: 3.5 or 3,5 (different national conventions)
- decision on the indication of ranges: e.g by hyphen or tilde or slash or arrows;
- and possibly other decisions, such as double hyphen for from-to time indications, arrows concerning stretch of road (length)

Concerning units/quantities the following considerations/decisions have to be made with respect to a systematization and harmonization across Europe:

- fonts and case: same font (typeface “Tern”) for all units standardized in ISO 31 (Series)
- indication of unit or not: omission of unit, such as no indication of “km/h” in speed limit sign, to be considered, whenever applicable (e.g. for speed limits according to VC and from-to time indications according to ISO
- ° for indicating temperature: without further specifying “C.” (=Celsius).
- position (e.g. superscript): e.g. ton not written with superscript “T”, but only in lower case “t”, accoring to SI units
- avoiding misunderstanding: m = metre but not: mile, minute, minimum

- As a rule unit abbreviations should be used as given in standards, such as SI.
- No features of form, font or style etc. should be used, which are deviating from standardized ones.

Outlook

Step-by-step systematization and harmonization of verbal messages

The results of IN-SAFETY Task A2.3 can be considered as a first step towards systematizing and harmonizing verbal messages across Europe based on extensive investigations. Due to the promising result of this first step the following procedure can be proposed in general:

- Harmonise as many verbal messages and verbal message elements as possible;
- Deepen the systematization and harmonization duly coordinating it with the formulation of traffic events according to RDS-TMC (and DATEX etc);
- Simultaneously systematise the syntax of clusters of co-occurring signs, graphical symbols and verbal messages/verbal message elements, such as:
- Information around P (parking)
- Information around P+R
- Full systematization (including the respective localizations) of signs, graphical symbols and verbal messages as much as necessary/useful.

While having a positive effect on road safety, the harmonization of certain graphic symbols (like the “pictograms” for bus, tram, etc.) and (short) verbal messages or verbal message elements (to be recognized as “keywords” in written form) shall:

- facilitate to develop navigation systems or in other types of car-driver communication systems in different languages of Europe;
- facilitate the design of data models for such systems as well as for the traffic information systems at large;
- improve interoperability with traffic sign production (via eProcurement etc.) thus enhancing investment security for the industry;

and in general make the whole system of traffic signs, variable messages and verbal messages more consistent and at the same time more flexible – while improving perceivability and comprehensibility on the drivers’ side.

Naming and describing/defining every information element (be it a word, an abbreviation or a symbol/pictogram) is an essential condition for storing, maintaining, retrieving and applying information in a state-of-the-art terminology management system (TMS) adopted for this purpose. INFOTERM has done the respective ground work, from which relevant information systems can be developed which will enable the integration of the elaborated information elements into existing and/or future traffic information systems.

All graphical symbols and pictograms (and many/most letter symbols too) must have a verbal representation, in order to comply with special needs e.g. of accessibility. This comprises both written and spoken verbal forms. The written verbal form should consider situations, in which a spoken form can/must be used. Thus the spoken message should be conveyable unambiguously even in noisy environments.
Modern systems for structured data (such as traffic signs and verbal messages etc.) should comply with the recommendations in document MoU/MG/05 N0221 “Semantic interoperability” adopted by the Management Group of the ITU-ISO-IEC-UN/ECE Memorandum of Understanding concerning eBusiness standardization. These recommendations state that data and data structures of symbols as well as verbal messages should comply with the fundamental requirements for the semantic interoperability of structured content, which guarantee unrestricted:

- multilinguality
- cultural diversity
- multimodality
- accessibility (incl. the requirements of people with special needs)
- multi-channel presentations.

2.2.2 Bilingual information

INFOTERM did set out to also review nationally used bilingual traffic signs / variable message signs and the relevant national regulations. Subsequently a “Testing approach for bilingual variable message signs” (Annex 14) which includes the results of studies regarding the comprehensibility of bilingual variable message signs was elaborated.

From the conclusions drawn the following are considered to be the most relevant:

- It is no more demanding to display variable messages consecutively than to display them simultaneously.
- The consecutive display of bilingual information by turns of two seconds remains undisputed.
- The capacity of displays should be restricted to four lines of text (= two lines for both languages each).

As most of the information needed for display on VMS can be delivered in symbols/pictograms, with a few “Europeanisms” added on occasion, the above cited conclusions most probably will be of relevance only for the display of place names in bilingual regions/countries or border areas.

2.3 Typeface “Tern” for use on static signs and on VMS

Underlying Activity: A2.4 Content structure of pictorial and verbal messages on VMS and typeface (Leader: IIID)

The need to make optimal use of the restricted space on VMS did determine the decision for a slightly condensed design of the letterforms. Knowing that condensed letter forms are less legible than standard ones the IIID team with world renowned type designer Prof. Erik Spiekermann worked hard to outbalance this disadvantage for greater flexibility of displaying and structuring content on VMS. The result is a brand new typeface, called “Tern” (for “Trans-European Road Network”).

As with the symbols/pictograms the elaborated “Tern” has been designed in a vector graphics based format for general use and – in bitmap form – for use on VMS displays. The latter is available in 3 sizes: TernVMSonefour (body height = 14 pixels), TernVMStwozero (body height = 20 pixels) and TernVMSthreeone (body height = 31 pixels).

One additional size was designed to facilitate tests in comparison with the fonts currently used on many LED based VMS and to allow for their immediate substitution, if deemed appropriate: TernVMStwofour (= 24 pixels high).

All fonts are available in Latin and Greek character sets – free of charge for applications on European highways and motorways.

Deriving from the three interrelated Tern versions the sizes of both a “full size” symbol/pictogram and one approx. 25% smaller have been defined. The resulting modular concept of a VMS content structure is explained in “2.4 Proposal of a European guideline for content structure on VMS”

2.3.1 Determining the absolute size of the “Tern” versions

Considering Annex III of Council Directive 91/439/EEC of 29 July 1991 on driving licences (compare with statements in chapter “1.1.2 To drive a car visual acuity of 10/20 resp. 0,5 suffices”), the consequences with regard to letter sizes (and based on this, with regard to VMS sizes) can be easily figured out.

However, due to the interrelationships of speed, size, and the number of information elements to be displayed, concerning the latter a preliminary assumption must be made:

- Any VMS should be able to display up to 4 information elements (traffic signs and/or place names).

On this basis, let's assume, the speed of a driver with binocular visual acuity of 0,5 is 100 km/h.

For lack of internationally agreed conventions we may decide to refer to the Danish formula, already quoted in chapter "1.1.5 Physiological criteria to determine the dimensions of VMS":

$$t = 2 + n/3 \text{ seconds}$$

which requests a reading time of 3,33 seconds for viewing 4 information elements. In 3,33 seconds the car covers a distance of 92,51 m. Together with the distance from the point of disappearance of the information to the VMS (14,55 m) this sums up to 107,06 m.

The point of disappearance is defined as the distance between a driver and the message on a VMS, when the VMS gets beyond an angle of 15° above the eyeline of the driver. The latter is estimated to be 1,1 m above the road.

The x-height of lower case letters for "normal" acuity (20/20 = decimal 1,0) subduing a viewing angle of 5 MOA equals the size of a visual element of about 15 mm seen from a distance of 10 m.

From a distance of 107,06 m therefore the calculated x-height of lower case letters should not go below 161 mm.

To serve visual acuity of 0,5 the required viewing angle must be doubled to 10 MOA. The resulting requirement on the size of the x-height of lower case letters becomes approx. 322 mm.

If one wants to align three lines of text with one (square) symbol/pictogram, a very reasonable relation, the size of the symbol/pictogram would be roughly 6 times the x-height = approx. 1932 mm = approx. 193 cm.

Considering a minimum of 10 cm on both sides of the VMS for framing, a space of one x-height between elements belonging together, and a tripled x-height separating others (which for this purpose we assume to be symbols/pictograms), the display of 4 symbols/pictograms would sum up to approx. 936 cm = 9,36 m.

Compared with the width of an average two lane motorway which is 7,5 m in countries like Germany [xvi)], this just does not work out: a VMS cannot be wider than the motorway below.

In case of a speed of 130 km/h the problem would be even more dramatic: the width of the motorway would need to be approx. 12,78 m.

An alternative way to derive a workable letter size

As the number of max. four information elements cannot seriously be reduced, it is legitimate to question the requirement to serve drivers with visual acuity of 0,5.

It turns out that visual acuity 0,5 has first been introduced in national legislation (as in Austria in 1955[xvii)] when driving was easy:

- 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 2006[xviii)])
- Motorways in many European countries did not exist; in Austria the "network" of motorways amounted to 27,6 km[xix)]) against 1.677,5 km in January 2007 (plus 400 km of highways)

The figure of 0,5 seemingly got carried forward and forward without ever having been challenged.

As it is technically impossible to show four information elements big enough to be conceived and comprehended by drivers with visual acuity of 0,5 two questions need to be answered:

- Considering nowadays conditions with regard to traffic density, vehicle speeds, and the probability of accidents compared with the time when 0,5 visual acuity got introduced in legislation as a condition for being allowed to drive on public roads: shoudn't it be more appropriate to tighten requirements by relating the acceptable visual acuity to the average visual acuity of healthy eyes, which reportedly is said to be "20/16 (decimal 1,25) to 20/12 (decimal 1,67)" compared to the defined "normal" acuity of 20/20 resp. 1,0?
- Wouldn't it be feasible to generally restrict the maximum admissible speed of riders with poor eyesight driving on roads in general and on motorways in particular?

To find a technically feasible and socially acceptable solution, the following procedure was adopted:

- The mean value of the indicated "average visual acuity of healthy eyes", based on the attained figures of 20/16 (decimal 1,25) or 20/12 (decimal 1.67) was calculated. It is 1,46.

- Accounting for the needs of drivers with poor eyesight requirements on visual acuity are cut in half, resulting in a figure of 0,73.

- Sizes estimated for visual acuity 1,0 subsequently are multiplied by 1,37 (instead of 2,0 as deemed currently necessary to meet the requirements of drivers with poor eyesight).

Accounting for the smallest graphical detail

Based on the considerations of 1.3.2 "Resolution of the displayed information" which propose a grid of 22 mm increments, the definitive size of the x-height of lower case letters of TernVMStwozero becomes 24,2 cm, the size of a full size square symbol/pictogram becomes 140,8 cm.

If grid increments of 22 mm are implemented on a VMS with 64 x 64 pixels, the x-height of a lower case letter on a grid of three lines of text equalling a full size symbol/pictogram becomes 24,2 cm (11 pixels), the body becomes 33 cm (20 pixels). The 20 pixels are the name givers of the proposed standard bitmap typeface "TernVMStwozero".

All other type and symbol/pictogram sizes are derived from relationships defined by a layout architecture as illustrated in "2.4.1 The basic grid"

The three pixelled Tern typefaces (TernVMSonefour, TernVMStwozero and TernVMSthreeone) have been designed for use on freely programmable VMS. TernVMStwofour, which does not fit into the defined grid, was designed because of the existence of a variety of transport specific fonts based on an x-height of 13 pixels. The availability of TernVMStwofour did allow for comparison testing and will enable motorway administrators to easily and quickly replace currently used pixel fonts with the respective TernVMS-font.

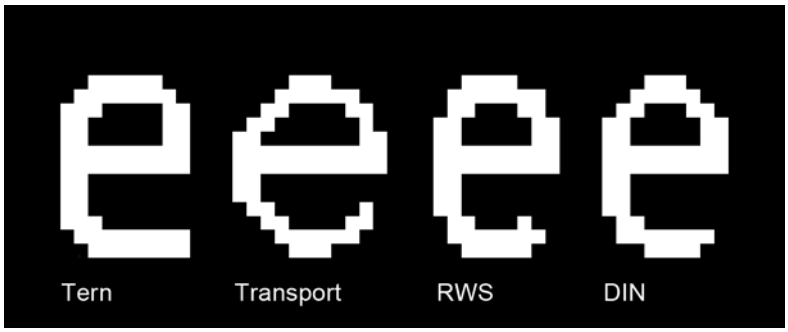


Figure 8: Equal x-height (13 pixels) of tested VMS fonts and TernVMStwofour

The following Tern versions are available:

Latin/Greek typeface “Tern”:

To cater for traditional signage application, “Tern” – a typeface homogenized with its VMS counterpart(s) – was designed, tested and further improved according to acquired insights:

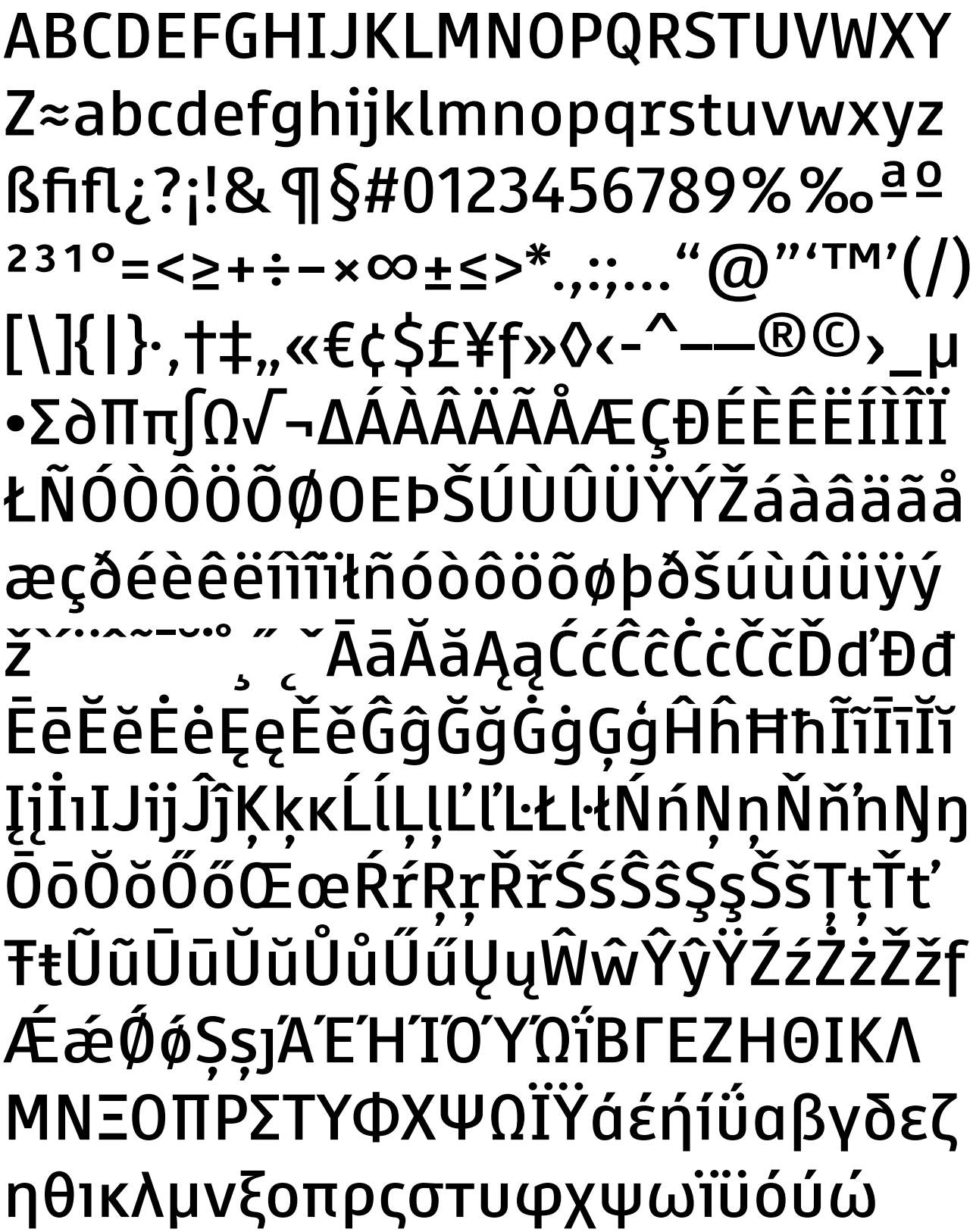


Figure 9: Tern typeface character set

Typeface “TernVMSonefour”: 14 pixels -> for 4 lines of text to go with a full size symbol/pictogram resp. for 3 lines of text to go with a symbol/pictogram of reduced size:

Figure 10: TernVMSonefour character set

Typeface “TernVMStwozero” = 20 pixels -> for 3 lines of text to go with a full size symbol/pictogram:

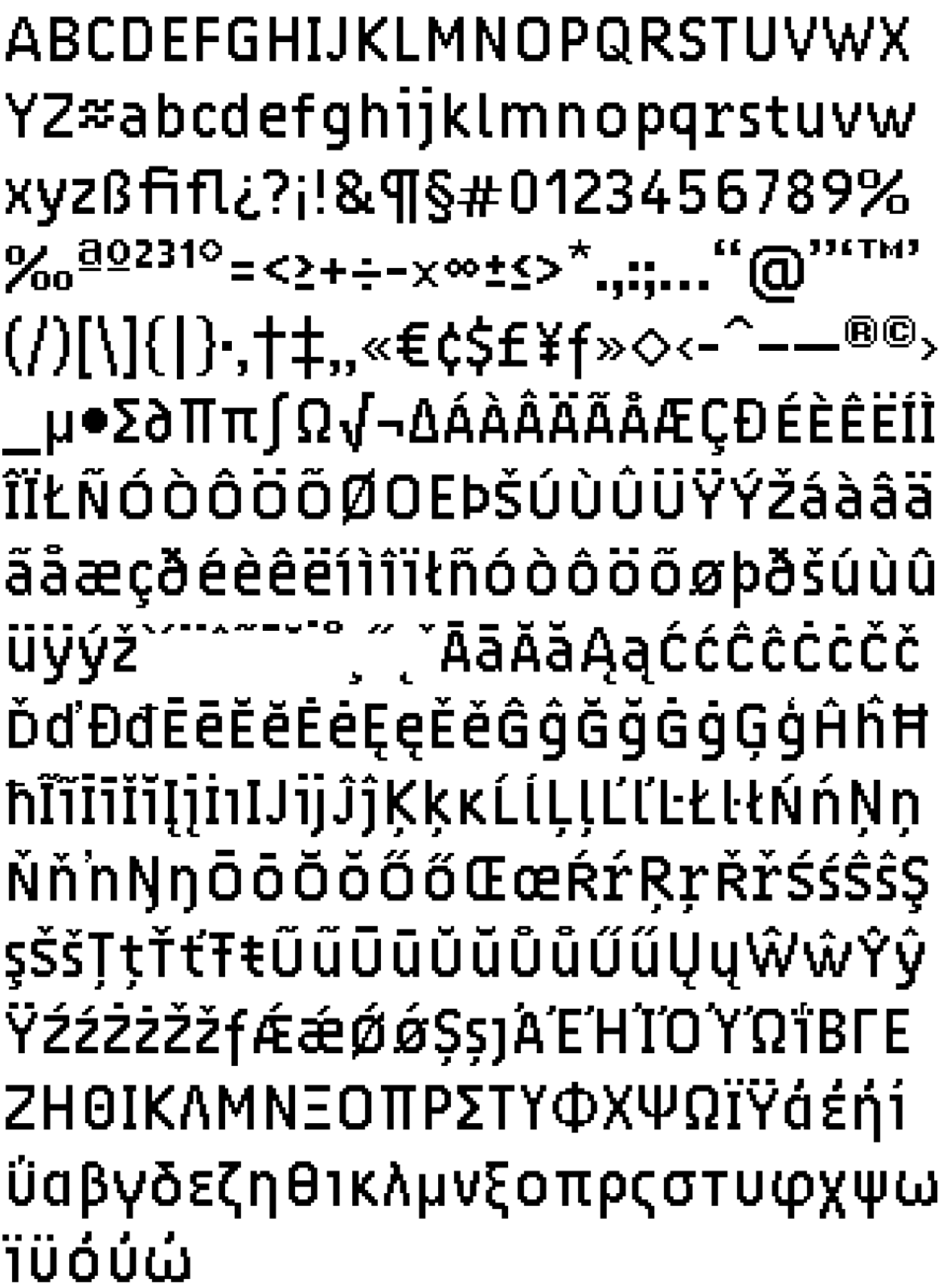


Figure 11: TernVMStwozero character set

Typeface “TernVMSthreeone” = 31 pixels -> for 2 lines of text to go with a full size symbol/pictogram:

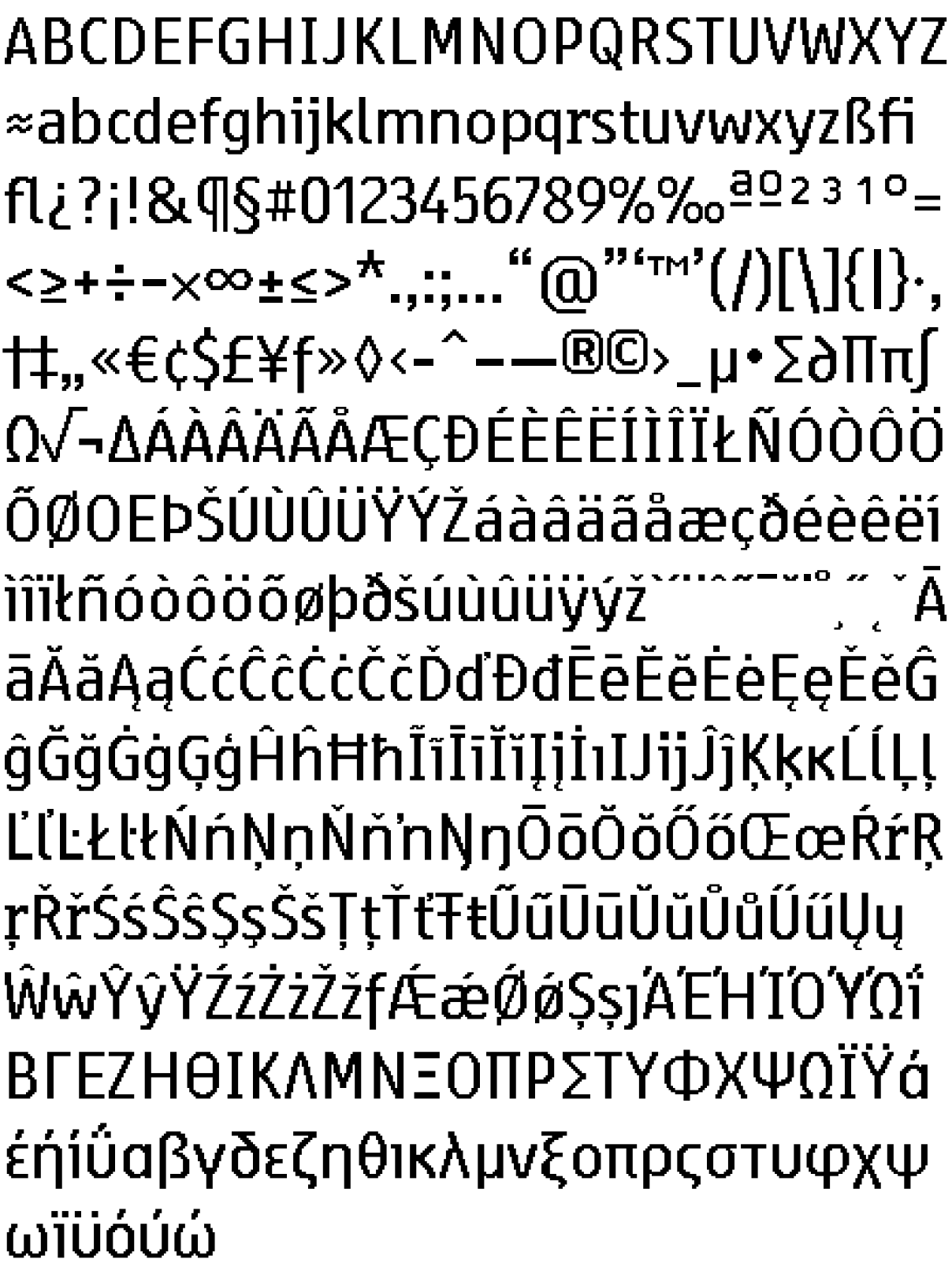


Figure 12: TernVMSthreeone character set

Typeface “TernVMStwofour” = 24 pixels -> to substitute currently used other typefaces of same x-height:

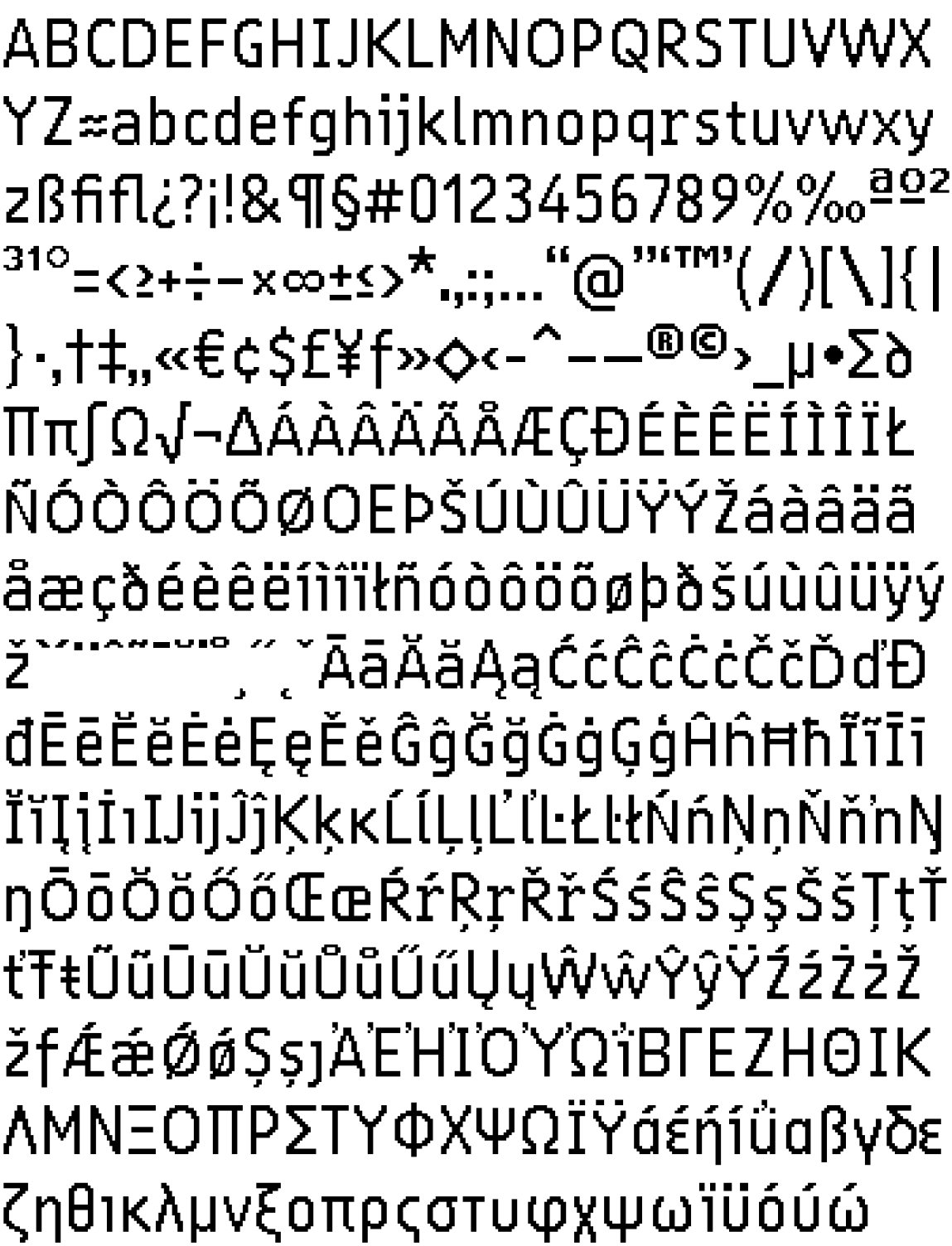
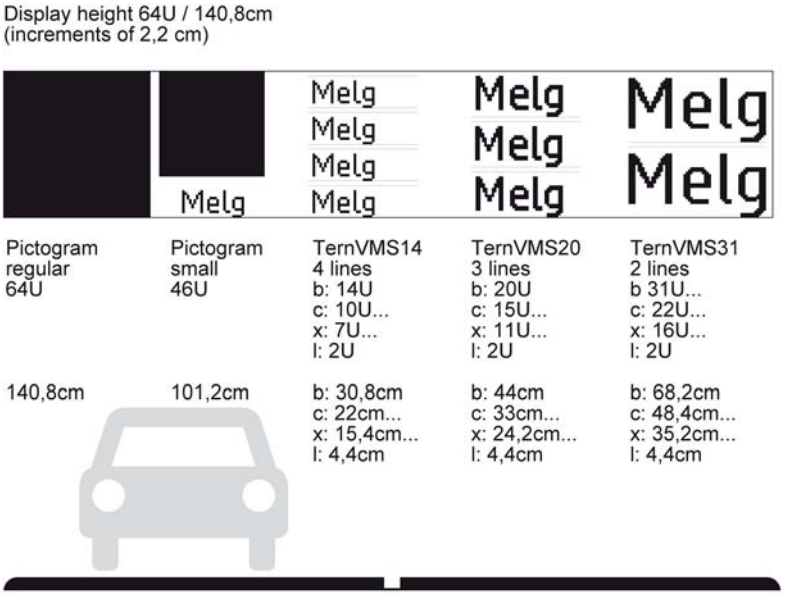


Figure 13: TernVMStwofour character set

2.4 Proposal of a European guideline for content structure on VMS

The content of VMS can be composed by relating to a well defined layout architecture which has been developed from the height of the standard sized “e” = x-height of the lower case characters of TernVMStwozero.

2.4.1 The basic grid



b: Body, here: from descender to top of ascender including accent
c: Cap height, Capital letter height
x: Lower case letter height (decender excluded), eg “e”
l: Leading, here: vertical distance between bodies
U: Units (LED´s, pixels)

Figure 14: VMS basic layout grid

2.4.2 Standard layout

- Three lines of text = height of a symbol/pictogram/traffic sign of 64 pixels (= 64 RGB LEDs)
- Deviation 1 (text subordinated): four lines of text = height of a symbol/pictogram/traffic sign
- Deviation 2 (text highlighted): two lines of text = height of a symbol/pictogram/traffic sign

2.4.3 Danger warning signs

The proposed solution to the problem with regard to VMS: to show every symbol/pictogram full size and to superimpose a flashing red bordered triangle, if needed, to heighten alertness.

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.

The procedure relates to Mare Nostrum considerations of "a possible distinction between the 'real' warning signs (for imminent danger) and signs informing about a more 'distant' danger (not using the red triangle, but for instance showing pictograms on a square background)". [xx)]
The Mare Nostrum position is also reflected in the already quoted paper of the UNITED NATIONS / Economic and Social Council / Economic Commission for Europe where it says [xxi)]:
"In order to differentiate as much as possible danger warning signs, only these should use the red triangle and should be placed on the spot or nearby the VMS (< 2 km).
In order to announce a dangerous situation at some distance (> 2 km) beyond the VMS, informative signs can use the same symbols, without the red triangle. To make clear the difference between acute danger warning and information on expected danger at some distance ahead, additional information (e.g. distance) is necessary."

The executed tests confirm the appropriateness of the approach.

As sizes of VMS on motorways need to follow a standard such is herewith suggested with reference to a max. driving speed of 100 km/h:

- Height of the display area: 140,8 cm (+ surrounding frame)
- Overall width of the display area corresponding to the width of the motorway. For a two-lane motorway this might be 7,5 m. In case the hard shoulder also needs to be covered (e.g. for the display of information in case the hard shoulder is released for general use to accommodate above average traffic or in case the hard shoulder is specified for emergency use), the width of the VMS should be aligned accordingly. However, under normal conditions a VMS should not extend into space above the hard shoulder.

It is possible to adapt the proposed modular concept to applications on roads allowing for generally higher speeds by increasing the overall dimensions of VMS along with the increments of the grid underlying the displayed information. Whilst only technical requirements restrict the height of an VMS, the width cannot exceed the width of the motorway.

In various cases there might be good reasons to use TernVMSonefour. This is considered permissible if restricted to short, generally well understood information, like the indication of a distance (e.g. "3 km") or length (e.g."100 m"), with or without accompanying arrows.
Another application could be the simultaneous display of bilingual place names in two by two lines. In such situations it is deemed necessary to check whether a preceding speed restriction should be decreeded to expand viewing time to appropriate length.

There might be other occasions on which more information needs to be displayed than permissible. This, of course, can be done in combination with imposed and enforced speed restrictions, well adjusted to allow motorists to assimilate and comprehend the message to be conveyed.

2.4.4 Examples for the use of the basic grid

Recommendations for the use of the basic grid with representative examples showing how symbols/pictograms, words, and combinations thereof, can be displayed to form composite messages:

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

Figure 15: Centered display of elements on VMS (Example)

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

Note: Information nearest to he upper edge of the VMS is the first that runs off in the point of disappearance.

Figure 16: Text messages to be built bottom to top (Example)

2.4.4.3 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.

Figure 17: Ranking of information elements on VMS (Example)

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 must not only be shown against reading direction it also reverses the sequential order of the overall composition of the display.

Figure 18: Ranking reversed in case of warning signalled by directional dependent element (Example)

2.4.4.4 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.

These rules, though plausible, need empirical confirmation.

Figure 19: Maximum number of elements on VMS, 4 x class 1 (Example)

Figure 20: Maximum number of elements on VMS, 2 x class 1 and 1x class 2 (Example)

Figure 21: Maximum number of elements on VMS, 1 x class 1 and 1x class 3 (Example)

2.4.4.5 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).

2.4.4.6 Spaces between information elements belonging together

(e.g. a danger warning symbol and he length between two indicated places) should be four times the defined smallest graphical detail; this would be 2 x 4 = 8 pixels (reference full scale symbol/pictogram = height of VMS display = 64 pixels).

2.4.4.7 For information elements not covered in 2.1.4

- “Tern Symbols- Complete list of symbols/pictograms elaborated in the project”, the following should apply:
One place name shown is to be considered Class 1.

Figure 22: One place name is considered class 1 (Example)

Additional place names shown on the same rate Class 1 but count 0,33, thus three additional place names get the same value as one solely shown place name.

Figure 23: One place name is considered class 1, every other name count 0,33 (Example)

2.4.4.8 To indicate a fair, a festival site or a sports event

the respective logo should be used = Class 2.
Regrettably it is near to impossible to design universally comprehensible symbols/pictograms for such referents.

Figure 24: Check marks and crosses indicate reachable/not reachable places (Example)

2.4.4.9 In case of an impassable stretch of motorway and indicated reachable and inaccessible places

the former are to be shown with appended check marks in green, the latter with appended diagonal crosses in red.

Figure 25: Check marks and crosses indicate reachable/not reachable places (Example)

2.4.4.10 A directional or rerouting arrow, a check mark, a danger warning triangle, and a diagonal cross

adjacent to a place name or superimposed a symbol/pictogram to indicate “out of order” may not be regarded an information element with a countable value attached.

2.4.4.11 To help drivers who need to consult road maps for orientation, place names are to be in correspondence with road maps

e.g. big cities in capital letters, others in capitals/lower case.

Figure 26: Place names to be shown in accordance to road maps (Example)

2.4.4.12 To avoid possible confusions with indications of distance or speed limits, exit numbers

should be shown as on directional signs (e.g. on circular, rectangular, or other well defined backgrounds in subject specific colours according to national regulations should such exist).

2.4.4.13 Length given by place names with an arrow in between

(e.g. referring to an obstruction from/to) are to be shown on one line (see Figure 27), not staggered. No other information element must be placed to the right of such an indication as this could enhance the impression of a (not existing) affiliation of the indicated length and the other information element. The same applies to the display of length/distance indicated in m or km.
In case the above said cannot be avoided, the distance between such neighboring information elements should at least equal 200% of the body height of related type of three lines of text; this would be 40 pixels (body of reference type TernVMStwozero is 20 pixels high, 200% of this = 40 pixels).

Figure 27: Distances indicated by place names (Example)

Figure 28: Distances indicated by place names. Names not to be staggerered (Example)

2.4.4.14 Length indications referring to a specified hazard

should build on research results of Mare Nostrum which suggest that an indicated length (e.g. “15 km”) should follow an equal sign to read “= 15 km”. [xxii]) This applies only to information given prior to the beginning of the indicated sort of length.
In the course or at the beginning of an indicated length the recommendation of the Vienna Convention applies (length from the given position to end displayed between arrows pointing upwards.

2.4.4.15 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.

Figure 29: Small size element application (Example)

2.4.4.16 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.

Figure 30: Possibilities of signaling danger, with regard to distance (Example)

2.4.4.17 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.

Figure 31: Lane separation provided by lines according to road markings on road surface (Example)

2.4.4.18 Whenever a symbol/pictogram is shown with superimposed triangle or diagonal cross

indicating prohibition or “out of order” these graphical elements are to be shown 3 tenth of a second in intervals of 8 tenth of a second.

Figure 32: Superimposing a flashing triangle (Example)

2.4.4.19 Static information on the TERN

to be composed in accordance with applicable national regulations.

3 Suggested further research

Due to the complexity of the task it became evident that some not anticipated problems would need to be cleared and that some of the elaborated results would need to be secured through further research.

3.1 Symbols/pictograms

3.1.1 Improvement of symbols/pictograms that failed to hit the benchmark

Redesign, refinement and retesting of symbols/pictograms which failed to hit the defined benchmark to be considered for inclusion into the list of recommended symbols/pictograms; such symbols/pictograms like “(Underground trains) depart every x minutes” stand for complex referents/meanings which require further investigations

3.1.2 Defining symbols/pictograms as character sets

Defining symbols/pictograms as character sets to go with the defined “Tern” fonts. This would facilitate the ease of application through automated display software.

3.1.3 Identifying the most usable arrow

Extensive evaluation of the standard Vienna Convention arrow in comparison with the “Belgian arrow” used for general public information; the evaluation would have to be done with regard to anticipated scenarios and applications

3.1.4 Evaluating variations of spacing between symbols/pictograms

3.1.5 Research on alternative durations and sequences of animations on VMS

- Research on alternative durations and sequences of flashing elements
- Research on alternative durations of sequences of animated symbols/pictograms

3.1.6 Research on a warning depending on the distance to a hazard

Research on the distance to a hazard or an impassable facility from which a symbol/pictogram should be superimposed with a flashing danger warning triangle or a diagonal cross

3.1.7 Evaluation of elements indicating impassable road infrastructure

Test result analysis and the need for a consistent logic of the system concerning VMS messages as proposed in this deliverable, demand further research to clarify whether to use a diagonal red cross (shaped like an “X”, see Figure 23 and Figure 25) or red circle as suggested by the Vienna Convention On Road Signs And Signals, Symbol C, 2, to signal impassable road infrastructure.

3.2 Typeface

3.2.1 Completion of the “Tern” with a Cyrillic version

Completion of the “Tern”-typeface with a Cyrillic version and with Roman and Bulgarian keyboard configurations

3.2.2 Complementing Tern comparison test

Verification of the superiority of the “Tern” over other defined VMS typefaces through a final (comparison) test

3.2.3 Integrating specific symbols/pictograms into the Tern typeface family

Advantages/disadvantages of the possible integration of specific symbols/pictograms (e.g. check mark (“tick”), diagonal cross, standard arrow, Rerouting/”Delestage” arrow, “Centre”, “Exit”) into the Tern typeface family

3.2.4 Integration of motorway exit numbers

IMPROVER in improver_final_report_sp4_appendix_f_060405.pdf, para 3.2 “Use of exit numbers” concludes “all exits should have numbers … they should be preceded by a symbol”, without, however, giving concrete recommendations on how the numbers should be differentiated from road numbers and what sort of symbol should precede the exit numbers.
To avoid confusions with road numbers and, more apparent, with indications of distances or exit speed limits, research on a possible common denominator of currently indicated exit numbers seems to be indispensible; based on the outcome a recommendation could be made of how to show exit numbers on VMS; subsequently their integration into the Tern typeface family could be undertaken whereby special attention has to be given that one, two and three digit numbers are to be accommodated.

3.2.5 Integration of nationality symbols

IMPROVER in improver_final_report_sp4_appendix_f_060405.pdf, recommends in Chapter 7 "Conclusions", Table 9: "The nationality symbol of the next foreign country should be added to the E-number close to the border." IMPROVER does not say anything about the rendering of the national symbols and seeminly takes it for granted that they should conform with the convention governing the use of nationality definitions on motor vehicles. Over many years the popularity of these identifications was enhanced due to their use in combination with postal codes. However, this has been stopped lately by the International Postal Union. At the same time ISO 3166-1 alpha-2 codes get a boost as affixes to TLD´s. It should pay off investigating the future of the two systems and the current and estimated future understanding of the codes by motorists.
Depending on the outcome of such an investigation exemplary applications could be designed, showing how to implement the suggestions of IMPROVER on VMS.
IMPROVER Subproject 4, Appendix F, Harmonization scenarios and recommendations, TREN-04-ST-S07.37022

3.2.6 Integration of E-numbers and national road numbers

IMPROVER in improver_final_report_sp4_appendix_f_060405.pdf, para 3.1 "Use of E-road numbers" states "The harmonised use of road numbers would likely to improve traffic safety, because driver decision making at the strategic and tactical level would be enhanced (the potential behavioural effect is high)" and recommends "the harmonisation should first focus on the use of E-numbers".
The integration of E-numbers in their harmonized appearance into the Tern typeface family could be undertaken whereby special attention has to be given that E-numbers with two and three digits, besides of the E, are to be accommodated.

3.3 Keywords/Europeanisms

3.3.1 Verification of adequate comprehensibility of the Europeanisms

Verification of adequate comprehensibility of the Europeanisms, suggested for use by INFOTERM, also considering the languages of the most recent EU member states, Bulgarian and Romanian

3.3.2 Place names, notation

Determining precise conditions for capitalization. Clarification of steps to be taken with regard to place-name and direction signs on roads and place names in road maps

3.3.3 Place names, abbreviations

Elaborating suggestions for abbreviating long place names

3.3.4 Verbal representation for all symbols

All graphical symbols and pictograms (and many/most letter symbols, too) must have a verbal representation, in order to comply with special needs e.g. of accessibility. This comprises both written and spoken verbal forms, which have to localized (not just translated) into the different languages of Europe. The written verbal form should not only follow the linguistic and specialized traffic conventions of the respective language, but also consider situations of noisy environments, particular hearing impairment, etc. The respective data and data structures, therefore, should comply with the recommendations in document MoU/MG/05 N0221 "Semantic interoperability" adopted by the

Management Group of the ITU-ISO-IEC-UN/ECE Memorandum of Understanding concerning eBusiness standardization, whose compliance guarantee unrestricted multilinguality, cultural diversity, multimodality, accessibility (incl. the requirements of people with special needs) and multi-channel presentation

3.4 Content structure

3.4.1 Developing advanced test techniques for the evaluation of the effectiveness of composite messages

Considering the importance of the correct reaction of drivers to the displayed information, advanced test techniques would combine the recording of message interpretation and, by employing a driving simulator, the resulting performance of motorists.

3.4.2 Scenario building and programming

Building scenarios and programming all conceivable combinations of information elements for concrete applications on freely programmable VMS as defined in D 2.3

3.4.3 Full scale test installations

Evaluation of the results and concluded suggestions elaborated under 4.3.2 on full scale test installations; also to find out whether a linear increase of increments underlying VMS displays would be justifiable for applications on motorways where vehicles travel faster than 100 km/h.

3.4.4 Sequence of information elements on VMS

Evaluation of recommendations of D 2.3 employing eye-tracking techniques; also to find out whether approaching hazards which have their origin outside of the motorway (e.g. “deer on road”) require the depicted referent to indicate movement from right to left (resp. from left to right in countries where traffic keeps to the left) or whether reading direction is the determining factor.

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 must not only be shown against reading direction it also reverses the sequential oder of the overall composition of the display.

3.4.5 Rules governing the maximum number of information elements on VMS

Evaluation of the rules governing the permissible maximum number of information elements on a VMS

3.4.6 Principles of diagram traffic signs

Developing principles of (VMS-) diagram traffic signs to graphically indicating (an) alternative route(s) in case of a blocked stretch of motorway

3.4.7 Positioning criteria

Developing rules for positioning VMS signs, also a declared concern of Mare Nostrum [xxiii]), of special relevance in complex road situations where information on the same event needs to be split up for being shown on two (or more) VMS signs

3.4.8 Repetition of information

Determining criteria for the repeated display of information according to insights reported by Covault et al. [xxiv]) which have a positive influence on lane-keeping and travel speed stability.

4 Policy recommendations

Insights gained from elaborating the results of D 2.3 make the Consortium proposing the following recommendations.

4.1 Recommendation to the European Commission to amend Annex III of Council Directive 91/439/EEC: Review the viability of 0,5 visual acuity

It is recommended to consider an amendment of Annex III of Council Directive 91/439/EEC of 29 July 1991 on driving licences which requires that applicants for a driving licence or for the renewal of such a licence shall have a binocular visual acuity, with corrective lenses if necessary, requiring at least 0,5 when using both eyes together.

The European Commission is reminded that it is technically impossible to display on VMS on a two lane motorway more than three information elements (e.g. pictograms) in a size easily comprehensible by drivers with visual acuity of 0,5 travelling with a speed of 100 km/h.

The requirement of 0,5 visual acuity is suggested to be changed to around 0,73, taking into account the opinion of experts that the average visual acuity of a healthy eye is significantly higher than 1,0 (1,0 was the basis of considerations behind the defined lowest acceptable visual acuity of 0,5). Compare with “2.3.1 Determining the absolute size of the “Tern” versions”.

Nowadays challenges of drivers, that unfavourably compare to the time when visual acuity of 0,5 was defined, should also be considered:

- 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 when 0,5 acuity was introduced against 4.205.000 in 2006),
- Motorways in many European countries did not exist (in Austria the “network” of motorways amounted to 27,6 km in 1955 against 1.677,5 km + 400 km of Highways in January 2007.

As an alternative to amend Council Directive 91/439/EEC it is suggested that drivers with visual acuity not higher than 0,5 should be requested to observe a speed restriction, the height of which would need to be defined. A lower speed would give such drivers more time to decipher VMS messages and wayshowing information on permanent signs.

4.2 Recommendation to motorway administrators: Invest in freely programmable RGB LED-VMS, 64 pixel high with increments of 22 mm for speeds up to 100 km/h

Freely programmable LED-VMS allow the combination of traffic signs/symbols/pictograms together with verbal information according to “2.4 Proposal of a European guideline for content structure on VMS”.

Grid increments of 22 mm cater for the need to render the smallest graphical detail (for eyes of visual acuity 0,73) which is about 44 mm in size. Increments and therefore also the overall size of VMS need to be enlarged for speeds higher than 100 km/h.

RGB LEDs enable the display of all colours defined in the Vienna Convention, and many more colours as needed to display emblems of transport companies and the logos of traffic generating events like trade fairs, festivals or athletic contests.

4.3 Recommendations to authorities responsible for decreeing and implementing regulations governing road traffic in general and traffic on motorways in particular:

4.3.1 Make “2.1 Proposal of a European guideline on pictograms for static and variable message signs” binding by amending/supplementing the Vienna Convention on Road Signs and Signals

The proposed pictograms for static and variable message signs are available free of charge from IIID for use in member states of the European Union. They are based on a development and evaluation procedure of several stages in which symbol/pictogram variants have been collected, designed, tested and redesigned to achieve highest possible comprehension.

The recommendation concerns:

- symbols/pictograms to substitute analogue ones regulated by the Vienna Convention
- symbols/pictograms depicting referents not yet included in the Vienna Convention

4.3.2 Take steps for making the “Europeanisms” as proposed by INFOTERM binding for use on VMS

The “Europeanisms”, based on an enquiry done across Europe, are listed in “2.2.1 Europeanisms”. They comprise those verbal information elements, which have the potential to be understood throughout Europe without learning (or only minimal efforts on the side of the learner) and to supplement pictorial information on VMS and static displays. This is recommended notwithstanding the proposed verification of adequate comprehensibility of the Europeanisms, also considering the languages of the most recent EU member states, Bulgarian and Romanian.

4.3.3 Define and harmonize referents/meanings, as suggested in "2.1.5.4 Referents/meanings, not yet generally introduced in the EU"

Referents/meanings to include:

- Fines doubled (as in areas of road works)
- ECO / ÖKO Zone
- Fog Speed Control dots on the side of motorways in districts of frequently occurring fog
- HOVs (High Occupancy Vehicles)
- P+R (Park and Ride)
- Rerouting ("Delestage" arrow)
- SMOG (Inversion weather)
- Congestion charge.

4.3.4 Harmonize traffic signs regulated by the Vienna Convention which are not meant to be used on VMS with those that have been adapted in Deliverable 2.3.

The adaption is recommended to be done according to
"Suggestions on how to adjust the not yet reworked Vienna Convention traffic signs (2.1.5.2)".

Figure 33: Schematic symbol-rendering (right) and outdated current practice example (left)

Considering that the Vienna Convention dates from 1968: the standard of road construction, road maintenance and the look, feel and performance of vehicles that drive on the roads have changed considerably. However, as the look of the road signs according to the Vienna Convention has remained unchanged, their feel resembles a world of long bygone days.

A more schematic rendering of the symbols is proposed – following a general tendency towards economic sign systems. This should be attained by not disregarding the need to conserve enough realistic features in the symbols to differentiate one from the other in an easily discriminable way.

4.3.5 Make "2.3 Typeface "Tern" for use on static signs and on VMS" binding by supplementing the Vienna Convention on Road Signs and Signals accordingly.

The proposed typeface is available from IIID free of charge for applications in member states of the European Union. The "Tern" has been designed, tested and refined for optimal legibility and economy of space in four sizes for use on freely programmable RGB LED-VMS (64 pixel high) and conventional road signage (for printing and plotting– a vector graphic based).

No other similarly versatile typeface for VMS and static traffic information displays exists.

4.3.6 Promote "2.4 Proposal of a European guideline for content structure on VMS" by supplementing the Vienna Convention on Road Signs and Signals or make it – notwithstanding suggested further research in para. "3.4 Content structure" – part of a VMS related official standard.

The grid underlying the content structure conceived for implementation on freely programmable RGB LED-VMS, 64 pixel high, allows for the most suitable composition of messages to be conveyed on motorways, consisting of traffic signs/symbols/pictograms with and without verbal information.

4.3.7 Future traffic signs to be regulated throughout Europe should not be released without having been tetsted for ease of comprehension according to ISO 9186:2001

ISO 9186:2001 Graphical symbols – Test methods for judged comprehensibility and for comprehension.

4.4 Recommendations to authorities responsible for decreeing and implementing regulations governing road traffic:

4.4.1 Harmonize vehicle symbols used on roads with those depicted in driving licenses

Symbols representing vehicle- classes used in driving licenses should not differ from those used for identical referents/meanings on traffic signs, steps to safeguard harmonization of such symbols/pictograms should be taken to be able to refer to specific road users whenever appropriate more effectively than currently possible.

List of annexes

Annex	Description	Author	File name
1	Categorized List of collected pictograms/symbols and referents referents	IIID	ResultsDesPsychVieOct05-11.pdf
2	Motorway relevant Vienna Convention traffic signs from eleven EU countries	IIID	TrafficSigns(VC)forVMS.pdf
3	Design guidelines for bitmap (VMS) displays	BM	Designing for bitmap #E877B.pdf
4	Comprehensibility Judgement (CJT) Test Report	DUK	CJT_Report.pdf
5	Comprehension Test (CT) Report	DUK	InSafety_CT_Report_Final.pdf
6	2nd Comprehension Test (2ndCT) Report	DUK	InSafety_2ndCT_Report_FINAL.pdf
7	Comprehension Test on Animated Pictograms (CAT) Report	DUK	InSafety_CT_Report_Final.pdf
8	Evaluation of Warning Elements for Matrix Displays (WET) Report	DUK	ReportOnWarningElements.pdf
9	Pictogram development and requirements	IIID	PictogramRequirements_v12.doc
10	[VMS-] Content Structure Test (CST) Report	DUK	InSafety_CST_Report_FINAL.pdf
11	Impaired Visibility Typeface Test (IVT) Report	DUK	InSafety_IVT_Report_Final.pdf
12	Methodology of Activity 2.3	INFO TERM	IN-SAFETY_A-2-3_Methodology_FV.PDF
13	Recommendations on “Europeanisms”	INFO TERM	IN-SAFETY_A2-3_Europeanisms_E#1DB_v3.pdf
14	Proposal on a Testing approach for bilingual messages	INFO TERM	TestApproachForBilingualVMS.doc

Table 26: List of annexes

5 Endnotes

i) UNITED NATIONS. Economic and Social Council. Economic Commision for Europe. Inland Transport Committee, Working Party on Road Traffic Safety, Forty-sixth session, 14-16 March 2005, REVISION OF THE CONSOLIDATED RESOLUTIONS R.E.1 AND R.E.2, agenda item 5 (j): Variable Message Signs, para. 6 “Message content and structure for VMS use”, item 7, 2005.

ii) Dirección General de Tráfico (ed.): Mare Nostrum: Towards a European VMS Contents Harmonization, p 10, Colmear Impresores S.L., 2006.

iii) CEDR - Conference of European Directors of Roads: action FIVE. Framework for harmonised Implementation of Variable Message Signs in Europe, 3.3.7, p 16, 2004.

iv) TROPIC - TRaffic OPtimisation by the Intergation of information and Control, Trial Phase: Final Report, 3.1.5.1 Information Overload, p 103, 1999.

v) TROPIC - TRaffic OPtimisation by the Intergation of information and Control, Trial Phase: Text and Combined Message Reference Manual, 4.3 Major Findings of WP12, p 13, 1998.

vi) ERKE Alena, HAGMAN Rolf and SAGBERG Fridulv: Traffic information and driver attention: A study of variable message signs and their effects on driver behaviour, modified to “Effects of route guidance variable message signs (VMS) on driver behaviour” for Science Direct, p 447-457, Transportation Research Part F 10, 2007, available online at www.sciencedirect.com

vii) KRAMPEN Martin: Signs and Symbols in Graphic Communication, p 12, Design Quarterly 62, Walker Art Center, Minneapolis,1965

viii) TROPIC - TRaffic OPtimisation by the Intergation of information and Control, Trial Phase: Text and Combined Message Reference Manual, 4.2.1 Experiments performed by PTV, p 11, 1998.

ix) European VMS Platform / Düsseldorf Workshop, Table 9: Regulatory Pictogram – Flashing Lamps and Messages, p 42, 43, Report, Highways Agency, London, June 2003,

x) “A single amber flashing light or two amber lights flashing alternately shall mean that drivers may proceed but shall do so with particular care.” Article 23, para. 1 (B ii) of the Vienna Convention under “Signals for Vehicular Traffic”

xi) British Statutory Instrument 2002 No. 3113 / The Traffic Signs Regulations and General Directions 2002, Regulations 38(a), 38(b), Schedule 11, Part II, Light Signals (for motorways and all-purpose dual carriageway roads), Illustrations 6031.1, 6032.1

xii) LUCAS Antonio: On flashing lights. Internal paper circulated to SOMS/IN-SAFETY members 2005-11-11.

xiii) British Statutory Instrument 2002 No. 3113 / The Traffic Signs and General Directions 2002, Schedules to the Regulations, Part X, Motorway Signs

xiv) KRAMPEN Martin: Icons on The Road; para. 1.3.5 and 1.3.6, p 31, Semiótica, Vol. 43, No. 1/2, 1983

xv) SIMLINGER Peter: Designing public information symbols, p 182-190, Information Design Journal, Vol. 1, 1980:
"*Solid forms* should be generally preferred. Psychologists agree that boundary contrast is more effective than line contrast (EASTERBY R. S.: The Perception of Symbols for Machine Displays, p 149-158, Ergonomics, Vol. 13, 1970). Outline forms, however, should be used to represent objects or elements made of glass, paper or other translucent or light materials".

xvi) http://www.sicherestrassen.de/_suchenfinden.htm
Fahrstreifenbreiten von Kraftfahrzeugen, Querschnittsgruppe A, zulässige Geschwindigkeit >= 100 km/h, Grundfahrstreifenbreite 3,75

xvii) Bundesgesetzblatt für die Republik Österreich, Jahrgang 1955, ausgegeben am 31. Dezember 1955, 73. Stück: 283. Verordnung des Bundesministeriums für Handel und Wiederaufbau vom 16. Dezember 1955 über das Kraaftfahrwesen (Kraftfahrverordnung 1955)

xviii) Documentation of Wirtschaftskammer Österreich: Kraftfahrzeuge / PKW-Bestand Kfz-Bestand Neuzulassungen von Kfz , "Kfz Bestand ab 1950.pdf"
Quelle: STATISTIK AUSTRIA, Aktualisierung: Mai 2007

xix) Documentation supplied by KfV:
Opening dates of motorways and highways in Austria (Date / Motorway / section / Length)

	A 1 WEST AUTOBAHN	
19.12.1949	prov. ASt Zilling (near Eugendorf) – ASt Salzburg-Mitte (right directional lanes): approx. 7,700 km	
19.12.1949 *)	Sam – ASt Salzburg-Nord (left directional lanes):	approx. 1,500 km
12.10.1951 *)	ASt Salzburg-Nord – ASt Salzburg-Mitte (li RFB):	approx. 1,600 km
13.9.1941 *)	ASt Salzburg-Mitte – Staatsgrenze am Walserberg A/D:	approx. 9,300 km
	A 10 TAUERN AUTOBAHN	
13.09.1941 *)	Kn Salzburg (A 1) - ASt Salzburg Süd:	7,524 km

*) According to the Bundesstraßengesetznovellen 1954 resp. 1958 these sections officially (again) became motorways. Note: The next section of motorway in Austria was not opened before 1958.

xx) Dirección General de Tráfico (ed.): Mare Nostrum: Towards a European VMS Contents Harmonization, p 40f, Colmear Impresores S.L., 2006.

xxi) UNITED NATIONS. Economic and Social Council. Economic Commision for Europe. Inland Transport Committee, Working Party on Road Traffic Safety, Forty-sixth session, 14-16 March 2005, REVISION OF THE CONSOLIDATED RESOLUTIONS R.E.1 AND R.E.2, agenda item 5 (j): Variable Message Signs, para. 5 "Relation between road situations and road sign classes for VMS", From danger warning to informative, 2005.

xxii) Dirección General de Tráfico (ed.): Mare Nostrum: Towards a European VMS Contents Harmonization, p 35, Colmear Impresores S.L., 2006.
Correct answers given in Comprehension Tests carried out in Spain, France, Italy and The Netherlands rate 79,8% against 67,2% conforming with the Vienna Convention showing one upwards pointing arrow on the right and one on the left of "15 km".

xxiii) Dirección General de Tráfico (ed.): Mare Nostrum: Towards a European VMS Contents Harmonization, p 41, Colmear Impresores S.L., 2006.

xxiv) COVAULT D. O., DERVISH T., KANAU A.C.: A Study of the Feasibility of using Roadside Communications for Traffic Control and Diver Information, p 32-36, Highway Research Record, 1967