TRUCK MASSES AND DIMENSIONS

Impact on Transport Efficiency

Prepared by Kenth Lumsden
Professor Department of Logistics and Transportation, Chalmers University of Technology
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The participants in the workshop included the following:

- Professor Kenth Lumsden
  | Chalmers University, Gothenburg, Rapporteur
- Marco Monticelli
  | Iveco, Chairman
- Massimo Fumarola
  | Iveco
- Anders Lundström
  | Scania
- Ulf Ehrning
  | Volvo
- Liesbeth Geysels
  | IRU
- Laurent Selles
  | European Commission, DG Enterprise
- Willy Maes
  | European Commission, DG TREN
- John Berry
  | European Commission, DG TREN
- Giuliano Lamoni
  | CEMAT
- Huub van Berlo
  | DAF
- Reinhard Ball
  | DaimlerChrysler
- Stefan Klatt
  | MAN
- Dolf Lamerigts
  | ACEA
- Michael Hollingsworth
  | ACEA

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  | Volvo 3P

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This report does not necessarily reflect the views of ACEA
or the other participants, but is intended to provide a
contribution to the discussion on the topics concerned.

The ACEA Scientific Advisory Group

To overcome the shortfall of scientific understanding of
freight-related transport policy issues, the commercial vehicle manufacturer members of ACEA established a Scientific Advisory Group (SAG) in 1998, to examine important issues relating to freight transport and commercial vehicles.

The ACEA SAG has reported on transport infrastructure, freight transport policies and freight distribution of the future. Other reports have looked at e-commerce, intermodal transport and marginal social cost pricing in transport policy.

This report is the result of the eighth meeting of the SAG, on “Truck Mass and Dimensions – Impact on Transport Efficiency.”
There are a number of different ways to change the mass and dimensions of a truck and the combination of trailers and other equipment. This document is not intended to pinpoint one particular solution, but rather, to show the importance of the subject and, hopefully, lead to more efficient truck use.

One essential way to increase productivity is to use longer and heavier trucks than those generally allowed within the European Union (EU) today, thereby creating more space to be commercially used without more trucks entering the road system. This report will review the effects of such increased productivity and show that the issue of truck mass and dimensions is important and must be focused upon more intensively by the logistics business and EU regulators.

The objectives of the meeting were:

- To evaluate what, from a practical standpoint, can be changed in truck weights and dimensions over the next ten years, given the trends in European goods transportation
- To establish a methodology to assess the benefits that might arise from any changes in, for example, the vehicle fleet, CO2 emissions, etc.
- To assess the potential for public acceptability of such changes

Most scenarios for the future of road transport foresee significant growth coupled with challenges, not the least of which being the limits of road network capacity. This challenge has to be solved within the existing logistics means due to a number of societal constraints. Thus, a way must be found to augment the level of transport without increasing the level of traffic. This will require optimising every aspect of increased productivity, including cost, congestion, environment, sustainability, the road network and so on.

Within the scope of this study, there are several different aspects to the mass and dimensions of trucks that must be evaluated, such as economy, logistics, traffic safety, environment, etc. This report will mainly focus on the logistic effects.
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Road transport is developing fast due to developments in society and logistics. Goods volumes are increasing, as are transport distances. Road transport will continue to be the dominant mode in the future. The problem of congestion, thus, must be tackled and road transport efficiency must be increased further.

There are several solutions, which should be adopted in combination:

- More efficient logistics
- More efficient transport modes, longer and heavier trucks, etc
- Better infrastructure
- More intelligent trucks
- More combined transport

One essential issue is how to increase the load capacity of trucks. Today, this is to a very large extent connected to the mass and dimensions, which are strictly regulated. There is an ongoing debate on this issue, with demands from several stakeholders to allow longer and heavier trucks than permitted today.

Mass and dimensions of trucks in European international road transport are regulated by Directive 96/53/EC. Discussions have started regarding the possibilities of opening up this directive for changes, but, for the time being, there are no plans for that. However, sooner or later the time will come when this has to be done and, therefore, it is important that we are prepared for a serious discussion.

Increasing the size of trucks will have an impact on several issues, all which have to be analysed thoroughly:

- **Truck efficiency**, due to fewer trucks needed for a given amount of goods, and not least since most long distance transport is volume sensitive.
- **Road utilisation**, since fewer trucks will be needed for a given amount of goods.
- **Environment**, since fuel consumption per tonnekm will be reduced.
- **Safety**, both active and passive, where further analyses are needed for the impact on, eg, driving stability, overtaking, braking, swept path, collision risk and driver education.

All of these together have technical as well as political aspects and all have to be thoroughly investigated before there can be a common view on the technical solutions for the future.
Transport is a prerequisite for economic growth in society. Historically, there has been a correlation between transport growth and GDP growth. Although our politicians try to “decouple” this correlation, there are no signs of this becoming reality, even if the correlation factor may change slightly.

Over the last decades, transport growth in Europe has been clearly focused on road transport and short sea shipping. Road transport is responsible for around 44% of European transport. The EU White Paper on Transport Policy released in 2001 predicts a further 38% increase in road transport in the period 1998–2010. Other prognoses from the EU Commission claim that, within the enlarged EU, road transport will more or less double during the period 2005–2030. This increase in road transport will clearly aggravate already existing problems of congestion in certain parts of Europe.

Logistics developments and the need for efficient logistic solutions mean that transport modes and trucks must be optimised for their tasks. From an “economy of scale” point of view, trucks should be as large as possible, but there are also a number of other factors that have a strong influence on truck size.

An effective solution must be based on an analysis of supply and demand. When it comes to truck load capacity, the importance is either dimension, counted in loading area length or volume, or load weight.
The United Nations has predicted strong growth of megacities. Although most of the largest ones will be found in Asia and South America, Europe will also see growing cities. According to the UN, in year 2015, 20% of the world population will live in 225 megacities, each with more than 2 million inhabitants. Some 85% of the world’s population will live in cities with more than 50,000 inhabitants.

In Europe, due to a rather low population growth, cities are not expected to grow too much. Nevertheless, Europe will be even more urbanised and city structures will change to some extent - a development that has already started.

A large city can be seen as consisting of a number of concentric circles surrounding the city centre:

**City centres** are attractive areas, often populated by small families or 1-2 person households with rather high purchasing power. Restaurants, cafés, theatres and other forms of entertainment are found more and more in city centres, as are offices in less cost-sensitive businesses. Shops are often smaller, “the little shop around the corner”, 7-11, etc. Shops for more expensive durables, such as clothing, jewellery, as well as “show-rooms” for larger capital goods (cars, white goods, etc) can also be found there. Centrally located department stores often develop into shopping malls consisting of many smaller shops. In these areas, consumption is less cost sensitive.

Deliveries to city centres are smaller and, thus, so are the distribution trucks used (not only due to delivery quantities but also due to the city structure with narrow streets, etc).

**Outside the main city centre**, there are “former centrally located suburbs” with lower cost profiles, populated by people with moderate purchasing power. This part of a city also holds industries, offices and shops that are more cost/price sensitive and more sensitive to distribution costs, but still need a rather central location.

Old, large manufacturing industry is rather difficult to relocate and these kinds of companies were historically located to suburbs, but not too far away from living areas, making it possible for the personnel to live within a reasonable distance from their jobs.
**Further out, attractive areas for shopping can be found.** Supermarkets, hypermarkets, larger shopping malls, etc, are located in areas outside city centres, with good infrastructure, high accessibility and good parking possibilities, since hopping often requires the use of cars. Distribution consists of larger volumes and large distribution trucks can be used.

**Suburbs** are often residential areas with private houses, populated with families with normal to high purchasing power. These areas have high accessibility and good infrastructure. Consumers living here use their car for shopping and often practice some kind of "weekly shopping", meaning that shopping volumes are rather big. These areas also attract offices and smaller industries, which are rather low cost sensitive.

City planners try to locate new industries in specific **industry areas** close to extended parts of the infrastructure network. This is especially valid for transport-intense industries.

All of these developments have a high impact on goods distribution.

### 2 TRANSPORT DEVELOPMENT

**Logistics and Transport Development**

The implementation time of changes in society and transport is, in some cases, very long, such as for building new infrastructure. It may take 10-15 years to decide and build a new motorway. Other changes may give immediate effects, such as political decisions. Remember how quickly the Berlin Wall came down.

Changes in logistics have had a very important impact on transport needs. The traditional supply chain in manufacturing industries has developed into networks. Key words have been Outsourcing, Supply Chain Management, Vendor Managed Inventory, Third Party and Fourth Party Logistics, etc. Manufacturing industries have concentrated their core business on innovation and design of products, combined with manufacturing of key components and keeping up the contact network with their customers. Simpler forms of manufacturing, assembling, etc, have been outsourced to partners and sub suppliers. Manufacturing is centralised and concentrated in fewer locations. All this has created new transport patterns and increased transport demands.

- Increased product and goods value
- Shorter commercial cycle time
- Smaller shipments
- Continuous goods flows
- Higher frequencies
- Tighter time frames
- Increasing total volumes

**Transport network – definitions**

A number of parameters are necessary in order to describe and calculate transport solutions and their utilisation. Traditionally, tonnekm has been the most widely used parameter. This is sufficient for describing the physical materials flow and the utilisation of a truck. In principle, the parameter tonne can be substituted or recalculated into volume or load area length, to get “m³km” or “mkm”.
A disadvantage of these parameters is that they do not take the value into account. Today, when capital tie-up is of much more importance, there is a need for a parameter for “transported capital value and distance - €\text{km}”. However, even this is not enough, since capital tie-up is not related to the transport distance, but only to transport time. A parameter taking care of that would be “transported capital value and time - €\text{h}”. But this can easily be regarded as artificial and is difficult to calculate.

Therefore, there is a need for further development of an easy-to-use parameter to complement tonnekm as the basic parameter for transport analysis.

### Logistic Trends

There are a number of trends within transport and logistics, with new ones continuously developing. While an exhaustive list of these trends is beyond the scope of this paper, we would like to pinpoint some particularly relevant to international transport:

- Evolution of logistics
- Customer
- Product
- Flow
- Logistic company and
- Shipper

**The evolution of logistics**

There has been a lot of discussion about the influence of IT solutions on logistic performance. It was thought early on that the introduction of IT would lead to a decentralisation of most operations in the supply chain. What we have encountered is rather the contrary: most operations, such as manufacturing and stock keeping, have been centralising due to phenomena like economies of scale. This has been supported by the real time information created by a number of IT systems.

Manufacturing systems have focused on the demand for lean production and made to order. The prerequisites for this type of behaviour are short lead times through all kinds of production systems.

At the same time, because consumers are demanding individualised items or articles made to order, there is a concomitant need to identify these individual items. This requirement arises very early in the supply chain for some products. When the customer order point is moved upstream, it becomes ever more critical. Moreover, research has shown that the benefits of identification turn out to be more financially favourable the closer the freight comes to the point of destination, or even better, the point of consumption.

Moreover, there has been a clear tendency in the development of e-business towards inter-company business - B2B. While the growth in this segment has been high, the coming challenge is within the distribution to the end customer or consumer - B2C. This development will mean heavy demand on the trucks used in distribution. Trucks and loading units must be designed to be used for different transport requirements, like long haul and short haul, and in combination.

In almost every industrial segment today there is a tendency towards centralisation of the physical flow. This change results in two different developments. First of all, the centralisation of stocks to decrease the capital tied up in any distribution chain and to improve the level of service. Secondly, is the centralisation of distribution, in the form of Hub-and-Spoke systems, for instance. Such systems will increase the level of service given by logistics suppliers.

Normally, a number of different actors are needed to build up a supply chain of any kind, which requires significant internal resources on the part of the shipper. This is why an increasing number of companies prefer to rely on one external actor: this is known as Third Party Logistics.
Also, because a supply chain consists of many actors, the freight often has to be moved from one mode of transport to another mode – known as intermodality. This transfer creates problems, such as increased handling costs and delays. It is an appropriate political approach to support intermodality to reduce the heavy load on the roads. The outcome of this is that the use of modular units that can be moved between modes will increase in importance.

The customer
With the increasing trend towards focus on the customer, the demand structure will be the base of all distribution structures and requirements. The time to the customer from order being placed - fulfilment time - is of utmost importance, as it is directly connected to time to cash.

In the future, demand will increasingly be identified earlier and will be for ever more customised products and individualised items. A method used more and more to accomplish this is postponement, which means that you will customize a bulk product in the supply chain just before it goes to the customer. The outcome is, however, that the trucks will handle a bulk flow most of, but not the entire, journey to the customer.

The product
A product is not just a piece of material; it is something that creates value for the consumer or the buyer – and the value of products is increasing. Moreover, most industrialized products are subcomponents of larger or more complex articles. These subcomponents may perform a specific function, such as a power line (car engine with components), for a higher value finished component (car). Such a product will, in many cases, require a unit load to fulfill the identified demand.

The flow
To fulfil the requirements of the customer, supplier and society as a whole, the flow of resources must be assured.

This does not mean that there has to be a very rapid flow, but rather a continuous flow of resources. The flow itself must also stand up to the increasing obligation of security for freight and humans in the transport chain.

The time freight spends in any transport or supply chain is not only moving time, but also non-moving time. This inactive time is, in most cases, spent in some kind of terminal and is time that should be minimised. Today, there is more focus on the interaction between the different actors in moving items and terminals, such as in the concept of Merge-in-Transit. Here the different consignments will be put together in a continuous flow through the terminal. This requires modular system solutions to be effective.

Environmental impacts on individuals and society will, in future, play an even more important role in the logistics sector as well. The solutions to these requirements will also be perceived as interesting business opportunities.

The distribution network
Traditionally, networks for distribution of goods have, to a large extent, been built up by direct transport between the producer and the consumer. This kind of distribution...
For this kind of network it is especially beneficial to use as large trucks as possible between the central terminals in the net. The demands on planning are higher, but with modern logistics management systems, this is possible without loss of flexibility.

The logistics company
Most logistics companies have small profit margins. As a result, they must try to reduce their assets. The most effective way to do this is to have standardised resources like trucks, trailers or modules of load units.

The tendency towards unit standardisation also has its origin in the globalisation of the logistics market. International trade requires the use of standardised units, although this makes it more difficult to develop local solutions.

The shipper
The overall tendency for the shipper is an increased focus on:

- Improvement of transparency for cost and environment
- Reducing costs and capital
- Improving time and service performance

network often results in a large number of transport relations, which, in turn, mean that the transport units have a rather low utilisation and result in low frequencies, especially when volumes are small. This also means that a large number of transporting units are needed and much time has to be spent on transport planning activities.

The need for fast and frequent distribution from a manufacturer to a number of different customers in different locations is the background to all distribution systems. These systems are developing from generally direct transport with quick but low-frequency distribution towards hub systems, with frequent but rigid relations.

A hub system basically does not distinguish between producers and consumers, but treats all equally. It also means a substantial reduction in the number of relations between customers and an increase in truck load factors and utilisation.

**One-terminal networks** use a single hub and several local terminals. They are suitable when there is a limited amount of goods and the area to cover is large.

**Multi-terminal networks** are based on several terminals on the same terminal level. To minimise complications, the basic idea is to avoid transport between all terminals and instead send goods between those connected to desired terminals.

**Hierarchical multi-terminal networks** are based on a number of centrally located terminals and a number of sub-terminals. This hierarchical network creates possibilities for concentrated flows in local areas with high capacity utilisation, combined with short distances to customers through the local terminals and short distances.
Ongoing development

According to EU DG-TREN, transport growth in Europe in recent decades has been mainly accounted for by road transport and short sea shipping, with rail shrinking (see graph). There are several reasons for this, with the most important being:

- The Just-In-Time (JIT) philosophy, which strives towards smaller deliveries with higher frequency
- Industry development with concentration of production in fewer locations serving larger areas, increasing the need for high quality JIT-transport
- Rail transport is most suitable for large volumes on a limited number of routes, as well as for goods that are easily loaded and unloaded, like mass goods, ore and liquids; the transfer of goods, especially general cargo, between rail and other modes is rather expensive
- Road transport companies have been the only ones really able to provide true door-to-door transport solutions
- Short sea shipping is to a large extent linked to the development of road transport and is thus showing a similar development

Looking at this transport development and comparing it with GDP growth and heavy truck sales, it is evident that road transport productivity has improved, since the sales of heavy trucks has had a slower development than road transport network development.

Truck sales have not risen in parity with the increase in road transport due to a number of factors, including increased truck sizes, increased efficiency in logistics, the development of the EU internal market, reduced time for border crossing, etc.

However, this total increase in road transport has resulted in congestion problems in certain areas of central Europe. All of this results in increasing demand for higher productivity in all parts of the logistic chain, including transport:

- Higher utilisation of trucks
- Use of trucks adapted to the needs (size, type of body, etc)
- Use of larger trucks
- Extended use of IT/IS

Transport network and truck fleet

In 1998, road transport counted for 1265 billion tonnekm in the EU states (EU DG-TREN). In addition, during the years 1996-98 (for later years Eurostat statistics are unfortunately not complete):

- 65% of road transport (tonnekm) was at distances of 150 km or less
- Only 20% of road transport (tonnekm) was at distances over 500 km
Truck Masses and Dimensions – Impact on transport efficiency

The lower down on the list of goods above, the higher the degree of long distance transport required.

The number of heavy trucks >16 tonnes GVW on EU roads is around 1.8-2 million. Taking 42-45% of those would mean that 700,000–900,000 trucks on European roads are used for longer transport distances.

Looking at sales of new trucks, yearly volumes in Europe of trucks used in combinations with Gross Combination Weight (GCW) > 16 tonnes is around or just above 200,000 trucks. Out of these, roughly 130,000-140,000 trucks can be expected to be equipped with bodies for transport of palletised goods of different kinds.

These two ways of calculating indicate that, out of Europe’s existing fleet of heavy trucks, roughly 700,000–900,000 trucks are used in situations where there is, from a logistics point of view, a possibility to use heavier and longer trucks than allowed today.

Load size

Load capacity for trucks can be calculated in three different ways, depending on the kind of goods and industry segment:

- Load capacity measured by volume
- Load capacity measured by load area length
- Load capacity measured by weight

Moreover, goods transport can be segmented in several different ways. One way is to look at the type and characteristics of goods, the type of truck body needed for the goods and the industry branch the goods belong to. The use of trucks regarding both type of goods and transport distances has been studied by Volvo Trucks in different surveys. According to one of such survey covering five European countries (BEL, FRA, GBR, NLD, SWE), the use of trucks > 10 tonnes Gross Vehicle Weight (GVW) can be summarised as below (based on the industry segments for which new truck sales are intended):

Of these transport segments, long distance transport within segments 1-5 (in yellow) and partly within segments 6 and 7 (in blue), consists of the type of goods and transport characteristics for which the use of longer and heavier trucks than those allowed today would be best suited. This means roughly 42-45% of European heavy trucks.

Another way to look at this is volume per type of goods. Eurostat statistics for EU15 present the following figures for 1994-1996 (data for later years are not available):

<table>
<thead>
<tr>
<th>Group of goods</th>
<th>% of total transport (tonnekm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement &amp; building materials</td>
<td>21%</td>
</tr>
<tr>
<td>Ore and waste of ore &amp; steel</td>
<td>1%</td>
</tr>
<tr>
<td>Coal &amp; other solid mineral fuels</td>
<td>1%</td>
</tr>
<tr>
<td>Petroleum &amp; petroleum products</td>
<td>5%</td>
</tr>
<tr>
<td>Chemicals, fertilizers</td>
<td>8%</td>
</tr>
<tr>
<td>Agricultural products</td>
<td>31%</td>
</tr>
<tr>
<td>Machinery &amp; manufactured articles</td>
<td>27%</td>
</tr>
<tr>
<td>Metal products</td>
<td>6%</td>
</tr>
</tbody>
</table>

FIG. 7 Truck use in different industry segments

SOURCE: VOLVO TRUCKS

* Where the content is unknown or of no interest
Most transport over longer distances consists of general cargo. In studies of some important European transport companies made by NEA and TFK, the number of trips representing an average year for a company transporting general-cargo goods over longer distances in central Europe was analysed. The study showed that transport is most sensitive for the number of pallets = load area length.

- **Pallet wise:** The average utilised pallet capacity was 92%. For around 40% of the trips, the trucks were fully loaded by pallets and 2/3 of the trips were loaded (no. of pallets) to at least 90%. No trip had utilisation by no. of pallets lower than 55%.
- **Volume wise:** The average utilised volume capacity was 82%. Half of the transport was loaded to around 90%. No trip had utilisation by volume lower than 38%.
- **Weight wise:** The average utilised weight capacity was 57%. Less than 10 trips were fully loaded by weight. No trip had utilisation by weight lower than 10%.

Other analyses have indicated similar results.

**Conclusion:**

*Long distance road transport in Europe is most sensitive to a truck’s load capacity measured by number of pallets or volume. These trucks are seldom fully loaded by weight.*

There is, therefore, a potential for increased utilisation of the trucks. By adding load area length, the amount of weight capacity used can be increased. The above result also explains why the method of measuring transport in tonnekm is not optimal. However, at the moment there is no better alternative. This is a potential subject for further research.

**Adapting trucks to their use**

Truck use should be adapted to the real transport needs, especially when it comes to size. For example, supply of goods to cities by truck can be divided into three main categories:

- Direct transport to inner city locations
- Mixed cargo transport to inner city locations
- Mainly direct transport to larger suburban centres

From a distribution point of view, this means that a large part of goods volumes serving a city goes to hypermarkets, etc, in areas outside city centres, where there are good infrastructure connections.

As a result, large trucks can be used even in some distribution to urban areas and are therefore not solely intended for long distance transport.
3
FUTURE TRANSPORT NEEDS

EU white paper prediction on transport development

In 2001, the EU Commission released its White Paper on Transport Policy, predicting 38% transport growth between 1998 and 2010, if all measures presented by the White Paper are taken.

One possible way to decrease these effects is wider use of trucks with higher load capacity than utilised today. For a given transport need (measured per tonnekm), increased load capacity means:

- Increased productivity per truck
- Fewer trucks per transported goods quantity
- Less utilised space on road per transported goods quantity
- Lower fuel consumption per transported goods quantity
- Lower emissions per transported goods quantity

Increased transport needs and impact on the number of trucks

As shown earlier, long distance road transport is normally volume sensitive. This might be one reason why statistics show a rather low utilisation of trucks, since that is counted in tonnekm.

Taking the example of the period 1998 – 2010 (EU White Paper) for an analysis produces the following result, based on Eurostat figures:

- In 1998, total road transport was around 1220 billion tonnekm
- Counting 60-65% as long distance means around 770 billion tonnekm
- A long distance truck makes around 100,000 tonnekm per year
- In 2010, total road transport is estimated to be 1650 billion tonnekm (+38%), of which 750 billion tonnekm is long distance.

The following calculation shows that, to meet the extended goods volume requirements, some 250,000–300,000 more long distance trucks will be required on European roads in the period studied, if nothing is done with regard to productivity per truck. However, if the productivity per truck is increased, for example by using longer and heavier trucks, the need for additional trucks will be lower.

At the same time, it says that road transport may not necessarily increase its market share during the same period.

Effects of predicted transport increase and possible actions

With this 38% increase by the year 2010, road transport would reach 1746 billion tonnekm. In addition to the goods volumes, this will also impact:

- The number of trucks on roads
- Transport costs
- Environment
- Road safety
For different levels of improved productivity, this results in:

<table>
<thead>
<tr>
<th>Year</th>
<th>Increased productivity per truck, %</th>
<th>Total transport bn tonne-km per year</th>
<th>Of which long distance, bn tonne-km per year</th>
<th>Transport work per truck, tonne-km per year</th>
<th>Nr. of trucks needed</th>
<th>Increase in nr. of trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>–</td>
<td>1220</td>
<td>770</td>
<td>1000</td>
<td>770,000</td>
<td>–</td>
</tr>
<tr>
<td>2010</td>
<td>± 0</td>
<td>1680</td>
<td>1060</td>
<td>1000</td>
<td>1,060,000</td>
<td>290,000</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>1100</td>
<td>965,000</td>
<td>1100</td>
<td>965,000</td>
<td>195,000</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>1200</td>
<td>885,000</td>
<td>1200</td>
<td>885,000</td>
<td>115,000</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>1300</td>
<td>815,000</td>
<td>1300</td>
<td>815,000</td>
<td>45,000</td>
</tr>
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**Potential to reduce truck numbers within the weight limits**

As shown earlier, to increase truck productivity by increasing the length of the trucks does not automatically mean that truck GCW must increase. The idea behind increasing truck length is to increase the utilisation level and thus reduce the number of truck km driven for a particular transport run. This is the main goal since reduced number of truck km driven reduces the risks of congestion. It is about moving the focus from weight to resources.

Weight $\Rightarrow$ Volume $\Rightarrow$ Resources

An increase in truck length, or primarily load area length, even within today’s limits for GCW, will result in trucks getting closer to the full utilisation of allowed weight, and increased productivity. The basic idea behind this argument is that trucks with very low loading factor by weight could be eliminated by redirecting their freight to other trucks. These other trucks can use their extra free weight (below nominal GCW) to accommodate the freight from the low utilised trucks (see illustration below). This is in line with the development of hub-and-spoke systems.

The exact potential and outcome need further analysis.

**FIG. 11** The more vehicles with higher load capacity than allowed today, the fewer additional “trucks” will be demanded

**FIG. 12** Truck utilisation could increase by using trucks with higher load capacity thus reducing the number of trips needed (compare fig. 8)
TRUCK MASSES AND DIMENSIONS

There are two main types of Regulations regarding truck mass and dimensions:

- General regulations for international transport within the EU, as presented in the Directive 96/53/EC
- National and local regulations, varying by country and area

1. INCREASING SIZE

The truck

One way to improve productivity of trucks over long distance transport is to increase truck size for increased load capacity.

There are several ways to increase truck size and load capacity:

- For volume sensitive transport, add new dimensions to the present units such as longer semitrailers, longer swapbodies, etc
  - Lower the platform of the “Kingpin”
  - Lower the floor of the trailer
  - Decrease the distance between the loading units using short couplings
  - Increase the width of the truck
  - Increase the allowed height of the truck
  - Increase the length of the truck
- For weight sensitive transport, add more axles and/or increase allowed axle loads

Both of these solutions require changes in the present EU directives. There are also some technical problems to solve, for example, steerable axles. Also, most European roads do not allow higher axle loads due to road wear.

The question, then, is how large a unit can be, keeping in mind security, safety, economic, environmental and technical aspects.

The load unit

The focus must also include the possible expansion of the loading unit. The increasing value of articles and products transported means that an increasing proportion will be loaded into container units, for reasons of security and safety (Lumsden, 2004). As a consequence, there will be a decreasing density of the freight moved and an increasing need for volume capacity of the loading units. To meet these requirements, the physical dimensions of the containers must be increased up to technical and societal limits.

The width of the container (8’ = 2.42 m) is not adapted to smaller modules like pallets. This results in a poor filling rate. At the same time, there is scope to widen the container up to the maximal width of the road (8_’ or

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2,60 m). This will allow EUR-pallets to be loaded two by two in a container. The problems with this are more related to container ships.

The length of a container (40' = 12,1 m) can, for all transport modes, be increased with rather small modifications, while creating an expanded volume capacity. The limitation to increasing the length of the containers is more or less related to infrastructure requirements. In some big cities (eg, New York) there are limits to the length (53’ = 16 m) to avoid traffic congestion. Today, the commercial trend is to use containers with a length of 45’ (13,72 m), 48’ (14,63 m) or 49’ (14,94 m).

The height of a container is limited by tunnels and different structures within the infrastructure of road and rail. Road restrictions are the result of the connections with the rail infrastructure. The restrictions of rail are related to two phenomena: the electrification of the European railroads and the double-stacking of containers on North American railroads. In Europe, almost all the rail infrastructure is electrified, limiting the height of the container. As long as containers in Europe cannot be double stacked, the restrictions created by the European railroad have no impact. The North American double stacking of containers however creates an important final limitation to container heights. The American railroad infrastructure has a tunnel profile dimension of 19’. With a double stacking, this means a maximum container height of 9’6” (2,87 m).

Even if new containers can be enlarged in the way outlined here, to be wider, longer and higher, these units must be handled by unitised equipment, such as trucks, forklifts and cranes. This means that design elements like corner boxes must keep their positions and internal distances (40’ and 8’). There are two possible solutions: either to have a long introduction time, which is linked to the investment cycle of the containers, or to introduce adaptable handling equipment, like intelligent cranes that can handle all possible dimensions.

In this discussion, the proposed new European container dimension must be emphasised. The European Union has, of course, identified the need for an enlarged container, especially regarding the width. As a result, a new, larger container has been decided although not yet implemented. The “European Intermodal Load Unit” (EILU) is wider and higher. The final dimensions are, however, not yet decided but lengths coordinated with Directive 96/53/EC are proposed.

### PRESENT MASS AND DIMENSIONS

**Length**

When discussing truck size, it is sufficient to address length, since width and height regulations apply to all trucks.

National regulations vary by country. General regulations for international transport within EU are presented in the Directive 96/53/EC. This directive gives the following maximum truck lengths for European international transport:

<table>
<thead>
<tr>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 m</td>
<td>motor vehicle</td>
</tr>
<tr>
<td>12 m</td>
<td>trailer</td>
</tr>
<tr>
<td>16,5 m</td>
<td>articulated vehicle (semitrailer combination)</td>
</tr>
<tr>
<td>18,75 m</td>
<td>road train (rigid truck with trailer) combined</td>
</tr>
<tr>
<td></td>
<td>with a regulated max total load area length</td>
</tr>
<tr>
<td></td>
<td>of 15.65 m (or 2 x 7.82 m).</td>
</tr>
</tbody>
</table>

Countries may, on national level and for national transport, decide on other limits.

As a result of the directive, there are two “standard units”, a short unit of max 7.82 m long (half of the 15.65 m) - and a long unit of ~13.6 m (semitrailer length).

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1 Semitrailer length is defined as 12,0 m length from kingpin to the back plus 2,04 m radius from kingpin and forward, resulting in a length ~13,6 m.
Width
The EU directive limits the width to 2.55 m and 2.60 m for refrigerated trucks. There are a few national exemptions from this.

Height
The EU directive limits the height to 4.0 m. A few countries, like France, Norway, Sweden and the UK, do not regulate the height. The 4.0 m limit sometimes creates problems since many transport buyers require a loading area inner height of 3 m, to be able to stack 3 pallets, and thus these trucks are too high.

Masses
Trucks could be divided into several groups, depending on Gross Vehicle Weight and Gross Combination Weight. The most important groups are:

- > 3.5 tonnes general definition “heavy vehicle”
- 7.5 tonnes limit for some driver’s licence
- 12 tonnes limit for Eurovignette and upcoming German road fees, etc
- 16 tonnes limit for heavy trucks
- 18/19 tonnes limit for single two-axle trucks (depending on national regulations)
- 26 tonnes limit for single three-axle trucks
- 40 tonnes limit for trucks generally in Europe
- 44 tonnes limit for vehicles carrying a 40 ft ISO container as a combined transport operation

In addition, there are several national limits, for instance: 44 tonnes in Belgium, Great Britain and Italy, 48 tonnes in Denmark, 50 tonnes in Norway and the Netherlands, 60 tonnes in Sweden and Finland, etc.

Over time, GCW has continuously increased in European countries:
3  

**EFFICIENCY AND ENVIRONMENT**

The environmental impact of trucks is mainly related to fuel consumption. The regulated emissions from diesel engines in heavy trucks have been dramatically reduced and in the long run they will be more or less negligible. The remaining emission is CO2, which is directly related to fuel consumption.

The larger the truck, the higher fuel consumption per truck - but the lower the fuel consumption per tonnekm.

Efficiency can be measured in terms of a “road efficiency index” and a “fuel efficiency index”. Calculations can be made of different truck sizes where data is available: Modular Concept trucks (18,75m), standard EU trucks (16,5m) and single trucks (12m, “26 tonner”).

“Pallet index” is measured as “meter road used per pallet” for the truck, including a safety distance (three alternatives: 70m, 40m, and 2\_ x truck length).

“Fuel index” is measured as litres per 100km and pallet.

As demonstrated in the table, the larger the truck, the better the index, both for “pallet index” and “fuel index”. The larger the truck, the lower the fuel consumption per tonnekm, which also affects emissions. Efficiency and environmental impact, therefore, go hand in hand.

<table>
<thead>
<tr>
<th>Type of truck</th>
<th>“Pallet index” at 70 m safety distance</th>
<th>“Pallet index” at 40 m safety distance</th>
<th>“Pallet index” at 2.5 x truck length safety distance</th>
<th>“Fuel index”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger truck</td>
<td>(\frac{25+70}{52}=) 1.83</td>
<td>(\frac{25+40}{52}=) 1.25</td>
<td>(\frac{25+2.5\times25}{52}=) 1.70</td>
<td>0.81</td>
</tr>
<tr>
<td>52 pallets/truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18,75 truck</td>
<td>(\frac{18.75+70}{38}=) 2.34</td>
<td>(\frac{18.75+40}{38}=) 1.55</td>
<td>(\frac{18.75+2.5\times18.75}{38}=) 1.73</td>
<td>0.92</td>
</tr>
<tr>
<td>38 pallets/truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16,5 m truck</td>
<td>(\frac{16.5+70}{33}=) 2.62</td>
<td>(\frac{16.5+40}{33}=) 1.71</td>
<td>(\frac{16.5+2.5\times16.5}{33}=) 1.75</td>
<td>0.97</td>
</tr>
<tr>
<td>33 pallets/truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“26 tonner”</td>
<td>(\frac{12+70}{19}=) 4.32</td>
<td>(\frac{12+40}{19}=) 2.74</td>
<td>(\frac{12+2.5\times12}{19}=) 2.21</td>
<td>1.37</td>
</tr>
</tbody>
</table>

19 pallets/truck
SAFETY

Although the purpose of this report is not to deal with safety, some basic aspects of that issue should be addressed. The use of longer combinations is one way to increase truck productivity. In order to get a view of safety aspects related to truck size, experience can be drawn upon from countries where longer and heavier trucks than those allowed in the EU, are permitted.

**Truck driving stability**

The larger the truck, the more it tends to be used on larger highways for long distance transport. This means that the most important areas from a driving point of view are driving stability (rollover stability and dynamic lateral stability), overtaking and swept path.

Rollover stability depends on the height of the centre of gravity, width of track and flexibility.

Dynamic stability, measured as rearward amplification, is dependent on the design of the truck, the number and position of articulating points, the distance between articulating points, length of units, wheelbase, tyres, overhang, load distribution, etc.

Tests of dynamic stability according to ISO 14791, measured as rearward amplification at a path-following lane change, show that among the most common European vehicle combinations, a standard 16,5 m tractor-semi-trailer combination has the highest stability while a standard 18,75 m road train, truck and full trailer combination has by far the lowest stability.

Driving stability in terms of rollover stability is also affected by the height of the truck. Not least the use of double loading decks can heighten the centre of gravity.

**Overtaking**

The Swedish National Road and Transport Research Institute has studied overtaking of longer combinations. The meeting margin in seconds was used as a measure.

No significant differences were found between 18 m and 24 m trucks. This is also affected by the fact that, today a very large portion of long distance road transport is done on multi-lane motorways, where overtaking distance is of less importance.

**Braking**

A truck combination brakes on all axles and each axle brakes its own load. This means that trucks have the same braking capacity per load irrespective of how the different modules are combined.

**Swept path**

It is obvious that a longer truck combination will have a larger swept path than a shorter combination. However, the intended use of longer trucks than allowed today would be on an adapted road network only. These longer truck combinations are not intended to be used in city centres or other high-density areas.

**Collision risk**

The risk of collision is difficult to quantify. Experience, however, shows that the risk is much more closely correlated to the number of trucks on the road than to the size of the trucks. This means that the number of “truck fronts” exposed to other traffic is a critical factor. A good way to reduce risks for collision is to keep the number of trucks down.

**Driver education**

Driving heavy and long trucks demands a high degree driver responsibility and skill. The need for extended driver education for larger trucks must be further investigated.
Road transport is expected to increase rapidly over the coming years. Not least, EU enlargement will have a big impact. This will put high demands on efficient transport and logistics solutions.

To achieve optimal efficiency, the following factors must be emphasised:

- Vehicle size must be adapted to local needs and circumstances.
- Flexible combinations based on modularity make it easier to use trucks in different traffic environments. It should be possible to rearrange longer trucks into shorter units for local adaptation when shorter units are required.
- Transport must be integrated with production in wider logistics chains; load units should be able to be used all the way into production activities.
- For a vast majority of long distance transport, dimensions are more important than weight. General cargo is normally volume-sensitive.
- Environmental impact of road transport is highly related to fuel consumption and land usage. However, road efficiency and fuel efficiency go hand-in-hand. The larger the truck, the more efficient use of resources.
- Intermodality must be facilitated and standardised dimensions of units is a prerequisite. Chosen dimensions must be stable over time and it is essential to take into account the needs of road transport, the mode by which most freight is transported.
- Safety is highly related to the number of trucks on the roads. The use of longer and heavier trucks than allowed today would mean fewer trucks for a given amount of freight. Safety is also related to driving stability and there is no evidence of longer trucks being less stable than shorter ones. To the contrary, longer units even increase stability.