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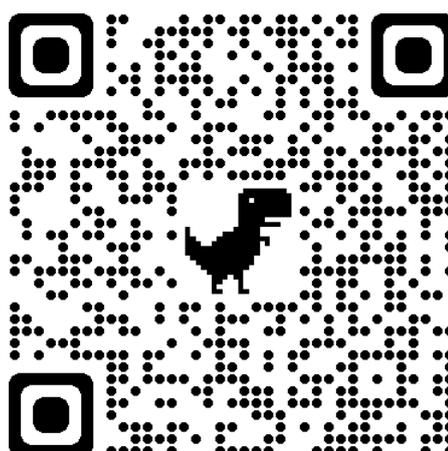
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# Compact MOVA



This leaflet describes Compact MOVA, its development and its application. It is aimed at engineers and traffic managers with a view to encouraging its wider use.

## **BACKGROUND**

MOVA (Microprocessor Optimised Vehicle Actuation) is a well-established traffic signal control strategy that was researched and developed on behalf of the Government by the then Transport and Road Research Laboratory (TRRL) in the 1980s to replace Vehicle Actuated (VA) System D. Considerable research was

carried out to develop MOVA<sup>1</sup>, culminating in the 20-site trial in 1989<sup>2</sup>. Research and development, funded by the Department for Transport and the Transport Research Laboratory, has continued and one of the recent outcomes is the development of Compact MOVA<sup>3</sup>.

MOVA is extremely effective at all types of isolated signal control junctions. It can also be applied effectively as 'linked' MOVA in small networks, especially signalised roundabouts. Not only is MOVA effective at minimising delay or maximising capacity (whichever is appropriate at

the time), research has shown it to be as safe as VA System D with Speed Assessment or Speed Discrimination Equipment (SA/SDE)<sup>4,5</sup>.

The effectiveness of MOVA can be attributed to the application of fundamental traffic theory and the strategic placement of vehicle detection. Operationally, this manifests itself as an ultra-responsive strategy, dealing with the prevailing traffic conditions rapidly and effectively.

Estimates suggest that at the end of 2008 there were approximately 3,000 sites equipped with MOVA (including linked MOVA implementations), with more than 250 per year being added to that. The Highways Agency has written an installation guide to MOVA<sup>6</sup> which, although only mandatory for Highways Agency roads<sup>7</sup>, can provide useful advice for those implementing MOVA on local road networks. MOVA can also help deliver the Department for Transport's policy of reducing delays by providing responsive signal control to maximise efficiency, safety and network capacity for all road users. MOVA can also help local highway authorities fulfil the requirements of the Network Management Duty by improving junction performance.

Full MOVA implementation employs two sets of detectors for each lane; an IN-detector positioned approximately 8 seconds travel time from the stop line and an X-detector placed approximately 3.5 seconds travel time from the stop line. The travel time is based on what is known in MOVA as the cruise speed (CSPEED), which is approximately the 10<sup>th</sup> - 15<sup>th</sup> percentile speed of vehicles approaching the junction after any queue has cleared. IN-detectors are still used in the majority of installations. However, in

urban areas, the IN-detector requires additional ducting to connect it to the signal controller. This often results in extra costs due to the need to reinstate pavements and avoid existing underground services.

## COMPACT MOVA

To encourage the use of MOVA in urban areas, Compact MOVA was developed to allow selected approaches to operate without IN-detectors. In terms of ducting and detector installation, the requirements are similar to VA System D<sup>8</sup> which means existing duct work can be re-used.

There are many sites in the urban environment where Compact MOVA can provide benefits over conventional VA control. Standard MOVA approaches may be combined with Compact MOVA approaches; for example where a low-speed side road forms a junction with a higher speed main road. In such cases a potential solution might be to provide IN-detectors on the main road to cater for the higher speeds, whilst omitting them from the side roads where speeds might be lower and the approaches are not as free flowing. Compact MOVA is an integral part of MOVA version M5 and later versions.

Where IN-detectors are omitted, it is recommended that the X-detectors are placed slightly further upstream (Table 1). The distance is based on the cruise speed. Cruise speeds at low speed sites would normally be between 7ms<sup>-1</sup> and 10ms<sup>-1</sup> which leads to recommended X-detector placement of between 37.5m and 50m (see Table 2 and MOVA Application Guide 45, Issue C<sup>9</sup>, for more details).

**Table 1: Recommended distance (in metres) of the X-detector from the stop line on Compact MOVA approaches, according to saturation flow and cruise speed**

Saturation Flow (v/h)	Cruise Speed (ms <sup>-1</sup> /mph)			
	7/16	8/18	9/20	>= 10/22
<= 1400	39.5	45.0	50.0	50.0
1500	39.0	44.5	50.0	50.0
1600	38.5	44.0	49.5	50.0
1700	38.5	44.0	49.5	50.0
1800	38.0	43.5	49.0	50.0
1900	38.0	43.0	48.5	50.0
>= 2000	37.5	43.0	48.5	50.0

A further recommendation is to set the MOVA data value known as GAMBER<sup>9</sup> to 1 second (it would often be 1.5 seconds, particularly when the cruise speed is 10ms<sup>-1</sup> or above – note that MOVA Setup for Windows automatically sets GAMBER to 1 for a Compact MOVA lane). Positioning detectors as suggested and ensuring GAMBER is set to 1 second will improve the delay optimisation performance once saturated flow has finished, which will usually give better performance.

However, note that there might be some situations where the more distant location of the X-detector may not be appropriate. One example is where lanes have opposed right turners, resulting in a greater variation of approach speeds.

At urban sites cyclists would often be making use of the junction. MOVA detection is generally intended *not* to detect cyclists as they will often be travelling at significantly different speeds from motor vehicles. To detect cyclists, some form of stop line detection is required.

As well as being able to operate efficiently at junctions, both standard and Compact MOVA works extremely well at stand-alone signal controlled crossings (i.e. Puffin, Toucan, etc). Whereas the green-to-traffic too easily extends to the maximum time under VA System D<sup>8</sup>, MOVA finds appropriate gaps in the approaching flow far more readily. This means that, with MOVA control, the pedestrian stage will appear more frequently before the maximum time is reached. Furthermore, pedestrians are unlikely to be able to cross in gaps before the change. (*The benefits mainly accrue to pedestrians, although MOVA will deal with vehicles at least as well as VA.*) Compact MOVA will be even more inclined

to service the pedestrian demand compared with standard MOVA.

The requirements for installing Compact MOVA at a stand-alone signal controlled crossing are similar to those for a junction, except installation and configuration will normally be easier. However, it is particularly important to locate the detectors as advised in Table 2 and described in AG45 Issue C<sup>9</sup>.



## SAFETY

Compact MOVA is not suitable for use on ‘high speed’ approaches to a junction (i.e. where the 85<sup>th</sup> percentile speed is greater than 35mph). The use of the X-detector without an IN-detector on a high speed approach cannot provide the necessary information to overcome the uncertainty due to the dilemma zone on high speed roads, where stopping is uncomfortable, but not stopping risks crossing the stop line after the onset of red. In *exceptional* circumstances, where there might be insufficient room to install IN-detectors, for example at signalised roundabouts, the use of Compact MOVA may have to be tolerated.

**Table 2: Overall simulation results for Compact MOVA**

	Vehicle delay			Pedestrian delay		
	Off Peak	Peak	Peaked - Peak	Off Peak	Peak	Peaked - Peak
Standard MOVA vs VA	-12.02%	-7.49%	-17.93%	3.49%	-7.45%	-8.89%
Compact MOVA vs VA	-2.82%	-1.22%	-15.83%	-14.15%	-19.04%	-16.48%
Compact MOVA vs MOVA	8.64%	6.19%	0.44%	-16.43%	-16.00%	-15.72%

## DETECTION REQUIREMENTS

MOVA was originally developed to use inductive loop type detector technology which was prevalent at the time. However, in urban areas, the installation and maintenance requirements have become an increasing burden on Local Highway Authorities, even when the more distant IN-detector is not required. In order to overcome the issues, the Department for Transport is encouraging the industry to develop alternatives. Examples, which include above ground and below ground technologies, reduce installation and maintenance costs. Further improvements might be realised by using wireless linking between detector and signal controller.

**Compact MOVA must not be used on 'high speed' approaches (i.e. where the 85<sup>th</sup> percentile speed is greater than 35mph)**

## DEVELOPMENT OF COMPACT MOVA

Compact MOVA was developed with research funded by both the Department for Transport and the Transport Research Laboratory. Initial trials compared standard MOVA without modification other than to omit the IN-detectors. As such it performed well but it did not effectively detect congestion. Subsequently, MOVA was modified so that congestion was more accurately

detected by the X-detector. The performance of what became known as Compact MOVA was assessed using micro-simulation and on-street trials. Compact MOVA was compared with both VA System D<sup>8</sup> and standard MOVA. A number of different junctions were tested using micro-simulation, including one stand-alone crossing.

The results were somewhat variable, with both standard and Compact MOVA giving sometimes large and sometimes small benefits. Table 2 shows the averaged results from micro-simulation. The flow headings indicate typical flow levels for the periods stated. The peaked-peak considers a level of demand that was high enough to assess very oversaturated conditions. (Statistically significant results are shown in bold).

On-street trials helped to confirm the potential benefits of using Compact MOVA. Compact MOVA achieved 13.3% journey time reduction overall at one junction and 45.9% savings to pedestrian delay at a stand-alone crossing compared with VA System D<sup>8</sup>, with no noticeable disbenefit to vehicles.

Compact MOVA tended to run at shorter cycle times, especially compared with VA<sup>3</sup>. In urban areas, a short cycle time is desirable because it provides pedestrians with a better level of service, potentially increasing safety as well as



amenity. However, all junctions tend to have their own characteristics and shorter cycle times cannot be guaranteed. This could be particularly true if the X-detectors are placed as recommended in Table 1 because Compact MOVA should extend the greens more readily than if placed slightly closer as it would be with standard MOVA.

When compared with VA System D<sup>8</sup>, Compact MOVA delivered approximately the same benefits as standard MOVA when any approach was congested. Congestion was being identified at least as well by Compact MOVA. In an urban environment, where long queues are likely during considerable periods of the day, it is desirable that any control strategy in operation maximises capacity effectively.

The most recent study into the performance of Compact MOVA considered safety<sup>10</sup>. Given that standard MOVA has been found to be at least as safe as VA System D<sup>8</sup> at low speed sites, there was no reason to believe that Compact MOVA would be any different. However, the Department for Transport was keen to establish and assess, through research commissioned to TRL, the safety performance of Compact MOVA. A behavioural study considered five sites: two junctions and three stand-alone Puffin crossings. Comparisons between Compact MOVA and VA using Microwave Vehicle Detection (MVD) were made by taking video of each site and analysing selected behavioural aspects. The comparisons

made included: the time into the amber and red before the last of the vehicles stopped; conflict analysis; pedestrian waiting times and compliance with the green man. Some significant differences were found between the stopping behaviour under the two control strategies and MOVA either did as well as or better than VA System D<sup>8</sup> in terms of red running. There were no dangerous incidences of red-running observed. The conflict analysis did not give rise to any particular concerns, mainly because even when including very minor conflicts, the outcome was encouraging.

## OTHER RELEVANT FEATURES

The current version of MOVA is M6. Compact MOVA is included in this version and it was first included in MOVA M5. A feature that has been added to MOVA M6, which may be relevant if pedestrians are involved, is known as pedestrian priority. The facility introduces revised maximum stage lengths whenever a pedestrian demand is made. Use of the facility can help ensure that pedestrians benefit from shorter waiting times when they are present; in the absence of pedestrians, vehicles can get longer green periods to improve junction capacity. This feature was tried at a site where a delay saving to pedestrians of almost 50% was observed, even though the site was already running very short cycle times. See AG45 Issue C<sup>9</sup> on how to use the feature.



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## OTHER PUBLICATIONS

- LTN 1/95, Assessment of Pedestrian Crossings. (Available from TSO).
- LTN 2/95, Design of Pedestrian Crossings. (Available from TSO).
- TAL 5/05, Pedestrians Facilities at Signal - Controlled Junctions. DfT
- TAL 1/06, General Principles of Traffic Control by Light Signals. DfT
- LTN 1/98, The Installation of Traffic Signals and Associated Equipment. TSO
- TAL 2/03, Signal Control at Junctions on High Speed Roads. DfT

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