Metropolitan Transport
Research Unit

Why increasing HGV length could reduce efficiency, and increase environmental and safety costs

Analysis of new research into the introduction of longer articulated vehicles

Report prepared for
Freight on Rail

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Freight Discussion Note

Prepared by MTRU for Freight on Rail

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Introduction

Context

There has been considerable discussion over whether longer, or longer and heavier, heavy articulated lorries should be allowed in the UK and generally across the EU.

Arguments often centre on whether the greater carrying capacity of such vehicles would result in less lorry traffic (fewer lorry kilometres). This is extremely complex because of:

- the diverse nature of goods transport, with highly variable densities,
- the different special demands such as refrigeration, and
- the different methods of loading such as pallets, roll cages and containers.

What is more, the size of individual consignments varies, only the distribution of goods between factories and depots can sometimes achieve continuous flows of a constant size and density. Few end user freight demands are of this type.

Patterns of use of the standard "workhorse" of the public haulage sector, currently the 16.5 metre articulated lorry, reflects this wide variety of goods transport demand. Thus they are often part loaded even from the point of pick up, and the opportunity to carry loads back from the delivery destination is limited, although there has been some improvement in this "return load" market. All this makes freight transport very different from passenger transport and very hard to generalise about.

There is however one observation which holds true and is the result of this diversity of load. When the size and weight of a large heavy lorry is optimised for low density goods, it is bound to be inefficient in carrying higher density goods. When optimised for heavy loads, the size and weight limits will be wrong for low density products.

To illustrate the point, an existing 16.5m lorry could be full by volume (***volume constrained***) at a payload weight of 6 or 7 tonnes. Some payloads are dense enough to reach the weight limit (around 26 tonnes) without taking up all the volume in a vehicle of the same length (***weight constrained***).

For this reason, the pattern of changes to heavy lorry size and weight limits has been a constant swing from increasing payload volume to increasing payload weight. The low density goods transport sector will complain about being volume constrained, show how it could save money to have larger vehicles, and after some argument, size has been increased. Once this has happened, the weight constrained sector points to the greater under use by weight of the new larger lorries and the cycle begins again. The problem is that operators always seem to standardise on a vehicle which is at the maximum size and payload weight – buying the biggest vehicle that they are ever likely to need. This problem would be far less if the goods vehicle could be better matched to the specific load. However, this is inhibited by standardisation of the articulated vehicle fleet around the largest and heaviest. This is discussed further in a later section.

The results of this are clear. Successive increases in size and weight have not been accompanied by specialisation of vehicle use and efficiency gains. HGVs are still part loaded, both by weight and volume, with many consignments simply lighter or of lower volume to require the largest permitted vehicle. As well as part loading (even when goods are neither weight nor volume constrained) empty running is high – around 27-28%. In order to compete, public hauliers will try to have the largest vehicle possible. Competition is intense, but this is achieved at the cost of inefficient operation and under utilisation.

New case study work on low density goods transport

This note has been prepared as a response to a recent assessment of low density goods transport and the potential impact of longer articulated vehicles by Huddersfield University, using case studies. The proposed new HGVs would be 25.25 metres long as opposed to the current 16.5 metres for tractor unit plus standard trailer. In addition the total length of a rigid vehicle pulling a short trailer is currently permitted to be 18.75 metres.

The Huddersfield report uses case studies of low density goods transport and draws some conclusions about potential savings if these vehicles were to be permitted in the UK. This note reviews their conclusions and discusses why these savings may be outweighed by costs elsewhere, and how the efficiency of the road freight system overall could fall if a simple change to weights and dimensions alone were to be introduced.

The key issue is that once a goods vehicle is defined which is perfectly suited for one particular type of load, and thus can achieve savings, as soon as it is used for a different type of load there are potential losses. Thus to extrapolate from case studies to overall costs or benefits in the road freight sector as a whole is misleading.

In addition, there are specific issues about how part loading (load factors) change according to the type of operation. A dedicated operation may achieve excellent results in terms of filling the vehicle by weight or volume on the outward journey, but carry very little back (poor return loading). Estimates of costs and benefits are sensitive to the assumptions about load factors, and this is clear, for example in the European Commission research quoted by Huddersfield.

Finally, there are issues about how much road space longer vehicles take up, how safe they are, and how they influence the patterns of depot location, regional versus national (or European) depots, and choice of supplier.

All of these may not alter tonnes of goods being transported (tonnes lifted), but they will affect the distances they travel and thus vehicle kilometres. It may be that tonnes lifted are not very sensitive to changes in vehicle size, but tonne kilometres and vehicles will be.

Some of these issues have been discussed in a range of reports in recent years including several by MTRU and the literature review undertaken by Huddersfield is incomplete in this respect. For example, the conclusion that there is a consensus is not correct, in particular there is no consensus that freight demand is “fixed” (page 18, 4.1, para 2). In fact there is a consensus that it is not fixed, and that, while tonnes may be relatively insensitive to price, tonne kilometres and vehicle kilometres are far more sensitive.

Detailed commentary on the Huddersfield University study

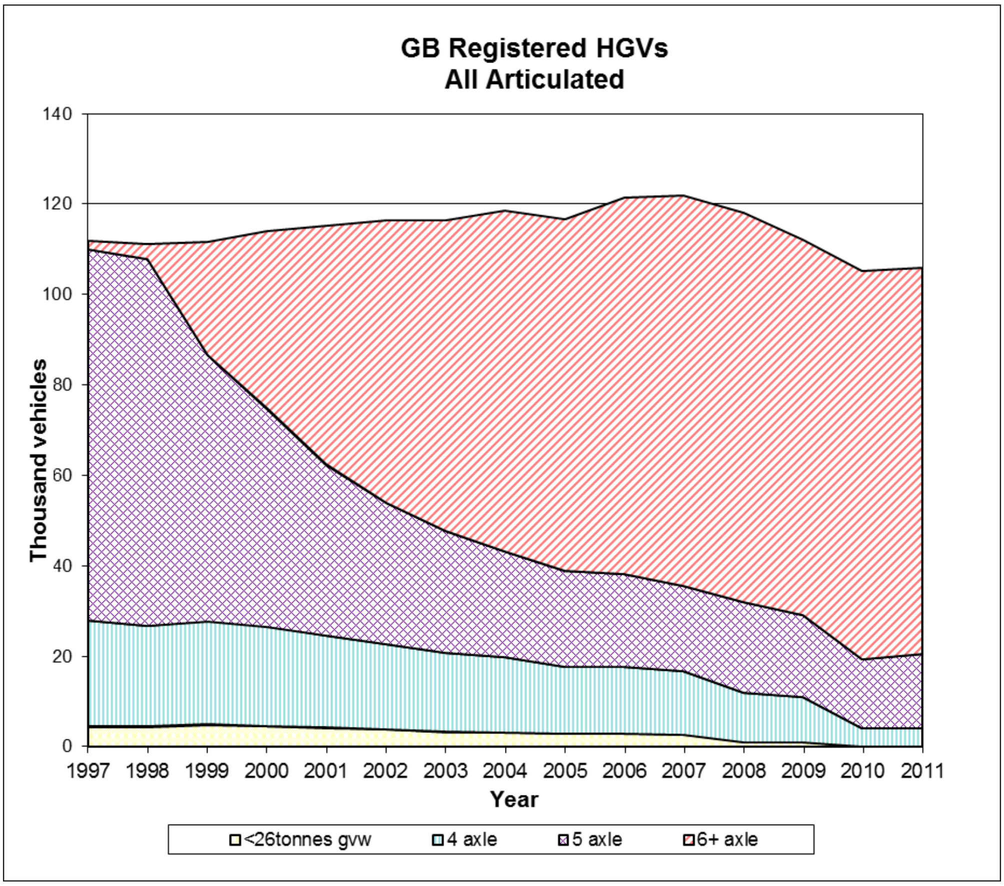
The Huddersfield report uses several case studies of low density goods transport, and essentially assumes that permitting longer vehicles will have no impact outside the specific goods traffic types that would benefit from the change. This is useful in terms of case study work, but less so for setting national standards for size and weight.

It is also true to say that the literature review is somewhat incomplete in terms of the evidence on the impacts of previous increases in size and weight. The lack of differentiation of vehicle type within the national fleet is an obvious concern. Changing limits without safeguards such as a weight distance tax for HGVs or better regulation of where the heaviest vehicles are permitted is likely to be counter productive. There is also the issue of applying more rigorous safety standards to larger vehicles and then comparing their performance to existing vehicles without such improvements. Like for like comparisons must be used. This is critical if the increase in efficiency, safety or environmental performance which is usually predicted to result from increasing limits is ever to be achieved.

Buying the biggest

One reason for this has been explored in more detail in previous reports and relates to how operators buy the largest vehicle they are likely to need and create an industry standard. This is shown in the chart below, updated from earlier MTRU reports.

Chart 1



Source: TSGB Table 9.6 to 2009 Gross Vehicle Weight (GVW), then Table VEH 0524 (axles). Equivalent GVW bands used are: 4axle: up to 33 tonnes; 5 axle up to 40 tonnes, 6 axle up to 44 tonnes[1].

1 *Heavier lorries and their impacts on the economy and the environment,* MTRU for Freight on Rail, 2008

Thus a key issue must be whether the new vehicle combinations would become more of a standard industry workhorse, or whether they would be confined to specialised operations. If the former were to occur, it could cause major problems in terms of efficiency, safety and environmental impact.

Problem 1 Matching vehicles to existing loads

Thus the first problem is whether the new longer vehicles will make a significant impact on the fleet, in other words operators decide they need to have such vehicles available rather than the previous maximum size. If they do, then many of the loads which are well matched to the existing vehicle limits will have to be carried in the longer vehicles and this will cause higher costs, more congestion and danger, and more emissions.

The Huddersfield report itself suggests that the new vehicles would use just over 30% more fuel than an artic which is a standard length, but designed for a lower maximum gross weight (33 tonnes). Moving any goods traffic which is not volume constrained in the new vehicles instead of the existing ones will thus create a significant cost penalty.

There is no proposed legislation or pricing which will affect the decision to standardise on the larger vehicles or not. The Huddersfield report is a case study for a particular type of flow. It does not examine the standardisation issue and thus should not be used for generalised cost/benefit estimates.

A further question here must be why there are not more artics registered at lighter weight limits, if volume constraints are such a serious issue. As Chart 1 shows, there are very few 4 axle, 33 tonne gvw, vehicles registered despite being much better suited to low density loads. Even the 40 tonners (5 axles) are a modest proportion of the fleet. The currently permitted drawbar trailer option would also give about 15% more volume, but is rare in the GB fleet. The reasons for this need to be explored, but one clear possibility is the industry desire to standardise as far as possible on a single vehicle type.

Problem 2 Return loads, empty running, and the impact on costs and benefits

Whether the longer vehicles are adopted widely or not, underutilisation is also likely to occur because there will be a reduced ability to take return loads. There are two key points. First, not all loads are full loads from one place to another, even for specialised operations. The second is that not all return loads arise at the same destination as the outward deliveries. Nor are the available return loads likely to be in perfect balance in terms of weight and volume with those outward loads.

If confined to certain specialised flows, the bigger vehicles should achieve some operational savings. For example, if light weight paper products or crisps are being transported by the manufacturer to a distribution depot in their own specialised vehicles, the outward delivery run will be full (by volume) and need fewer HGVs. However, it is extremely unlikely that such a specialised operation will take any loads back from the distribution depot to the manufacturer. The outward journey would be efficient, but the return would be virtually empty.

Using a more standard vehicle means that the probability of taking an existing return load is higher, except in the case where it is already volume constrained.

The importance of this is best illustrated by considering the assumptions behind some of the cost and CO_2 emission changes estimated in the Huddersfield report.

First, they have calculated which loads appear to be volume constrained from the Continuous Survey of Road Goods Transport (CSRGT) 2009. They have calculated the loaded vehicle kilometres, then increased this by 38% to allow for the fact that vehicles run empty for 27.6% of their time. This new total is divided by the increased capacity, measured as volume, of the new vehicles (assumed to be 54% greater).

However, if there is a decrease in the likelihood of return loads, the amount of empty running would have to be increased for the longer vehicles. In the extreme case of returning to base empty every time, there would in fact be a significant increase in costs and emissions from the road operations. While neither extreme case is likely, the significance of such a change can be illustrated by the following table, which uses the same assumptions as the Huddersfield report, but changes the load factor for the new, longer vehicles.

Table 1 Huddersfield table amended for load factor *(change shown thus)*

Opportunity	Opportunity scale	Cost factors	Annual Net Impact of 100% volume transfer to HCV (£'million)
Transfer of full loads of lightweight goods in palletised or roll cage form from standard articulated vehicles ('SAV') to HCV.	1,160 million SAV km	£0.81 per km standard articulated vehicle £1.01 per km HCV 54% capacity increase	178 benefit
As above	***As above***	***As above but HCV empty running 50%***	***162 loss***[2]

A further factor in the probability of obtaining return loads is the ability of firms to have sufficiently large access points for the longer vehicles. It is possible that one trailer from the new longer vehicle could be left somewhere while a return load is collected, then picked up later for the return trip. There are two further problems with this. First is where the trailer would be left in terms of on or off road and how much of a deviation would be needed to collect it. The second is that the latter also has a time cost for the deviation, as does the disconnection and reconnection. This is not insignificant.

This suggests that the simple extrapolation from a specialised one way operation to national policy is unwise. Of course, there will be operations where there are some more predictable return loads, for example depot to depot parcel deliveries. Even if overall there was little change in road costs and damage, the potential for transfer from rail to road (set out in the Huddersfield report) could tip the balance against any overall benefit from longer vehicles.

Problem 3 Congestion impacts

It appears that the Huddersfield calculations for congestion do not take account of the greater length of the proposed HCVs. All them appear to be in terms of vehicle kilometres

[2] The Huddersfield table in para 5.3, assumes 840 million current HGV (SAV) kilometres are being run full, with about 28% empty running. These could be replaced by 546 million kilometres by the proposed larger HGVs (HCVs). If they ran back empty, achieving a lower load factor than the average (about 28%) assumed for the existing vehicles, a predicted benefit of £178million would turn into a £162million loss. The £178million is the main benefit claimed in the Huddersfield table.

and not in passenger car units (pcus). Again some of the earlier work by MTRU[3], and in particular using the corrected version of the TML report[4] referred to by Huddersfield, would have helped the discussion. A table from the MTRU report illustrates the point about increased road space requirements comparing longer vehicles to the current 16.5metres.

Table 2
Increase in pcu value of longer HGVs in different road conditions

	18.75	19.4m	25.25m
Multi-lane grade separated dual carriageway, very low traffic	0	0	0
Free flow traffic, no junctions, but headways needed	+6.9%	+8.9%	+26.9%
Stop start traffic, length only counted	+13.6%	+17.6%	+53.0%

From the same MTRU report, two charts show that a decrease in vehicle kilometres can nevertheless lead to an increase in congestion, if the vehicle is longer. In the case shown in the charts the vehicle was the same length as that considered in the Huddersfield report. Both use the amended TML study data, plus the pcu adjustments by MTRU. It is very important not to use original TML data, which had a simple arithmetical error which had a major impact, and was corrected by TML in later versions. There is another error on load factors in the report which was discussed at the EU Peer Group reviewing this topic.

Both of the charts also allow for a "rebound effect" in which the lower costs generate more traffic, in terms of vehicle kilometres. A range is used and this is reflected in different elasticity values quoted in the Charts[5].

This is derived from several sources, including transfer to rail, and changes in depot locations and supplier choice resulting from lower costs, in this case from more extensive use of 25.25m HGVs. The extent of use is shown by the % figures on the horizontal axis. The Huddersfield report has calculated the rail transfer potential, but not other changes in the ratio of vehicle kilometres to tonnes lifted (the rebound effect)[6].

Chart 2 shows the reduction in vehicle kilometres allowing for various rebound effects, but not for any increase in road space required for longer vehicles. Chart 3 shows how this extra road space requirement could increase traffic congestion rather than decrease it.

Chart 2
Changes in vehicle kilometres (no pcu adjustment) from introducing LHVs

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3 *How much road space do heavy articulated lorries occupy?* MTRU for Freight on Rail, November 2010

4 *Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC*, De Ceuster et al, TML, November 2008, amended 2009

5 See: *Price sensitivity of European road freight transport – towards a better understanding of existing results,* De Jong et al, November 2010

6 This question is discussed further in: *Why are freight elasticities so problematic?* MTRU for the European Commission Peer Review Group for LHVs, November 2010

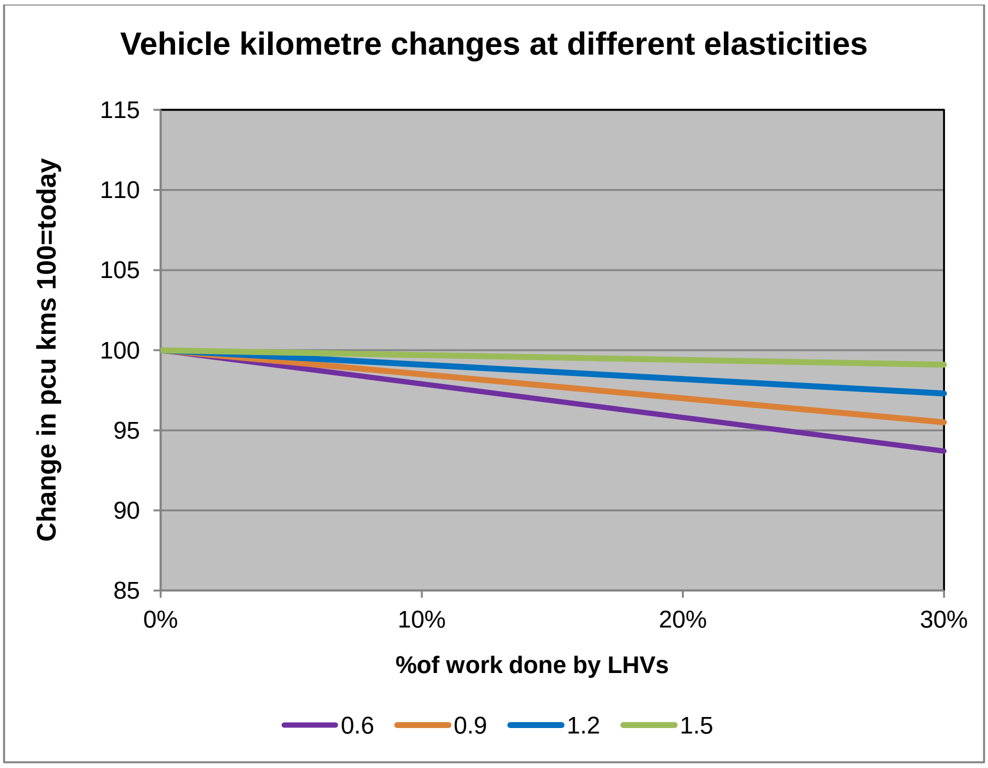
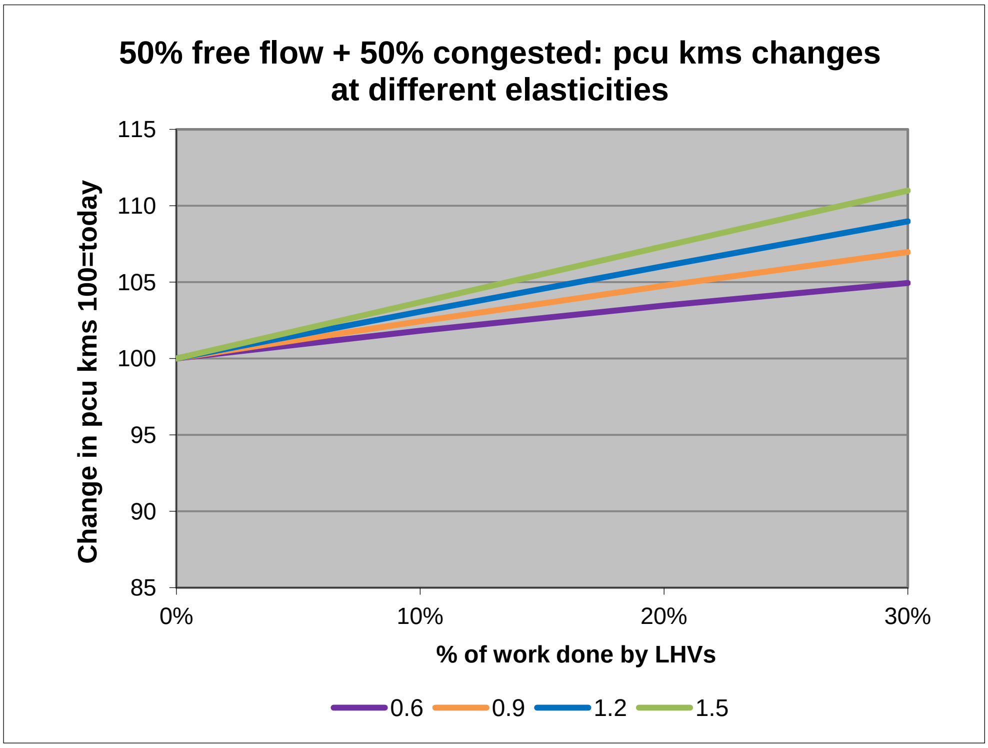


Chart 3
Changes in vehicle kilometres from introducing LHVs, adjusted for extra length of HCVs



Thus Chart 3 shows the impact of adjusting for an increased pcu value in line with vehicle length as shown in Table 2. It is clear that a reduction of traffic of up to 1% to 6% changes to an increase in traffic of up to 5% to 11%.

The Huddersfield report does not allow for the extra road space required by the new vehicles and therefore any assumption that there would be congestion benefits will not be accurate, and there may be disbenefits. This would also be sensitive to the assumptions on load factors and that there would be no change in depot location, stock holding or choice of supplier.

Problem 4 Safety

Section 6 in the Huddersfield report deals with safety and states that:
"There is largely consensus in key reports that the use of longer and / or heavier vehicles will have a generally neutral impact on road safety when considered on a per unit of goods moved basis." (Page 28).

This is not the same as a per vehicle basis, and the per unit basis is entirely dependent on assumptions about load factors and fixed demand. In fact, the same reports quoted are clear that there are serious risks on a per vehicle basis, which should be the starting point for any safety impact assessment.

For example, one of the references quoted is clear that:
"The safety of the individual LHV is worse than that of a smaller truck."
(Page 14, TML report)
The safety performance of heavy vehicles is complex, depending on the number of axles, their position, gross permitted weight, steered axles on the trailer (including lockability) and even height. There are trade offs between different characteristics such as manoeuvrability and lateral stability. Two of the references quoted, as well as other research, show major differences between vehicle configurations, and that existing shorter artics would benefit from some of the technology being suggested to make the proposed larger HGVs less dangerous. A level playing field is essential. To make the point we reproduce a table summarising some of the TRL data quoted by Huddersfield.

Table 3: TRL low speed manoeuvrability tests and EU limits

TRL vehicle type number	Vehicle length metres	Vehicle weight tonnes	Axles	Swept path 100% is limit	Out-swing performance: limit is 0.8m
1 & 2	16.5	44	6: trailer unsteered	94%	<0.3m
3	18.75	44	6: trailer steered	74%	<0.1m
N/A	18.75	45.8	6: trailer unsteered	100%	0.8 – 1.2m (fail)
4	25.25	44	8 on 2 artic trailers	84%	Pass
5	25.25	49.5	8 rigid + trailer	146% (fail)	<0.1m
6	25.25	60	8 on 2 artic trailers	84%	Pass
7	25.25	63.2	8 rigid + trailer	146% (fail)	<0.1m
8	34	82	11 on 2 artic trailers	128% (fail)	<0.1m

Source: TRL report PPR 285

The TRL report also describes some of the conflicting effects of different vehicle characteristics, which further illustrates the complexity of this issue. If the trade offs between low speed manoeuvrability and higher speed stability and safety were included, it would be even more complex. For example, more articulation points mean better manoeuvrability, but create potential for effects such as "snaking".

Table 4: Vehicle characteristics and stability

	Static rollover threshold	Rearward amplification	High speed off tracking
Higher gross weight	**XX**	**XX**	**X**
More articulation points	-	**XX**	**X**
Longer trailers	-	-	**XX**
Longer wheelbase	-	✓✓	✓
Longer overhangs	-	**XX**	**X**
More axles	✓✓	**XX**	**X**
More axle spread	-	**XX**	**X**

Source: TRL PPR285

In addition, it is important to understand that safety comparisons must be made for the same type of road. This is because accident rates differ between road types. For example, if HCVs in the Netherlands were restricted to roads with lower accident rates (such as motorways), the overall rate will be lower than standard vehicles running on all types of roads and mixing with vulnerable road users such as cyclists and pedestrians. This is illustrated by Table 5 below, which shows that HGVs are more likely to be involved in fatal accidents per mile on the same type of road.

Table 5: HGV traffic and fatal accidents by road type 2010[7]

Traffic is in billion veh kms

	HGV traffic	All motorised traffic	HGV %	% fatalities involving at least 1 HGV	**Ratio of HGV to all motor vehicles**
Motorway	11.9	98.2	12.1%	38.1%	**314%**
A	11.4	219.6	5.2%	16.1%	**309%**
Minor	3.1	178.2	1.7%	7.3%	**427%**

Source: Traffic statistics table TRA0104, Accident statistics Table RAS 30017, both DfT, MTRU calculation

The final point is that any safety (and manoeuvrability) assessment must adopt a fair comparison – i.e. the best performing existing vehicle versus the best proposed vehicle.

Conclusions

7 Data for 2007-2010 showing similar results can be found in *HGV fatal accident rates update,* MTRU, December 2011, for Freight on Rail

The Huddersfield case study report is useful in terms of its analysis of which loads nationally might be volume constrained, and how specific operations might gain from longer HGVs.

However, the vehicle kilometre savings take no account of changes in the probability of obtaining return loads. The calculations are very sensitive to this assumption and the predicted benefits could turn to costs from this source alone.

Road freight demand is assumed by Huddersfield to be "fixed" this is not the case especially for tonne kilometres and vehicle kilometres.

Safety (and manoeuvrability) impacts will depend on a fair comparison – i.e. the best performing existing vehicle versus the best proposed vehicle.

In terms of safety there are several factors associated with length, especially overtaking time, vehicle stability at speed, and blind spots, which need to be considered. It is important to compare results on the same type of road.

The idea of uncoupling part of the vehicle to make it more flexible does not appear to include the time costs of decoupling and recoupling, nor details of where the trailer could be temporarily parked, or of how far away it would to be parked from any potential customer. Both urban areas and sensitive rural areas would create problems in this regard.

The traffic impact calculations take no account of the increased demand for road space from the longer vehicles – this is a major omission which means that congestion may not be reduced even under the most favourable circumstances.

The key issues of why there are not more specialised vehicles in use for low density loads, and how far the proposed larger vehicles would be used outside such operations is not addressed. Such use would create counterbalancing costs to outweigh potential benefits.

Infrastructure costs such as access points, parking and forecourts, to accommodate the longer vehicles are mentioned in the Huddersfield report but not calculated. These could fall to both Local Authorities and to the private sector.

For these reasons, the simple extrapolation from specialised one way road freight operations to a national policy decision is not justified.

Annex: Base traffic data for vans and HGVs

Table A1

Road Traffic GB

	Light vans	Goods vehicles	All motor vehicles	Light vans	Goods vehicles
	Billion vehicle miles			*Percent of total*	
2006	**39.9**	**18.0**	**311.4**	**13%**	**6%**
2007	**41.9**	**18.2**	**314.1**	**13%**	**6%**
2008	**41.6**	**17.8**	**311.0**	**13%**	**6%**
2009	**40.7**	**16.3**	**308.1**	**13%**	**5%**
2010	**41.0**	**16.4**	**303.2**	**14%**	**5%**
2011	**41.4**	**15.9**	**303.8**	**14%**	**5%**

Source: TSGB

This data is shown in chart form below.

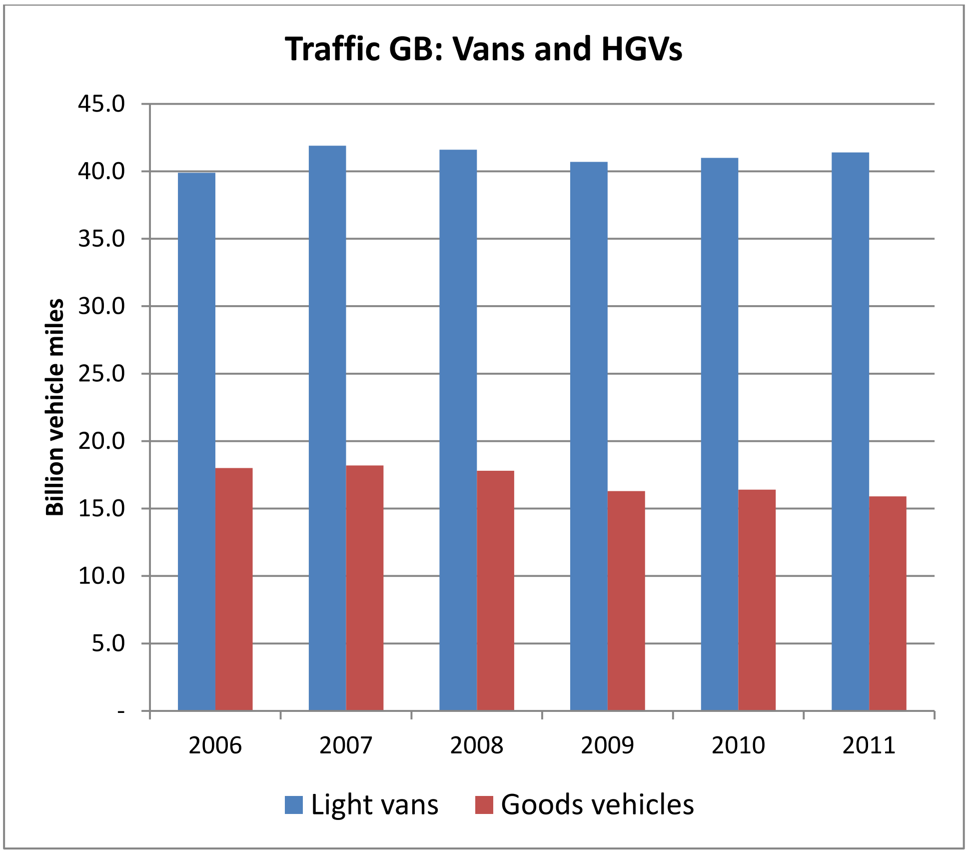


Table A2

HGV traffic by body type

Billion vehicle miles

	2006	2007	2008	2009	2010
2 axles rigid	7.0	6.9	6.7	6.2	6.3
3 axles rigid	1.2	1.2	1.3	1.2	1.1
4 or more axles rigid	1.1	1.1	1.2	1.0	0.9
3 and 4 axles artic	1.2	1.1	1.0	0.9	0.9
5 axles artic	4.1	4.1	4.1	3.6	3.5
6 or more axles artic	3.6	3.8	3.7	3.5	3.7
Total HGV	18.1	18.3	17.9	16.4	16.4

Source: TSGB Table 3105

This data is shown in chart form below.