SOUTHERN

AFRICAN

DEVELOPMENT

COMMUNITY

VARIABLE MESSAGE SIGNS

SECTIONS

MAY 2012

CHAPTER 9

CHAPTER 9: VARIABLE MESSAGE SIGNS

9.1 INTRODUCTION

9.1.1 General

1 The growing traffic congestion on sections of the road network, in combination with its ever-increasing complexity, requires that road authorities consider special management methods to control and optimise the use of the network. Such needs may exist in major metropolitan areas, on by-passes or on rural sections of roadway during peak holiday seasons.

2 Variable message road traffic signs may be used as a component of a Road Traffic and Safety Management System. The type of sign covered by the description VARIABLE MESSAGE SIGN varies extremely widely, from the well-known STOP/GO sign R1.5A/R1.5B, which is manually operated, to highly sophisticated, computer operated, gantry mounted fibre optic signs which offer the option of many different messages.

3 Economic considerations are often such that funding cannot be made available to build new roads. It becomes necessary as congestion develops that the best possible utilization is achieved from the road space available. In addition this will limit the environmental impact of a growing road network, and in cases where land is scarce, will allow a wider range of land use activities.

4 VARIABLE MESSAGE SIGNS can play an important role in the safe optimization of available road space whether it is in and around our cities, or on other sections of the network subject to operational break- downs due to bad weather, accidents or maintenance activities. In assessing the need for major variable message sign installations the economic considerations of not doing so must be thoroughly investigated. Roads, and in particular freeways, represent a major capital investment and the best return on this investment should be achieved.

5 Safety is undeniably of paramount importance, but although safety is obviously important from the point of view of relieving human suffering in the form of accidents, it also has major economic implications. On a national scale accidents and congestion cost vast sums of money. These costs occur in the form of damage to vehicles and public utilities and in hospitalisation, and in lengthy delays to thousands of people at a time. The less direct costs involved in providing emergency, ambulance, tow-away services and emergency traffic control together with the cost of administrative overheads add significantly to the national cost. Road traffic and safety management techniques aimed at reducing these costs are likely to produce worthwhile returns on the investment involved.

6 The harmonizing and stabilizing of traffic speed are vital factors in road safety. Harmonising traffic speed will increase the dynamic capacity of a roadway significantly and this is particularly important when the static capacity of the roadway has been reduced as a result of a lane closure due to an accident or roadworks. Drivers instinctively adjust their speed under adverse conditions. They will, however be unaware of conditions three or four kilometres ahead of them. If those conditions become unstable drivers are not able to react so as to maintain harmonious flow conditions. If a traffic control management system is provided, however, advice can be given remote from the site of an incident location, which will allow harmonious flow conditions to be maintained.

7 As a general example, due to reduced headways required, a reduction in running speed by some 35% could result in 150% more capacity on a given section of roadway.

9.1.2 Objectives of VMS

1 The introduction of VARIABLE MESSAGE SIGNS should be aimed at achieving one, or more, of the objectives listed in the following paragraphs.

2 The primary objective should be greater safety, achieved by:

(a) reducing the risk of primary accidents;
(b) giving advance warning of conditions which may result in traffic queues so that the increased likelihood of secondary accidents is reduced.

3 The next major objective should be better utilization of road capacity and therefore a reduction in the cost of congestion by:

(a) distributing traffic more evenly in the road network;
(b) achieving stable traffic flow conditions;
(c) avoiding localised congestion resulting in long delays.

4 It should also be an objective to make the task of the police, road construction units and other authorities responsible for the safe use of the roadway easier by:

(a) providing the means for rapid and effective action for incident management;
(b) offering aids which will enable roadworks to be carried out more quickly and efficiently.

5 In addition when a sophisticated system is under consideration it should be designed to collect traffic data with the objective of:

(a) facilitating an assessment of the state of the system;
(b) using the data to assist decision-making in order to optimize use of the system;
(c) developing new strategies which can be used to amplify the system at a later date.

6 The achievement of these objectives will best be realised by designing the system to provide one or more of the following:

(a) a facility for advising a constant (normally reduced) speed in special circumstances e.g.. mist, fog, accident;
(b) detection of disruptions in traffic flow and translating this into warnings to reduce speeds;
(c) adequate warning of changes in road situation e.g. roadworks, maintenance etc.;
(d) the use of the system to close off a lane simply and clearly with the emphasis on simplicity and speed;
(e) by making it possible for the police to close a lane

and/or introduce speed controls in the event of an accident;

(f) a flexible system of data collection and recording which allows for all forms of data to be collected simultaneously at a large number of points.

9.1.3 Applications for VMS

1 The number of applications for VARIABLE MESSAGE SIGNS in the traffic and transportation field is constantly growing. Typical of current applications are the following:

(a) hazard warning;
(b) speed regulation or advice;
(c) specific vehicle routing (including bus lanes);
(d) alternative routing;
(e) road construction and maintenance;
(f) lane control and reversal of lane use;
(g) parking availability;
(h) transport terminal information, both externally and internally.

2 Collectively these applications may be considered to come under the general description of Road Traffic and Safety Management Systems.

9.1.4 Types of VMS

1 The range of VARIABLE MESSAGE SIGN types is large. A number of examples of basic types are illustrated in Figures 9.1 and 9.2.The range in sophistication is also large and this is a factor which makes the selection of the most appropriate type for a specific task difficult. Ultimately the final decision is likely to be based on economic considerations and the more ex- pensive installations must only be chosen after a comprehensive cost benefit analysis has been carried out. Due to the lack of direct Southern African experience of VMS's, it is likely that pilot projects will be required over a number of years to determine the ideal parameters for a comprehensive variable message sign traffic management system.

2 The sign types listed below will be covered in more detail in subsequent Subsections. The more commonly used types of variable message sign, from the simplest to the most complex, are:

(a) manually operated (light reflecting) - Figure 9.1:

(i) rotating sign on a stand or easel such as the STOP/GO sign R1.5A/R1.5B;

(ii) flip sign;

(iii) hanging or clamped message;

(b) electro-mechanical involving moving parts (light reflecting) - Figure 9.1:

(i) various combinations of roller blind or belt;

(ii) different arrangements of rigid plates;

(iii) rotating plank or prism;

(iv) matrix with rotating discs *(lamella);*

(c) electrical or electronic with no moving parts (or a very limited number) (light emitting) - Figure 9.2:

(i) matrix of illuminated bulbs;

(ii) matrix of fibre-optic cones.

3 This volume does not cover details of the electrical characteristics of various types of variable message sign, however, a specific problem may relate to the use of such signs. The option to have a mains electricity supply in a rural situation will often not exist or will be prohibitively expensive. Considerable technological advances are occurring in the use of solar energy panels to maintain battery operated systems for long periods of time. Alternatively signs may be trailer mounted in conjunction with a portable generator. The possibility of using such power sources should be investigated in respect of potential rural installations.

9.1.5 VMS: Message Types

1 VARIABLE MESSAGE SIGNS may be used to transfer any of the traditional road traffic sign message types, namely:

(a) regulatory;

(b) warning;

(c) guidance;

(d) information.

9.1.6 Colour Code for VMS

1 Variable message sign types which do not require internal illumination can operate within the standard road traffic sign colour code without any difficulty.

2 Light emitting or internally illuminated electrical or electronic signs which are most likely to be of the matrix type, can, with existing levels of technology, illustrate symbols and text with acceptable legibility. However, the ability to provide a fully illuminated regulatory or warning sign background in WHITE, or BLUE for a PERMANENT sign or YELLOW for a TEMPORARY sign, in conformity with the Southern African road traffic sign colour code, whilst technologically possible, requires high electrical power levels. This requirement would, at present, rule out the use of battery or solar power, and if provided from a mains supply would be extremely costly.

3 In the interests of safety, and because of the conspicuity effectiveness of red at long range, the RED border shall be retained for circular PROHIBITION signs and triangular WARNING signs, when it is intended to enforce the prohibition message. If it is not intended to enforce such a message, the message should be given in an advisory manner as a text message commonly in association with a triangular warning sign indicating the reason for the advisory message. For practical considerations, however, all internally illuminated electrical or electronic variable message signs may use a WHITE or YELLOW symbol or text on a BLACK background.

4 Examples of regulatory, warning and advisory messages are given in Figure 9.3.1. Detail 9.3.1 illustrates two stages of a typical gantry mounted lane control VMS. These stages would normally be preceded by a default indication showing 80 km/h over all lanes, or, alternatively, a downward pointing arrow over each lane.

9.17 Manually Operated VMS

1 In order to realise the benefits of variable message signing in as many situations as possible the use of properly designed manually operated signs is recom-

mended. In fact, if some warning or guidance message is not applicable at all times at a specific site an inexpensive manually operated sign should be used. The initial cost of such signs is unlikely to exceed two or three times the cost of a conventional warning (or regulatory) sign, however, there is a manpower requirement in seeing that the correct message is displayed at all times.

2 It is pointless utilizing a variable message sign if it is not going to be used properly. Road users will quickly notice if a sign is displaying the incorrect message and will ignore it on subsequent viewings, perhaps with extremely serious consequences. This in turn will bring the whole road traffic signing system into disrepute.

3 Typical examples of manually operated variable message signs, which may commonly include as one of their two or perhaps three messages, a "NIL" message or blank signface, are :

(a) the STOP/GO sign R1.5AIR1.5B;

(b) various warning signs which ONLY have a temporary application, such as TRAFFIC CONTROL AHEAD sign TW304, SCHOLAR PATROL AHEAD sign TW305, ROADWORKS sign TW336, which may for reasons of convenience be permanently erected but displayed for a limited time, should therefore, when not relevant, have their message hidden leaving a blank sign face;

(c) this same technique may be used with certain SELECTIVE RESTRICTION signs which are applicable only for certain times of the day;

(d) some warning signs which have a "handed" message may be easily converted from a "left" side message to a "right" side message e.g. SURFACE STEP signs TW340 and TW341;

(e) combination warning and advisory messages, where the manual changing of a range of advisory messages may be expected. (The reason for the need for caution e.g., smoke, fog, flooding, etc. can be linked to an appropriate advisory speed, and perhaps the distance for which the condition may be expected can also be indicated.).

4 Examples of manually operated variable message signs are included in Figure 9.1. (See Section 9.2 for dimensional requirements).

5 Although such signs are simple in their operation it is recommended that in the case of the type covered in paragraph 9.1.7.3(e) a log of the number of alterations to the sign be kept. This data will be useful in justifying a decision to upgrade the sign to a more costly but more automated system.

9.1.8 Electromechanical VMS

1 Variable message signs of this type allow a wider variation in available messages from one sign face. The roller blind or belt could display a wide range of messages provided there is sufficient space to allow a long roller or belt to be accommodated. Such a situation could be cost-effective at a toll plaza where segregation of vehicles by toll-class may be necessary. Normally if used at the roadside the number of messages will be limited to two or three, one of which may be a blank display.

2 Rigid plate, rotating shutter and rotating plank or prism signs are all likely to have a limitation on the range of messages. If the requirement is for a limited display these types may be cost effective. These signs will normally also have a manual override capacity in case of a loss of power.

3 As the technology develops the use of matrices comprising two-state (bi-stable) display elements known as the *"lamella* technique" will become more attractive for road traffic sign messages. Each individual element in the matrix is electronically separately controlled. A short current impulse of about 350 ms is sufficient to turn the *"lamellas•* or discs. A very wide range of messages is possible and later developments with up to four faces per element may allow full colour display. Such systems have to be computer controlled and are extremely expensive on a unit rate (per m^2) basis. However, with greater use, costs may come down to the extent that this sign type becomes cost effective. The sign type is widely used in USA and Canada, and in advertising.

4 Even in a normal environment this group of signs is likely to require regular maintenance. The ingress of water, dust or other foreign matter can cause break- down due to the often small spatial clearance between elements.

5 Manually operated and electromechanical variable message signs are light reflecting signs. As such they shall conform to the daytime luminance and night-time luminous intensity requirements laid down for standard signs.

9.1.9 Electrical or Electronic VMS

1 This type of variable message sign may be used for individual regulatory, warning or guidance signs, or for combinations of these categories of sign. Electrically or electronically operated matrices are most commonly used in comprehensive and dynamic real-time Road Traffic and Safety Management Systems.

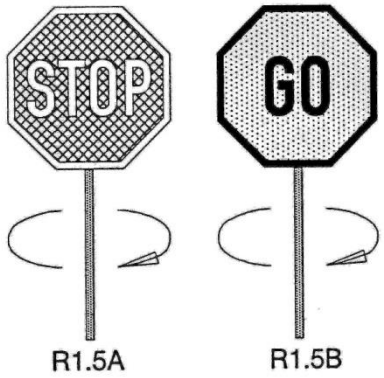
2 Technological advances in light emitting components are tending to result in the replacement of matrices using illuminated bulbs by matrices using fibre-optics or LED's (light emitting diodes). The image definition achieved using fibre-optics or LED's and the luminous intensity of the display make these types of variable message sign extremely effective in all-weather conditions.

3 Examples of typical electrical and electronic sign matrices are illustrated in Figure 9.2, 9.4, 9.5 and 9.7.

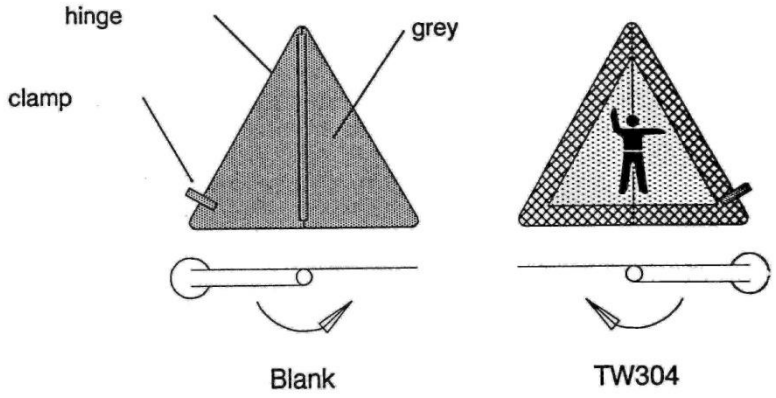
4 The cost of electronic fibre-optic or LED signs is likely to be high, however, they are extremely reliable and relatively maintenance free. These characteristics may make them cost effective for relatively small installations.

5 Due to the high level of reliability and the common practice of providing duplicate light sources and partial operation, electronic systems can be designed which are extremely safe in that system security can be built in to give default modes of operation and battery power back-up.

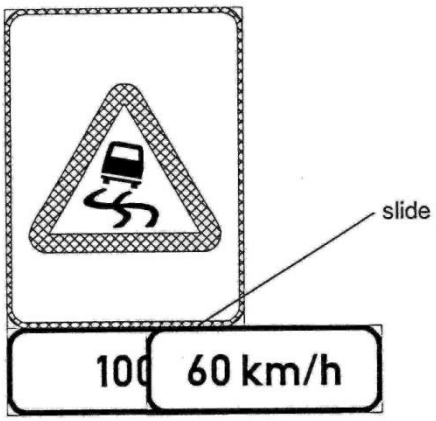
6 Examples of approved symbols for use on regulatory and warning matrix variable message signs are illustrated in Figure 9.7. These symbols shall be used when regulatory and warning variable messages signs are to be used and the regulatory signs will be enforced.



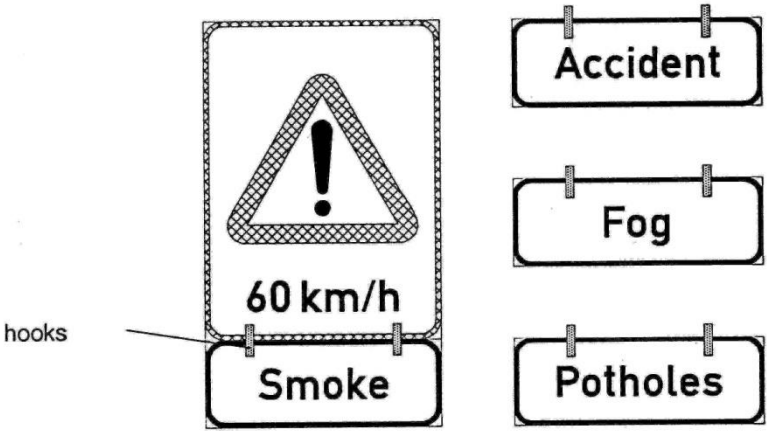
Detail 9.1.1 Back-to-Back Rotating Signs



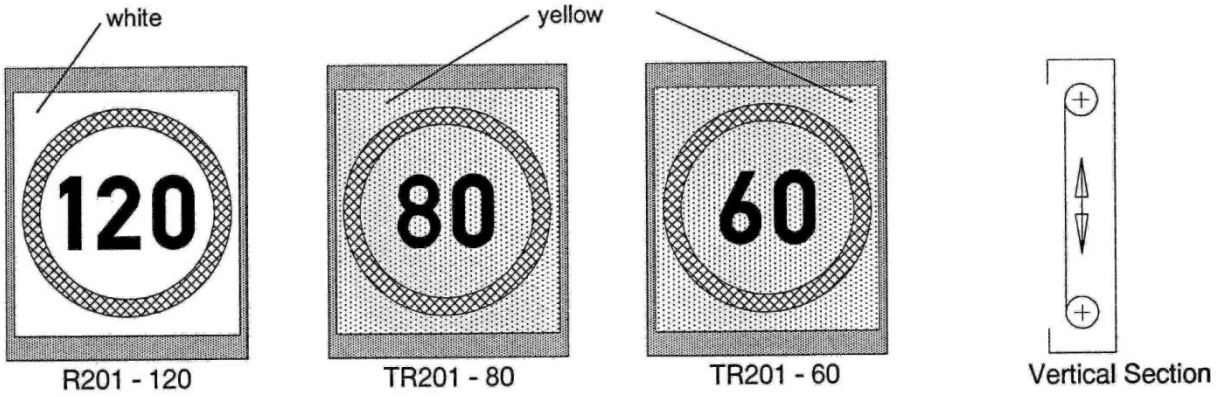
Detail 9.1.2 Flip Sign



Detail 9.1.3 Slide Alternative

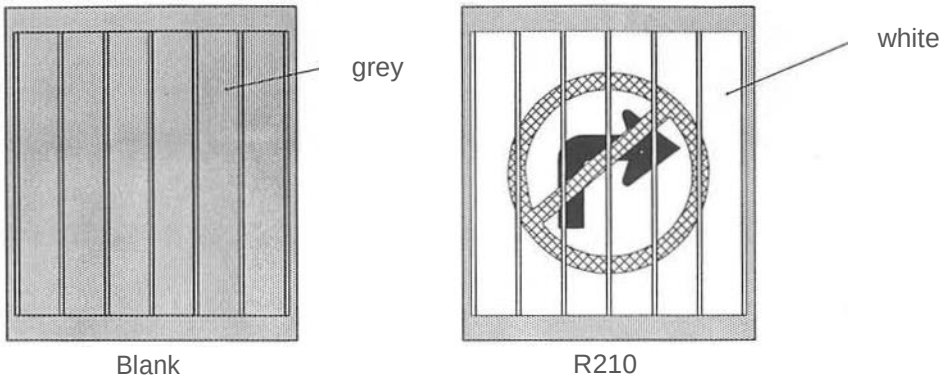


Detail 9.1.4 Hanging or Clamped Alternative

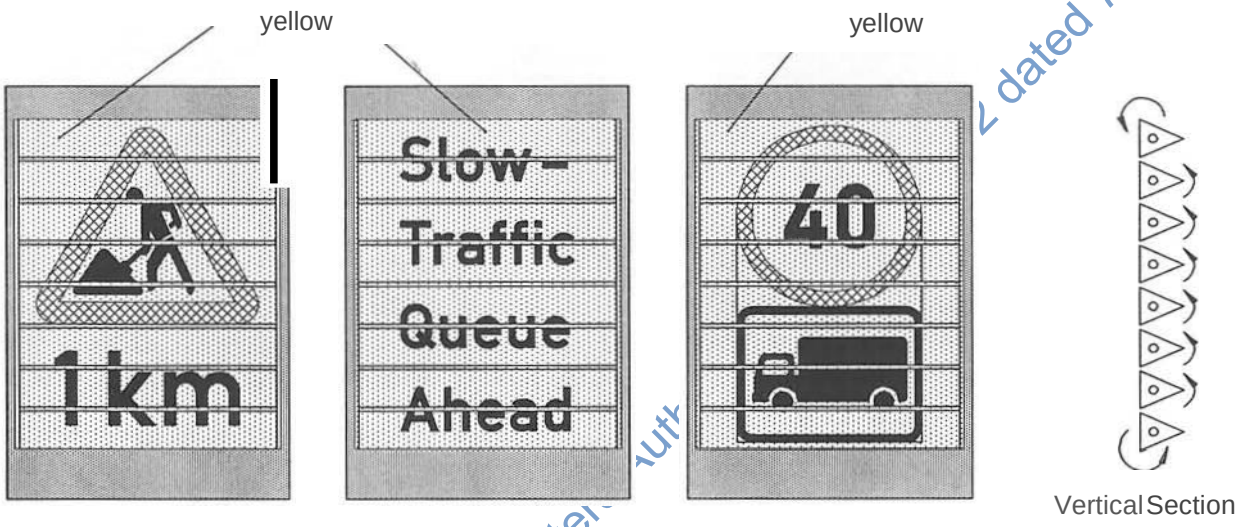


Detail 9.1.5 Roller Blind

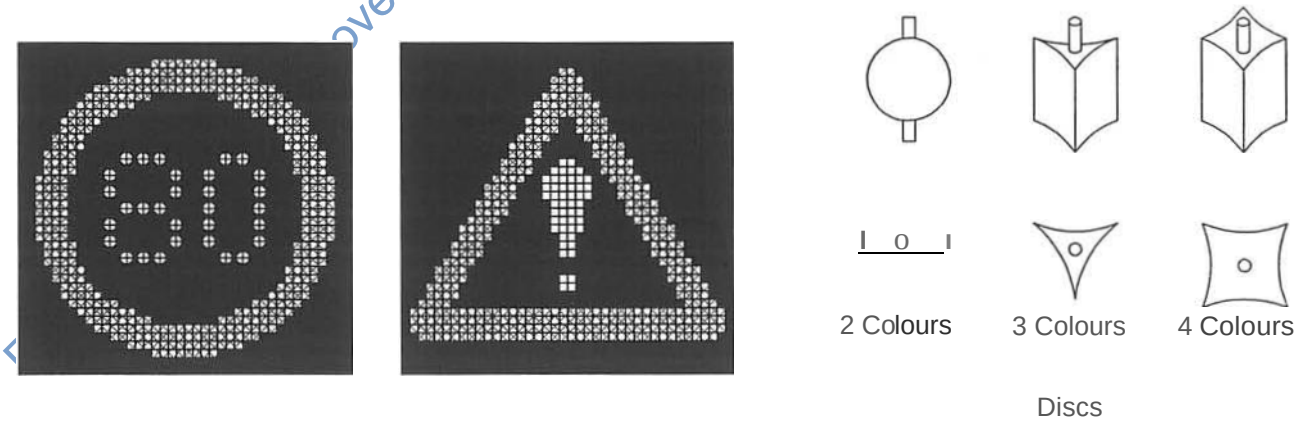
Fig. 9.1 Manually Operated / Electromechanical VMS



Detail9.1.6 Rotating Plank - Two Message (including "Blank")



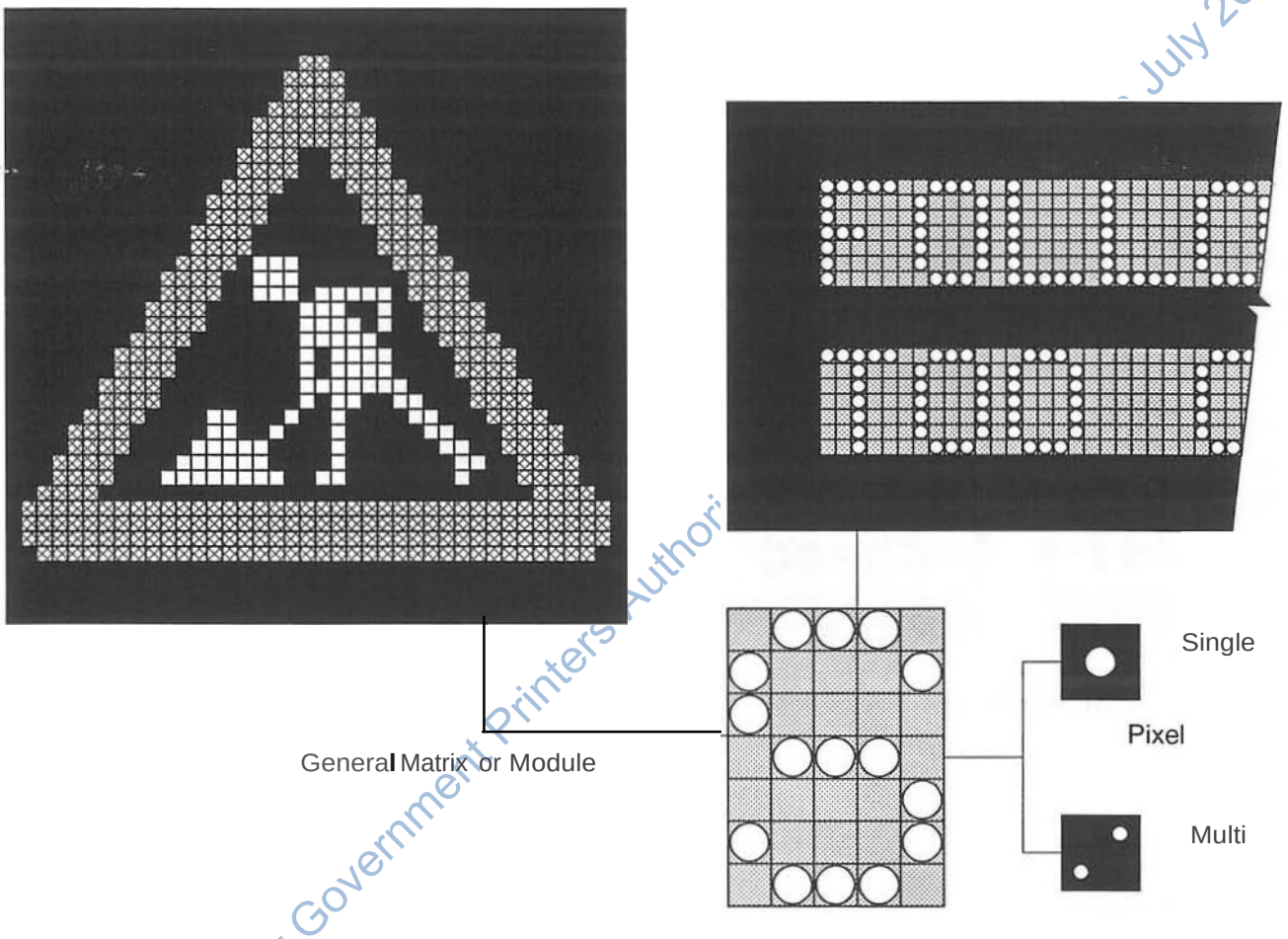
Detail 9.17 Rotating Prism - Three Message



Detail 9.1.8 Matrix of Rotating Discs - Multiple Message

Fig. 9.1 Manually Operated / Electromechanical VMS

Detail 9.2.1 Overhead Light-emitting Lane Control VMS



Detail 9.2.2 Text and Symbolic Light-emitting VMS

NOTES

1 The matrix principles illustrated apply for electromechanical, electrical or electronic VMS (see Chapter 10).

2 Text or symbolic signs may both be manufactured using a matrix either of filament bulbs, LED's or fibre optic cones. The matrix may be modular (letters) or cover the whole sign face.

Fig. 9.2 Electrical or Electronic VMS

9.1.10 Design Considerations for Electrical or Electronic VMS

1 The photometric and geometric (or dimensional) requirements for light emitting variable message signs are based on the following functional requirements, which are relevant to all road traffic sign design :

(a) conspicuity
(b) legibility;
(c) comprehensibility;
(d) credibility.

2 These aspects can be expressed in values of the required visibility distance provided details of the task and the observer population are known.

3 Messages may include symbols, numerals, and letters or words. These messages are normally ones to which the driver should adhere (regulatory) and react. It is common practice to supplement a regulatory or warning message with a measure of explanation. Parts of the message may be discerned individually as with numerals or as an entity with words or symbols. To be effective the message(s) must be perceived in time. Relevant factors in determining the "time" are:

(a) approach speed;
(b) sign content including type of message and amount of message;
(c) type of decision to be made by the driver;
(d) familiarity of message type;
(e) experience, motivation, age and visual capability of observer.

4 These factors are common to all road traffic sign design requirements. In general, in view of the large potential for variation in the different parameters, it is likely that it will be difficult to obtain meaningful local data relevant to the various variable message sign design parameters.

5 A number of overall values relevant to electronic variable message signs can be given which serve as practical guidelines, however. These are:

(a) the type of message i.e. regulatory, warning or guidance should be clearly recognisable from a distance of at least 200 m;
(b) essential messages, such as speed limit value or other legend must be clearly legible from a distance of at least 150 m;
(c) the light intensity of the optical signal should be adaptable to ambient brightness and a night-time mode should be offered;
(d) should the principal light source fail, a back-up bulb should come into operation in such a way that the essential characteristics of light intensity, visibility etc. are not affected;
(e) the system should be designed so that the sign is visible from a distance as close as 35 m, even when approached from a wide angle of vision.

6 The values given in paragraph 9.1.10.5 are relevant for freeways, major rural roads, or urban arterials. The likelihood that a variable message sign will be used, say in a residential environment, is limited. If sight distance falls below the recognition or legibility distances given, the use of an additional sign should be considered.

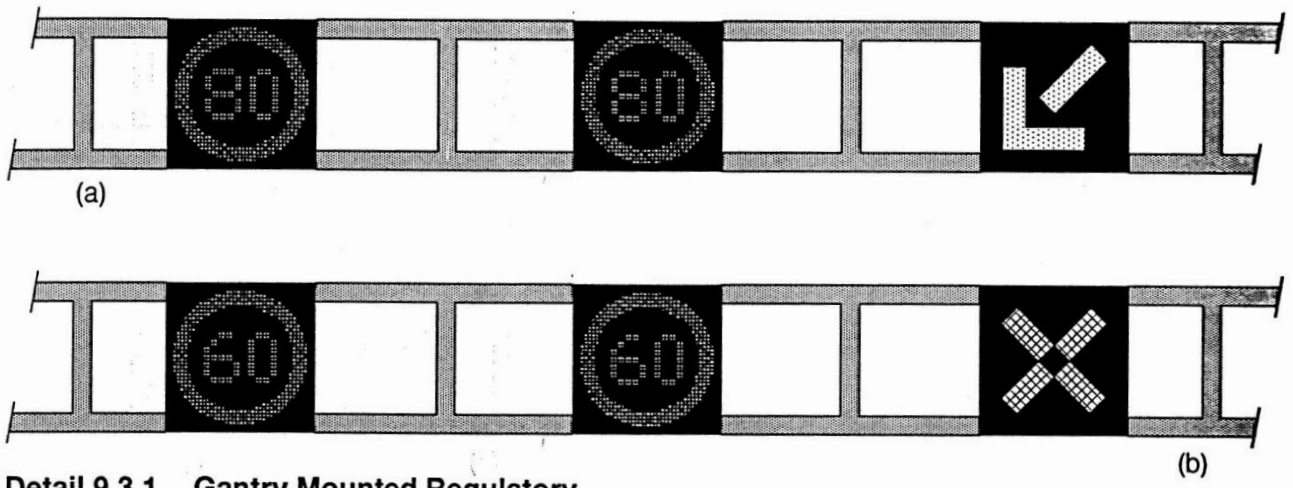
7 Experts consider that there is a sufficient influence of regional factors, such as ambient light, population characteristics and available technology that it is premature to prescribe a standard alphabet and set of symbols for use on dot matrix variable message signs. A set of 7 x 5 character matrices for upper case letters and for numerals is illustrated in Figure 9.4 and is recommended for development purposes. Other standard characters and limited matrix details are given in Figure 9.5. Typical symbols are illustrated in Figure 9.6.

8 The internal and external dimensional requirements for electrical and electronic VMS are not fully developed for Southern African conditions. Basic guidelines are given in Section 9.2. Research is needed in this respect as experience of installations, particularly in Europe, is tending to indicate that the letter shape ratio may be better for matrix signs if it tends towards a height to width ratio of 2 to 1 rather than the presently used ratio of 7 to 5. There are also indications that letter spacings need to be greater than those given by DIN 1451 for use with conventional retroreflective letters (see Figure 9.6).

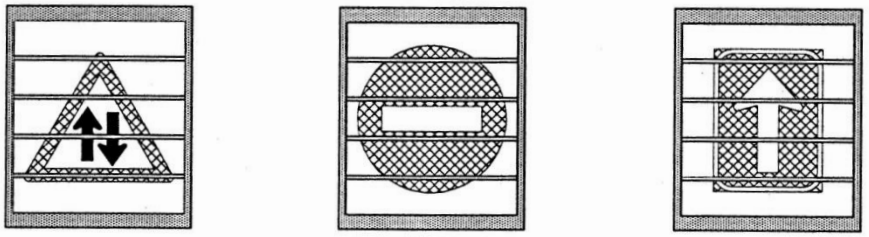
9 Light emitting matrix signs consist of a large number of dots or separate light units. In order that the observer can perceive the intended message these dots or light units must be seen both as a continuum when required and as separate entities when required. To achieve this, the spacing of certain of the dots must be less than a certain value and the separation of others greater than another value. Acceptable limits for these values depend on the conditions of observation, the characteristics of the observer, and all other factors mentioned earlier in this Section. The most important two factors are, however, the luminous intensity of the individual dots or light units and the background or adaptation luminance (see Figure 9.6).

10 The manner in which variable messages are switched is likely to affect the comprehension and credibility of VMS. This factor, although applicable to the switching of symbolic and text messages, will have a greater effect on the quality of a text message, particularly a relatively long one. If a number of text messages are to be given a driver is only likely to be able to read one message per sign, unless the messages are very short indeed. A number of signs may therefore be required if several messages have to be transmitted. A specific message must also be in view for sufficient time to allow a driver to read it. The reading time details given in Chapter 4 are relevant to this VMS design parameter. When a message is changed it may be changed totally in one operation or in a "flowing" movement. Many VMS requirements may appear similar to switchable advertising signs. Designers are cautioned against using advertising techniques without careful consideration of the road sign message transfer requirements. Although not substantiated the "flowing" switching movement appears more aesthetically acceptable. If the flowing movement of the change is from left- to- right and top- to- bottom (for larger messages in two lines) a reader will have the first message in view for a maximum reading period.

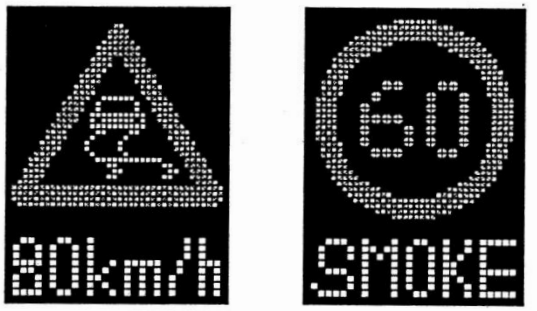
11 The quality of a light emitting variable message sign depends on:



Detail 9.3.1 Gantry Mounted Regulatory VMS

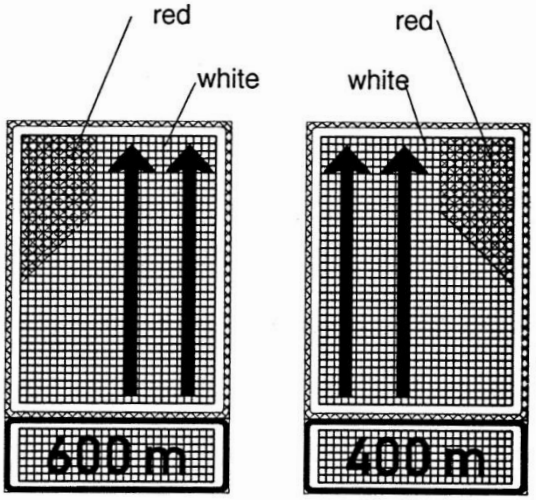


Detail 9.3.2 Regulatory / Warning VMS



Multiple message capability

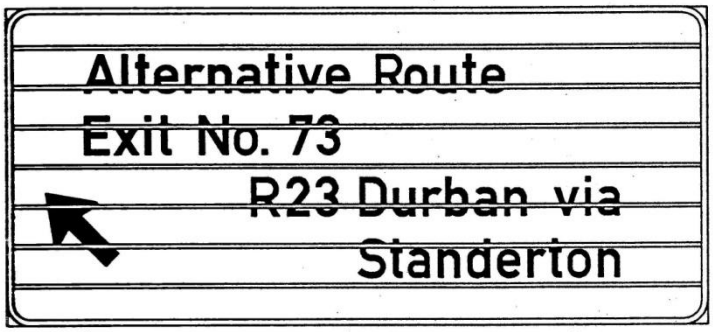
Detail 9.3.3 Warning / Regulatory VMS



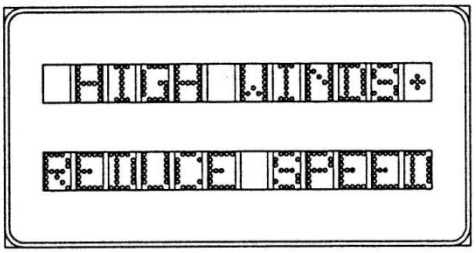
Only changing area provided with discs

Detail 9.3.4 Guidance VMS

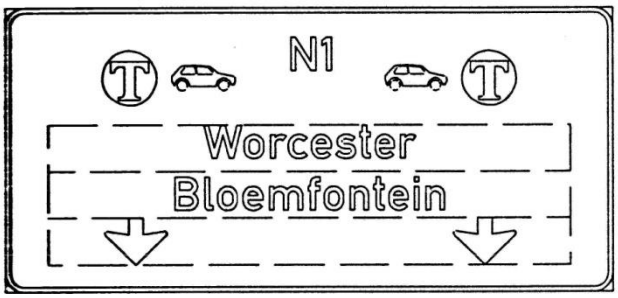
Fig. 9.3 Typical Regulatory, Warning, Guidance and Information VMS

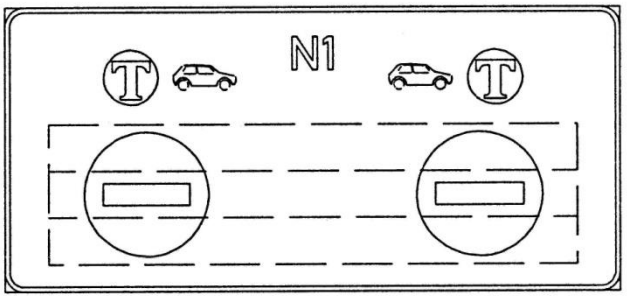


Detail 9.3.5 Guidance - Direction VMS



Detail 9.3.6 Information VMS





Detail 9.3.7 Regulatory / Guidance Combination VMS

Detail9.3.8 Combinations

Multiple arrangements of Regulatory, Warning and Information possible

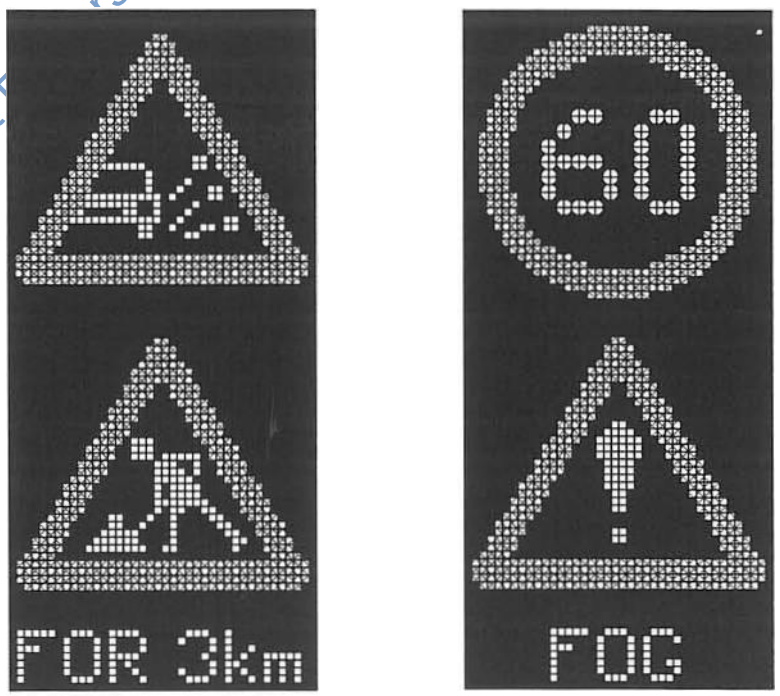


Fig.9.3 Typical Regulatory, Warning, Guidance and Information VMS

(a) light intensity and viewing angle (widely variable according to sign type);
(b) uniformity of illumination;
(c) contrast between the light emitted and the ambient light conditions;
(d) colour.

12 Available research is not conclusive on the best method of specifying performance for light emitting variable message signs. Specification may be made in terms of luminance or luminous intensity for individual light components or for the sign as a whole. For practical purposes the luminous intensity for white characters should be between 600 candela and 1000 candela for day operation, and between 60 cd and 100 cd for night-time operation. The values for red parts of a sign should be between 400 cd and 600 cd during the day and between 40 cd and 60 cd at night. It should be noted that light intensity values of 3800 cd can be obtained on the light axis of fibre-optic units. Losses will reduce this value substantially for the observer but it should also be noted that low values of luminous intensity reduce visibility of a sign whereas high values not only reduce legibility as a result of irradiation, but may also cause glare. As a general rule night-time intensity should be approximately one tenth of the daytime value. However, under bright Southern African sunlight conditions very high ambient light levels occur. In order to achieve adequate contrast levels during daytime the luminous intensity values may need to be significantly higher than those given above, whilst the night-time values will still apply. The day/night intensity ratio will increase under such circumstances. European research has indicated required contrast ratios be- tween the light emitting component and bright ambient conditions in the range of 7-to-1 to 50-to-1. Southern African ambient light levels could require higher ratios. The numerical values given are for illustration purposes only because the actual values achieved are dependent on the number of light units illuminated and on the stroke width of characters. (For further details refer to Volume 2, Chapter 19: *Variable Message Signs).*

13 Visible differences between individual illuminated light units can negatively affect the legibility of a sign or even lead to the misinterpretation of the message. The following guideline can be applied to all fibre-optic systems including those using larger diameter light units. The formula takes into account the interdependence between the number of light points and the clarity/definition of a sign.

$$\frac{I_{average}}{I_{sample}}$$ **should be between 0,7 and 1.3.**

where:

$I_{average}$ is the average light intensity per light unit for all the elements within one sign of the same colour.

and:

I_{sample} is the average light intensity per light unit for a random sample of points on the sign (a 10% sample is a valid sample size).

14 Good legibility is especially dependent on the contrast between the message, the sign background and the ambient background to the whole sign. Elements of character design have been covered, however, when designing fibre-optic signs, it must be remembered that lines of light points appear larger than painted or externally illuminated lines. It is possible to achieve adequate contrast for alpha numeric characters using only one row of light points. Such thin lines of high intensity light will be more clearly perceived by the eye than lines made of double rows. This effect must be compromised with the design requirement to have a back-up system whereby either an additional light source is automatically illuminated when the principal one fails, or a double row of light points is illuminated by two light sources which, on failure of a source will leave one row of light points illuminated. The use of double rows of light points is recommended if fibre-optic signs are used to create LANE DIRECTION CONTROL SIGNALS S16 (Green Arrow) and S17 (Red Cross).The recommended spacings of light points for various colours are given in Table 9.1 in Section 9.2.

15 To improve the contrast of a sign against a distracting ambient background such as the light of a clear sky or other illuminated features such as street lights or advertising boardings a minimum sign background clearance to any character of 1,1 times the letter height in use is recommended.

16 Colour rendition from fibre-optic signs is achieved by use of colour filters. Colours produced by variable message signs should conform to the requirements given in Section 1.5 according to Figures 1.11 to 1.14 - *Chromaticity Chart for Colours for Road Traffic Signs.* It should be noted that colour filters result in a loss of light output which must be taken into account when calculating specific light intensity requirements.

17 Phantom luminance should not exceed 10% of the luminance of the sign symbols for an illuminance of 104 lux.

18 Matrix signs are commonly used on high speed road-ways and are often placed in a regular sequence for lane control or gradual speed reduction purposes. A wide beam of emitted light is not required under these circumstances. Fibre-optic signs utilize optical cones at the signface to control light intensity and direction. Three types of cone are currently available

(a) 6° cone –

designed for high speed approaches with a light intensity on axis of 30 cd per point. The highest output levels occur at +or- 3°;

(b) 14° cone-

designed for intermediate approaching speeds with a light intensity on axis of 19,5 cd. The highest output levels occur at + or – 7°;

(c) 24° cone-

designed for low approaching speeds with an intensity on axis of 6,5 cd. The highest output levels occur at +or- 12°.

19 Variable message signs using dot matrix components need to be built into a housing which has certain characteristics. These characteristics apply to complete signs or modular units and include:

(a) the ability to dissipate heat by adequate ventilation;
(b) ease of access to replace components;
(c) a front screen to protect the light units should have anti-reflection qualities (slight curvature has also been found to help reduce condensation within the housing);

(d) tightly fitting components to eliminate ingress of water or dust (including filtration and protection of ventilation areas);
(e) internal surfaces a matt or semi-matt dark colour to avoid internal light reflection and interference.

20 The total light intensity of a fibre-optic sign is the sum of the light intensities emitted by the individual light points forming the signal. The total intensity depends on the following criteria:

(a) the number of bulbs;
(b) the use of a beam splitter;
(c) luminous flux of the bulb;
(d) efficiency with which light is channelled from the source to the individual light unit (cone)
(e) light transmitting properties of filters;
(f) the number of fibre-optic cables or arms;
(g) the length of the fibre-optic cables or arms in a harness;
(h) the optical characteristics of the cones;
(i) light transmission loss due to the front screen.

21 The total light intensity can be calculated from the formula for symbols of a single colour (a separate calculation should be made for each colour):

$$I_{TOTAL} = n \times I_{LP} \times F_F \times F_{SC} \times F_B \times F_L \times F_A \times F_C \times F_{AN} \times F_{FS}$$

where:

I_{TOTAL}	=	total luminous intensity of the symbol
n	=	number of light points
I_{LP}	=	light intensity per single light point
F_F	=	correction factor for the filter
F_{SC}	=	correction factor for the safety circuit
F_B	=	correction factor for the bulb
F_L	=	correction factor for the harness length
F_A	=	correction factor for the number of cable arms in the harness
F_C	=	correction factor for the cone type
F_{AN}	=	correction factor for the viewing angle
F_{FS}	=	correction factor for the front screen material

22 In an alternative form this formula may be used to determine minimum number of light points required for a given symbol or message. The correction factor "F_A" for the number of cables or arms in the harness is omitted because the value of total light intensity specified, "I_{TOTAL}", will be a minimum requirement. Where "n" is the minimum number of light points required to produce the specified total luminous intensity:

$$n = \frac{ITOTAL}{ILP \times FF \times FSC \times FB \times FL \times FC \times FAN \times FFS}$$

23 The testing of the design of a matrix sign should be done using standard measuring methods and equipment. Until such time as specifications are well established, new designs should be tested under representative traffic conditions by comparison with a "standard" sign. The following points should be borne in mind during testing:

(a) when assessing "visibility distance" as a variable, the light distribution, the angle subtended, and the atmospheric transmission characteristics must be taken into account;
(b) the comparison must involve a large number of observers performing a realistic task;
(c) the test should call for identification of signs and recognition of their components.

9.1.11 VMS and Road Traffic and Safety Management

1 Dynamic real-time traffic control can be achieved by designing an integrated computer operated intelligent system incorporating variable message signs.

2 Sections of roadway experiencing unacceptable levels of congestion and accident rates and therefore high user costs, may warrant such a system. Although the capital cost is likely to be high the benefits to be achieved can be cost-effective.

3 Comprehensive systems have been developed in Europe and the Americas which operate automatically with no need for manual intervention. Such systems are capable of detecting incidents, congestion, and even weather conditions. Components of such a sys- tem are illustrated in Figures 9.8 to 9.10.

4 Figures 9.8 and 9.9 shows diagrammatic representations of how variable message signs fit into a typical road traffic and safety management system. Also illustrated is a schematic arrangement of detectors, detector stations, outstations and sign gantries.

5 Figure 9.10 shows schematically how computerised control may be applied through the use of variable message signs.

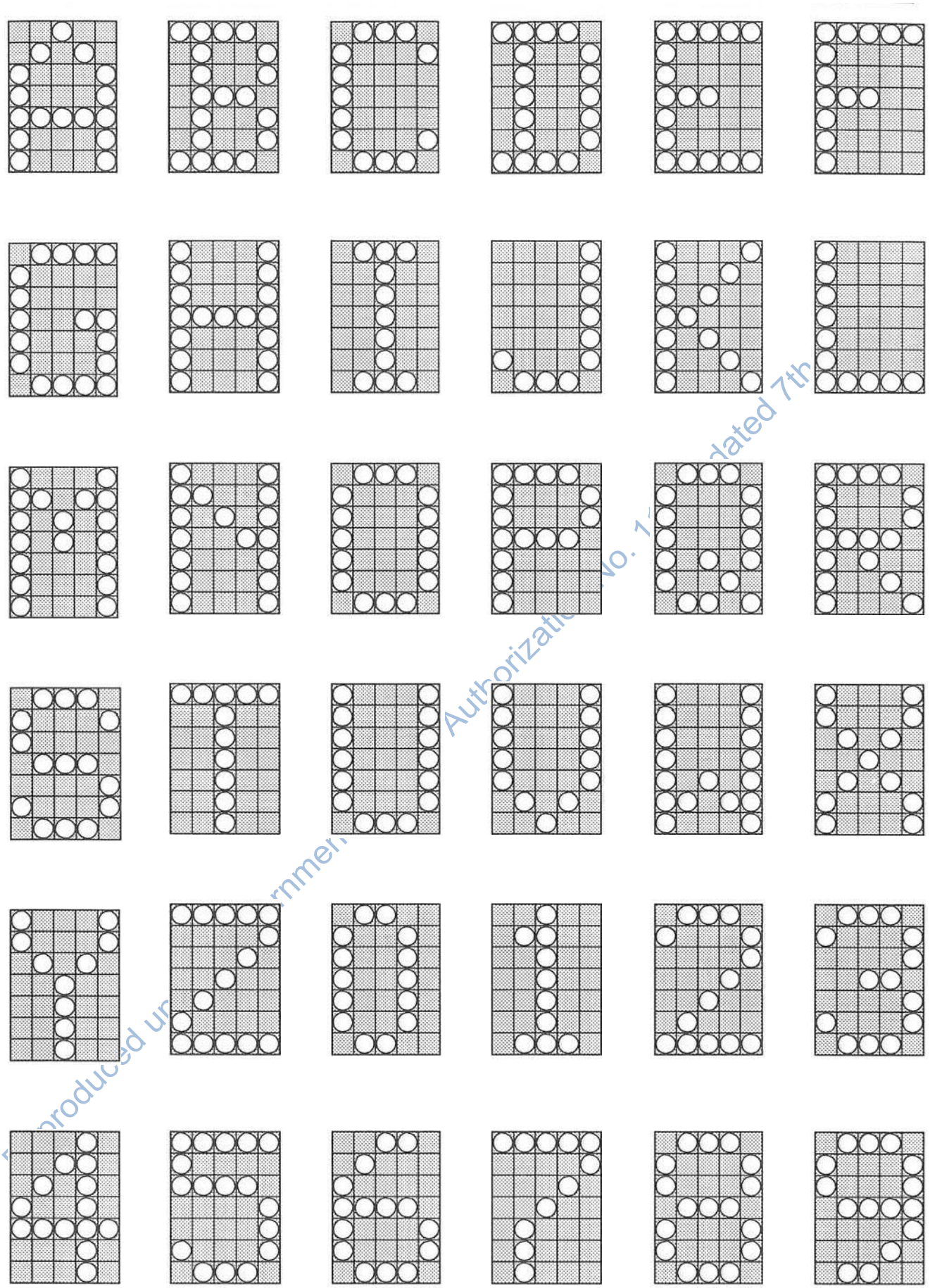
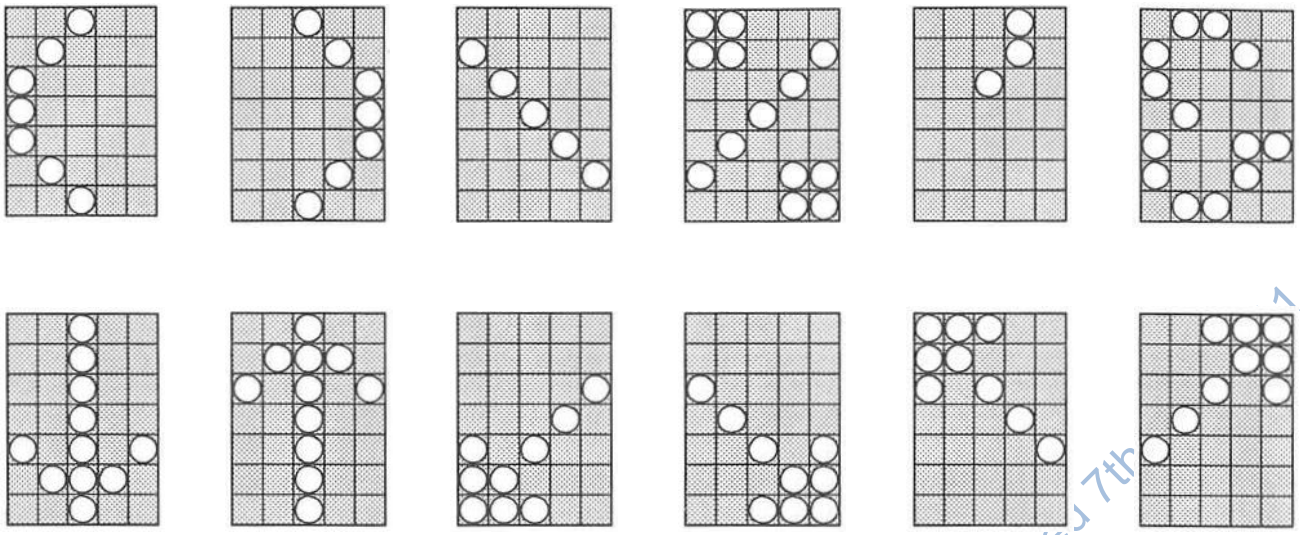
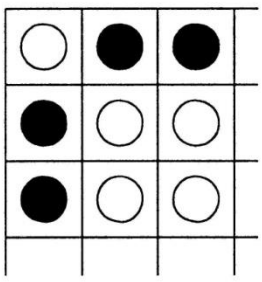


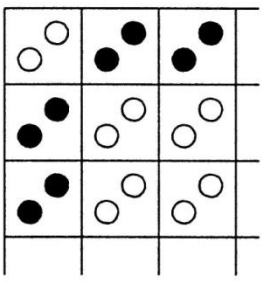
Fig. 9.4 7 - Character x 5 - Character Letters and Numerals



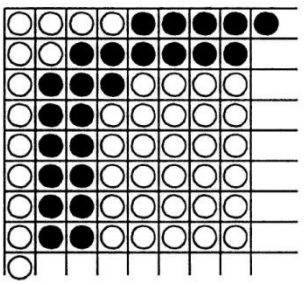
9.5.1 Other Selected Characters on Modular Base



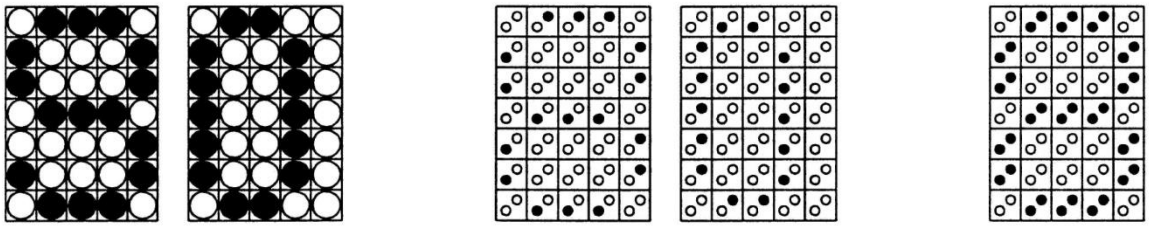
9.5.2



9.5.3



9.5.4



9.5.5 Effects of Bulb Failure - Example Numeral "8"

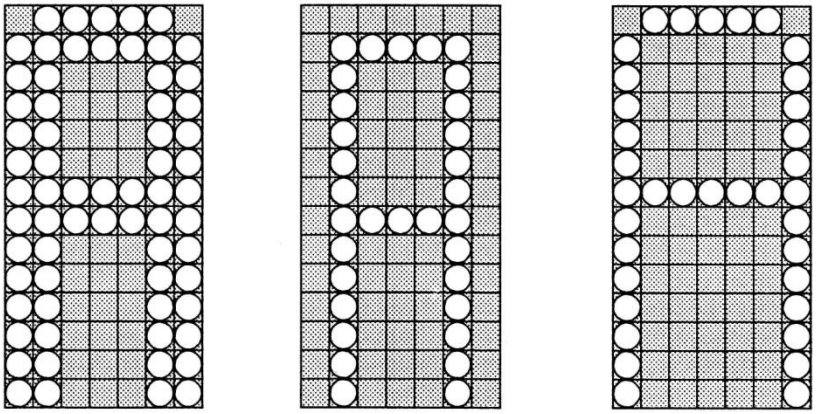
NOTES:

1 In Figure 9.4 and Detail 9.5.1 all elements can be illuminated - those required for each letter are indicated by a circle.

2 Details 9.5.2 to 9.5.4 show large and paired small illuminated bulbs, and fibre optic elements respectively.

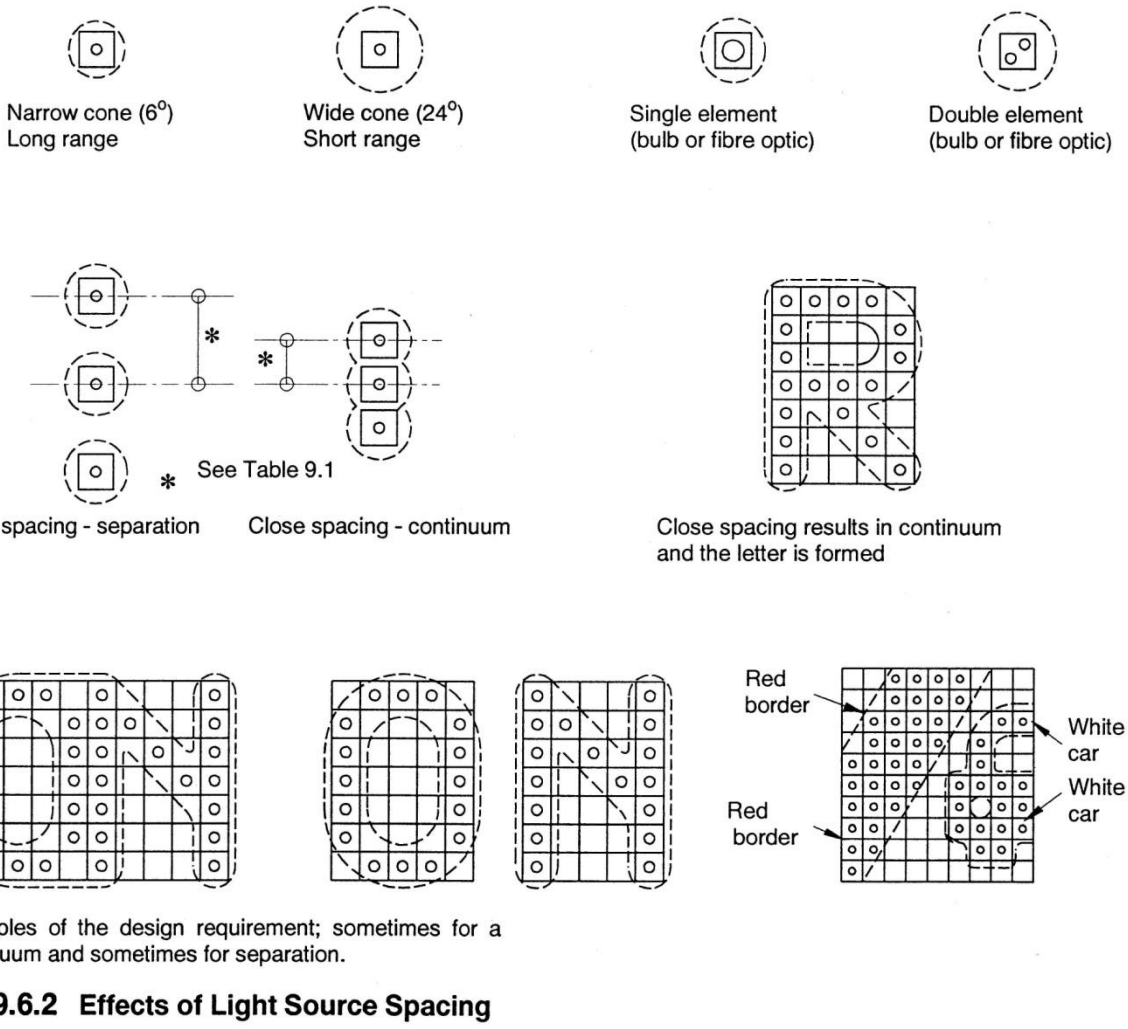
3 Detail 9.5.5 shows the effects of bulb failure. The small element normally has a dual circuit.

Fig. 9.5 Further Details of 7 x 5 Character Matrices



This matrix with a height to width ratio of 2 to 1 may offer better letter shapes and legibility. A dual circuit may also minimise effects of bulb failure.

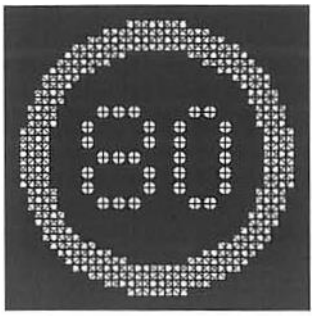
Fig 9.6.1 Alternative Letter / Numeral 14 x 7 Character Matrix



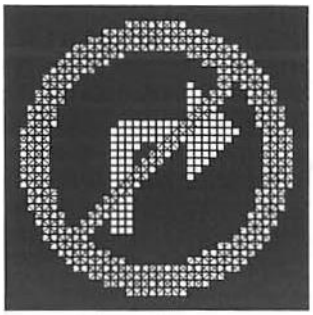
Examples of the design requirement; sometimes for a continuum and sometimes for separation.

Fig 9.6.2 Effects of Light Source Spacing

Fig. 9.6 Other VMS Design Considerations

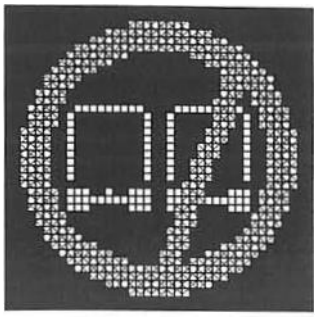


R201/TR201 *



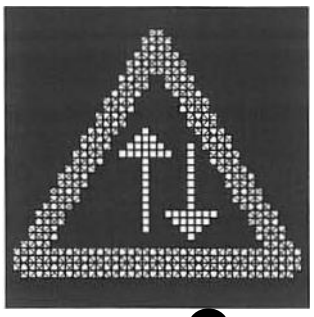
R210/TR210

R214/TR214

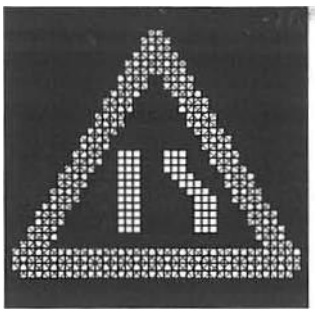


R215/TR215

Detail 9.7.1 Regulatory Sign Symbols {Prohibition)



TW212 ●



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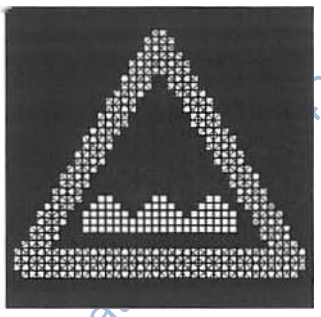

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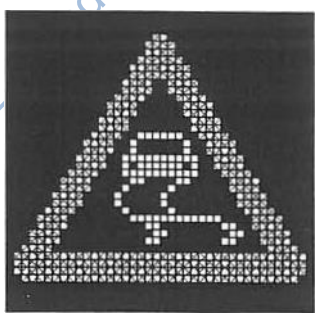

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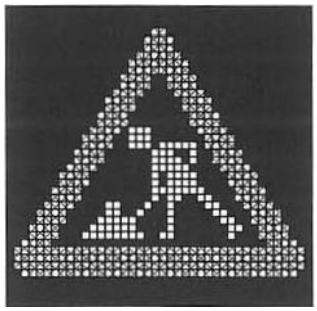

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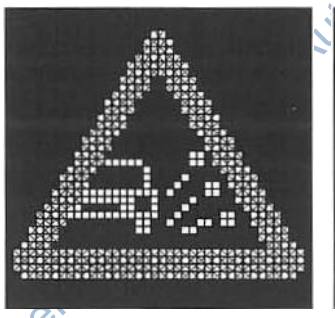

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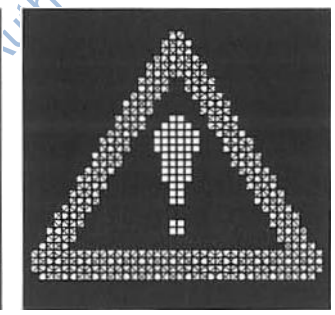

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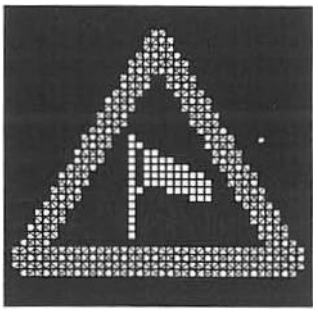
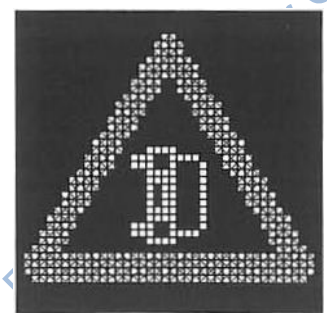


TW349 *



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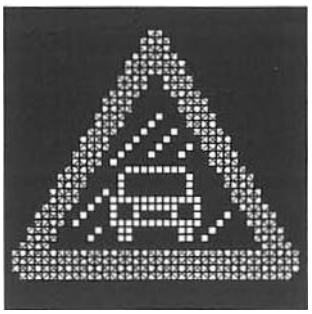

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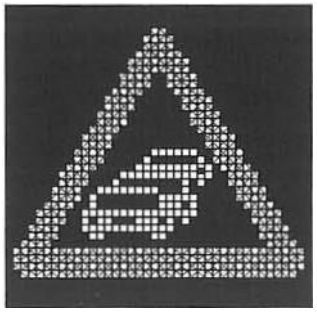

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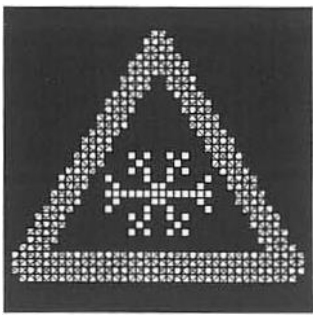

Snow

Detail 9.7.2 Warning Sign Symbols * International

● See Chapter 3, Section 3.7 for variations appropriate to individual countries.

Fig. 9.7 Symbols

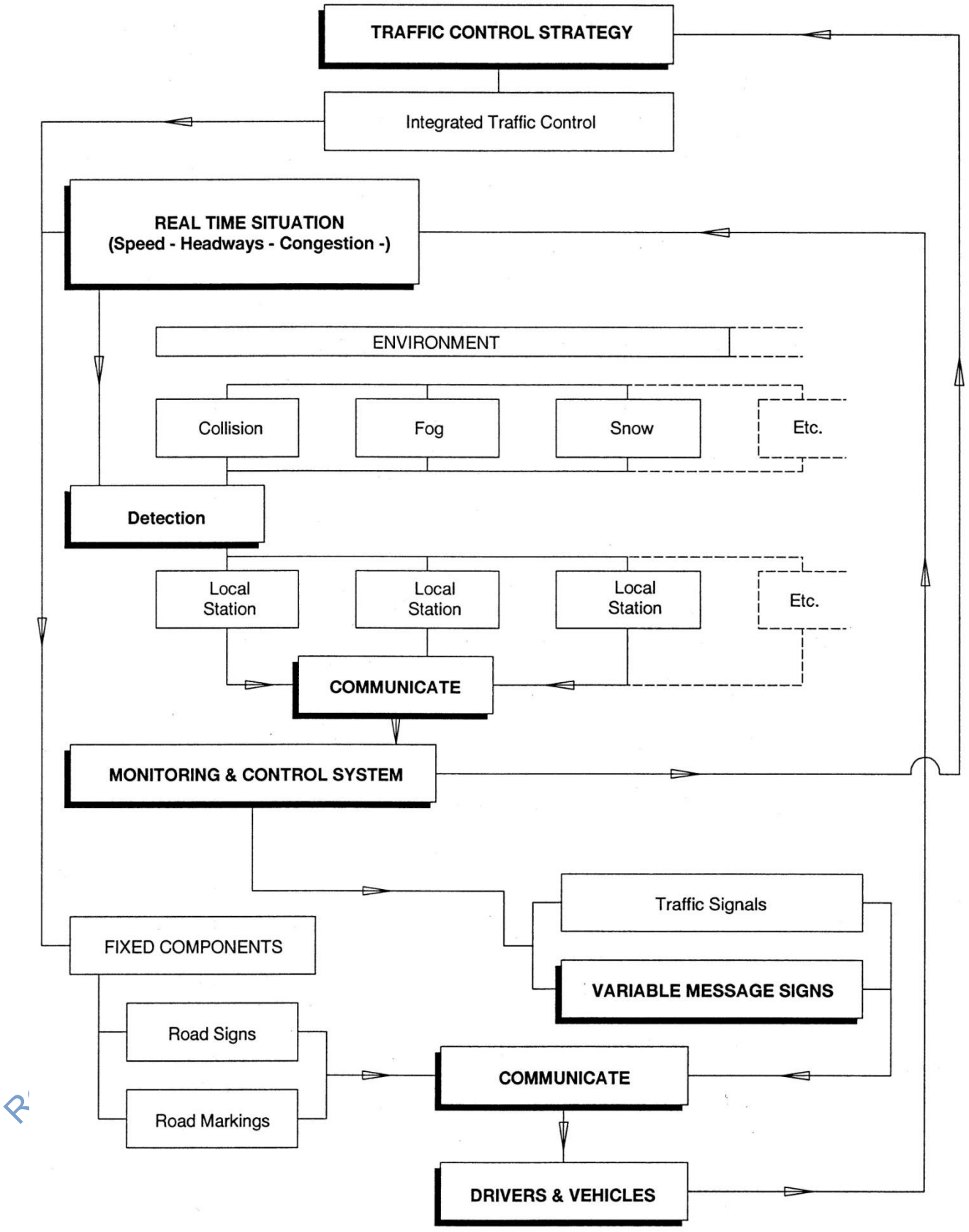

Fig. 9.8 VMS in a Road Traffic and Safety Management System

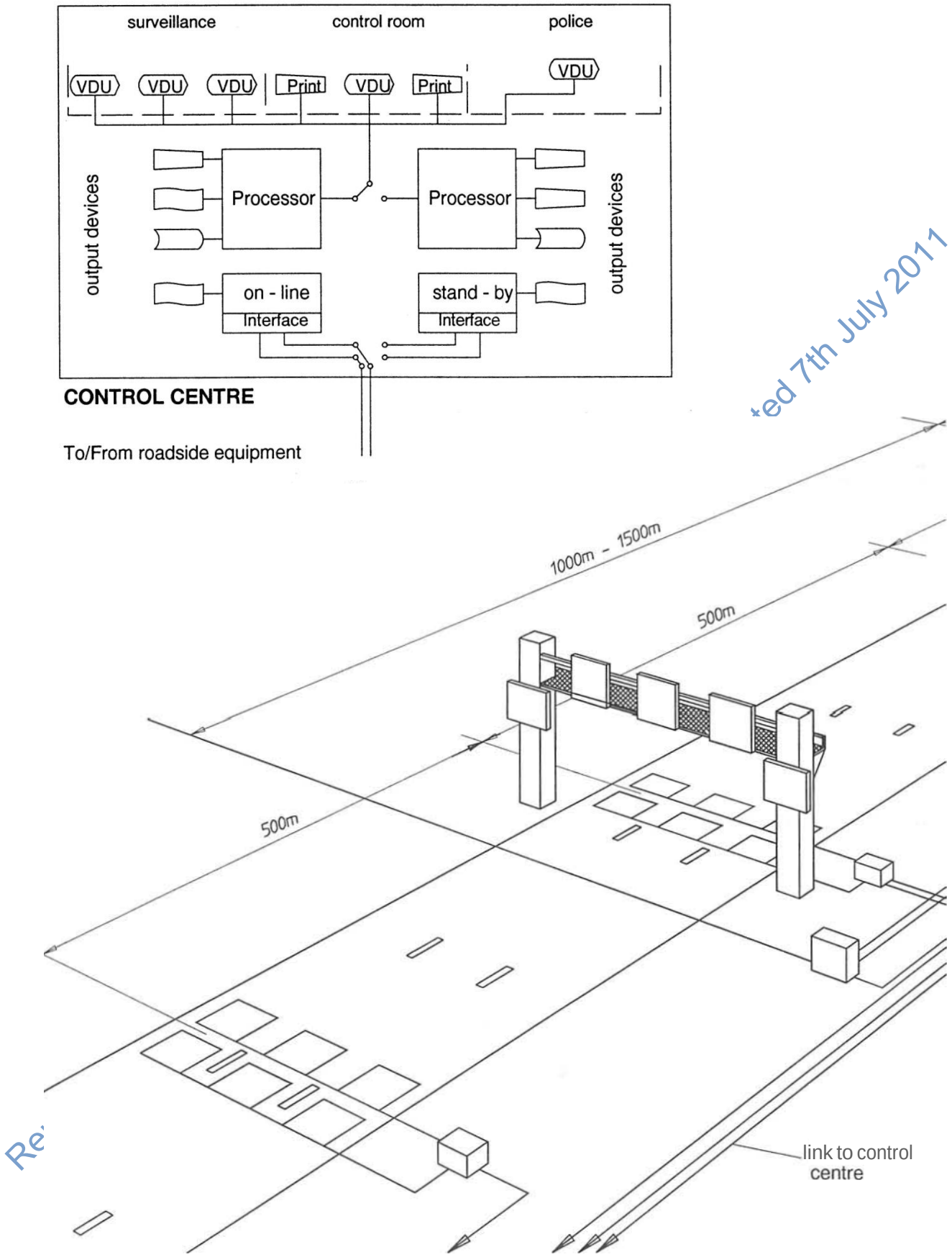

Fig. 9.9 Typical Components of a Freeway Control System

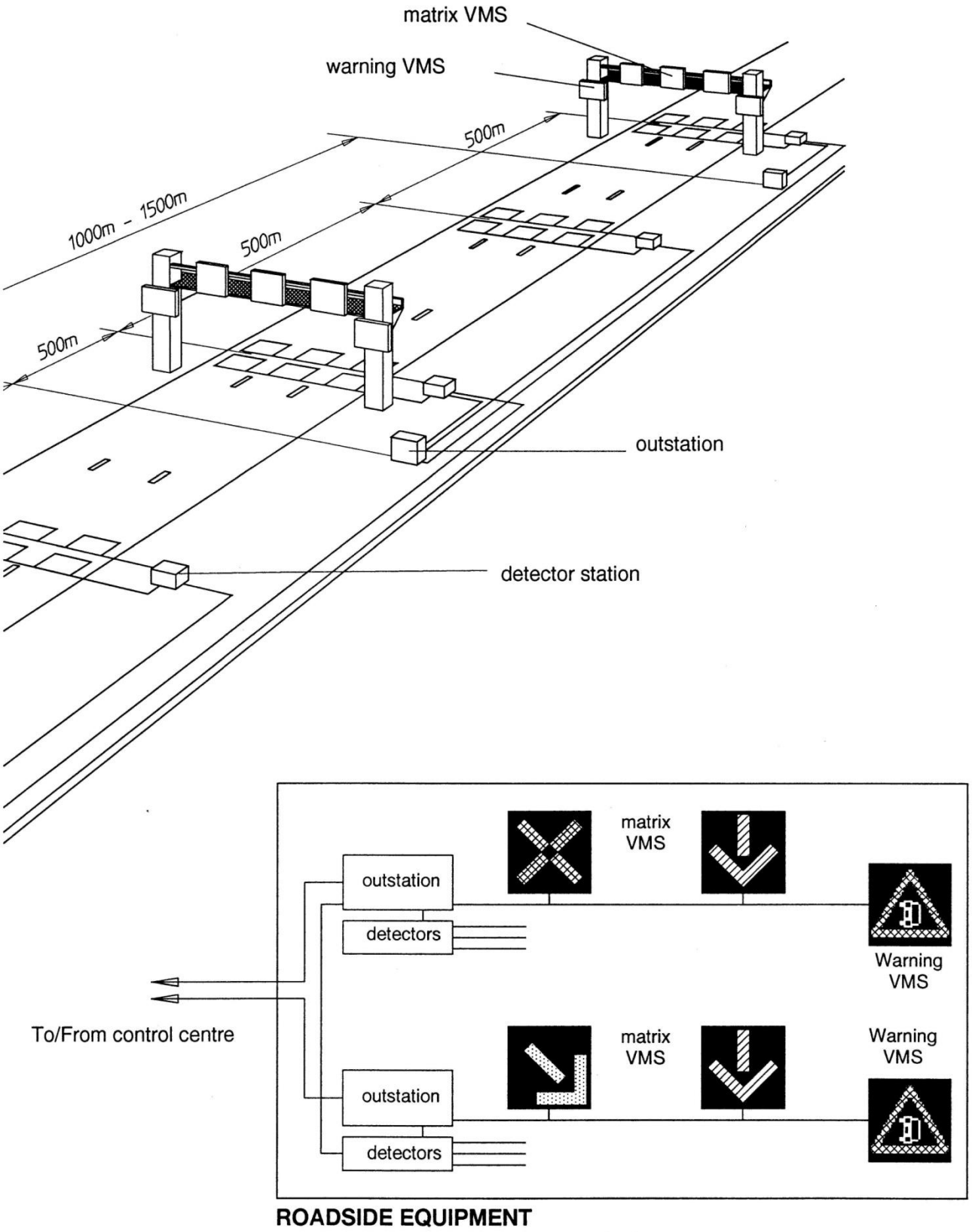

Fig.9.9 Typical Components of a Freeway Control System

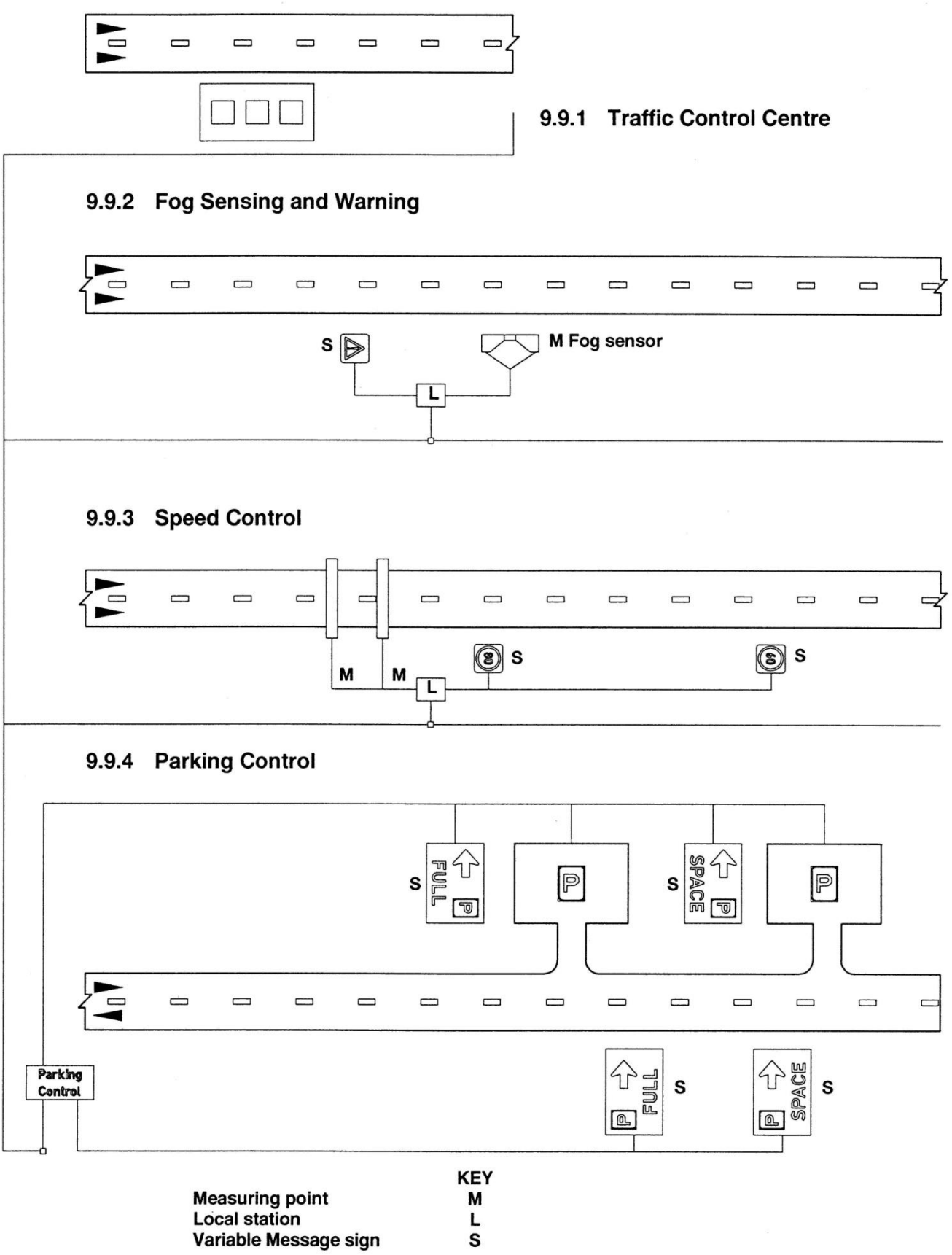

Fig. 9.10 VMS Applications in Road Traffic and Safety Management

9.2 DIMENSIONS FOR VMS

9.2.1 General

1 As has been stated in previous Subsections the design of variable message signs is in a developing stage world-wide and although standards are being developed by the CIE (International Commission on Illumination), these are not yet universally accepted. The number of installations of light emitting VMS in Southern Africa, from which local knowledge may be gained, is, at the time of publishing, very limited. Full dimensional details are therefore not given in this chapter or in Volume 4 at this time.

2 The matrix details given in Figures 9.4 and 9.7 should be considered to be guidelines only although they are based on UK and European practice. The high ambient light levels common in much of Southern Africa are likely to require modification or extension to any European based standard. Such modification is likely to affect dimensional criteria.

3 Until such time as local research indicates otherwise any regulatory or warning sign provided as part of a light reflecting or light emitting variable message sign shall conform to the diameter or side length dimensional requirements for standard regulatory or warning signs given in Tables 2.4 and 3.1.

9.2.2 Light Reflecting VMS

1 The dimensions of any manually operated or electro-mechanical light reflecting VMS depicting a regulatory or warning sign shall conform in all respects to the dimensions appropriate to standard regulatory and warning signs given in Volume 4.

2 It will be common for such signs to be contained within a frame or background. The dimensions of such a background should relate as closely as possible to those used for HIGH VISIBILITY signs.

3 Similarly light reflecting VMS guidance and information signs should conform to the dimensional requirements given in Volume 4.

4 If a combination of standard and light reflecting VMS, or light reflecting and light emitting VMS, is required, it may be necessary to increase certain internal sign spacings to accommodate structural or mechanical aspects of the message changing mechanism.

9.2.3 Light Emitting VMS

1 The dimensions of arrow or cross VMS mounted over individual lanes as part of road traffic and safety management control installations shall conform to those given in Volume 4, Chapter 10 for LANE DIRECTION CONTROL signals S16 to S19.1t should be noted that signals S16to S19 may be identical in appearance to changeable arrow and cross signs, but the signals have a specific function and shall be used in a specific manner (see Chapter 6). Changeable arrow and cross signs may be used as S16 to S19 signals provided they conform to the functional requirements for the latter. They may also be used for other forms of lane use control not involving the DIRECTIONAL, or reversible use of lanes.

2 The effectiveness of letters, numerals and symbols used on light emitting VMS will be dictated by the physical components of the matrix used. Factors which will influence this effectiveness are covered in Subsection 9.1.10. An acceptable visual definition must be achieved by all aspects of a sign. As a general rule the greater the detail required the closer or smaller should be the elements of the matrix used (see Figure 9.6).

3 A matrix may be produced by using off-the shelf modular components or by building up a customised matrix from the individual illuminated components such as bulbs or fibre optic cones. In the case of the modular components, normally forming letters and numerals, the spacing of the bulbs or cones will have been determined by the manufacturer. The 7 x 5 character matrix is not ideal for lower case lettering; therefore, variable message guidance and information signs using a 7 x 5 matrix should use only upper case letters. The use of letter matrices with fewer than 7 vertical components is not recommended. The spacing of the letters to form a word and the spacing between words, both horizontally and vertically needs to be confirmed for Southern African conditions. Figure 9.11 illustrates the basic dimensions used in the DIN 1451 lettering system for standard guidance signs. If a sign is subject to high ambient light levels the outer spaces should be increased from "5d" to "8d" and "6d" to "8d". The between line spacings may be reduced to a minimum of "3d" due to the fact that the signs use only upper case letters.

4 It is recommended that the letter height be derived in the same manner as for standard guidance signs (see Chapter 4). Due to the possibility of obtaining high light intensities from narrow focus elements (6° cones), it is possible that normal legibility distances required for adequate driver response and action may be achievable with smaller letter heights than derived by use of the nomograms in Chapter 4. Road authorities are recommended to require that any such claim by a manufacturer be proven in a representative on-site pilot test before accepting smaller letter sizes. Because the signs are light emitting, it may be practical, with an adequate approach distance to use very large letters to obtain reading distances far in excess of those obtainable under vehicle headlamp illumination of retroreflective letters. Characters as high as 1500 mm are available in European systems.

5 The recommended minimum spacing between letters is "1d" or the equivalent one vertical row of matrix elements. The minimum recommended spacing between words shall be the equivalent of two vertical rows of matrix elements. In all the above examples the matrix "element" dimension should be taken as the centre to centre dimension of the elements, normally "1d", NOT the diameter of the element itself.

6 The size of individual matrix elements will be "1d" square, based on a 7 x 5 matrix. The size of the illuminated element will be dependent on the technology in use and the manufacturers design. Sizes range from 50 mm or more in diameter for larger bulbs, down to small cones for fibre optics of 5 mm diameter. Recommended spacings of illuminated light points of different colours for more general message requirements such as regulatory or warning sign symbols, or for larger custom made matrices are given in Table 9.1.

TABLE 9.1	RECOMMENDED LIGHT POINT SPACINGS- FIBRE OPTIC SIGNS	TABLE 9.1
Light point Colour	Spacing (mm)	
White	30 - 35	
Red	15 - 20	
Yellow	20 - 25	
Green	20 - 25	

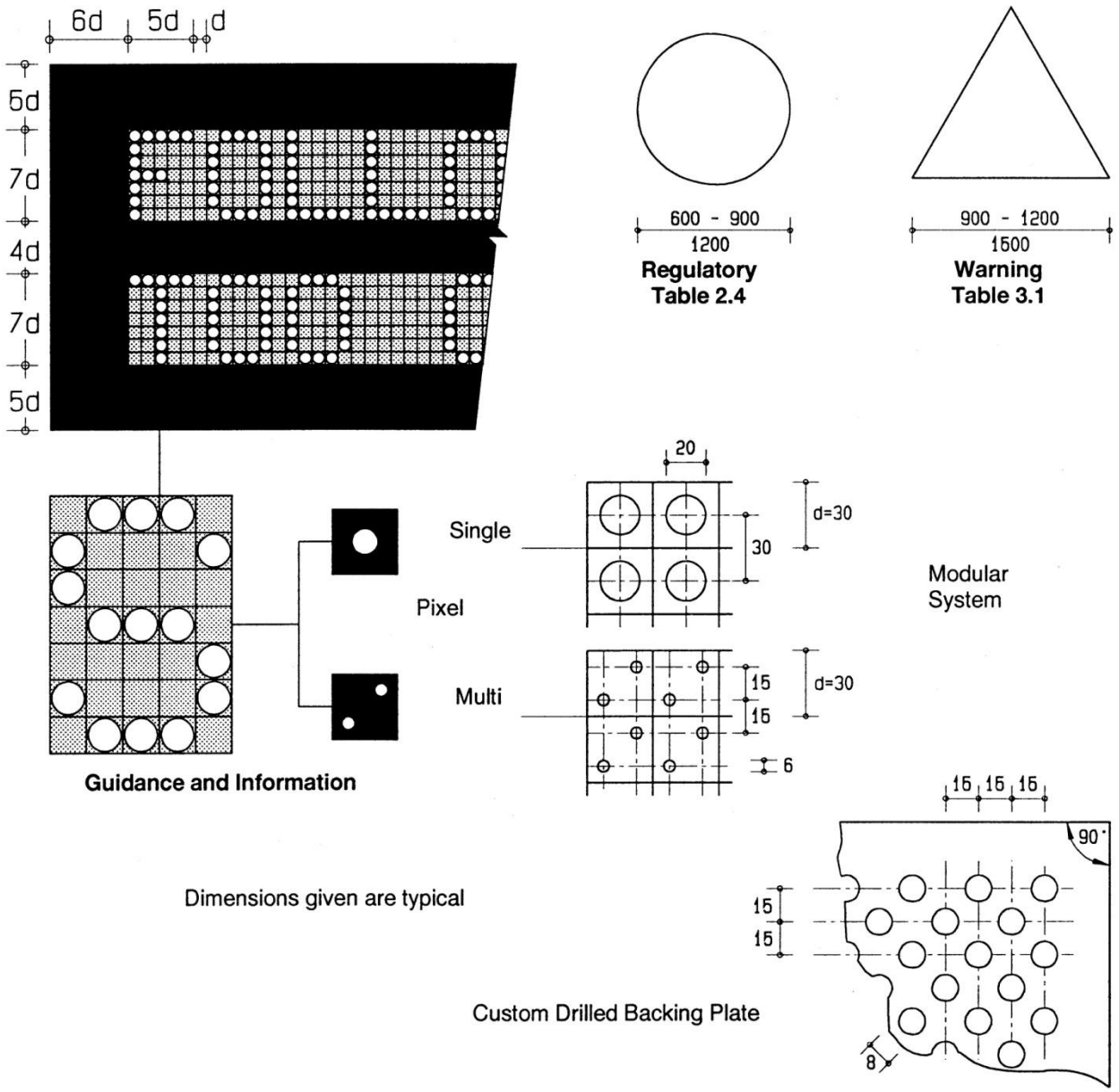

Fig. 9.11 Guidelines for Dimensions of VMS