Truck Masses and Dimensions - Impact on Transport Efficiency

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Content

Preface

The future of road transport is spectacular in its development and full of challenges, not least to handle the expected increase in road transport in connection within the limits of the road network capacity. This is the outcome of most scenarios and predictions made. However this predicted outcome of the industrial environment has to be solved within the existing logistics solutions because of requirement from the society in many different shapes. As measured the transport work should be able to, and obvious has to, be increased without an increase in the traffic work. It goes almost without saying that out of every aspect increased productivity is a must. This goes for the aspect of cost, congestion, environment, sustainability, the road network and so on.

Several different aspects on the masses and dimensions of trucks exist like economy, logistics, traffic safety, environment etc that must be evaluated. This report will mainly focus on the logistic effects.

There are by definition and out of identified commercial requirements a number of different ways to change masses and dimensions of the truck and the combination of trailers and other equipment. The intention of this document is not to pin point one solution but rather to show the importance of the subject. The intention of the report will hopefully lead to more efficient truck use.

One essential and in different states within the EU used way to increase productivity is to use longer and heavier trucks than allowed today generally within EU. The use of each one of such trucks creates more space to be commercially used without more trucks entering the road system. The purpose with this report is to review effects of increased productivity and to show that the masses and dimensions of trucks are important issues that must be focused more intensively by the logistics business and by the EU as the regulator.

Summary

Road transport is developing fast due to development in society and logistics. Goods volumes are increasing as well are transport distances. Road transport will be the dominating mode also in the future. The congestion problem thus must be attacked. Road transport must increase further in efficiency.

There are several ways to go, and all these are necessary:

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

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

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

Increasing the truck sizes will have impact on several issues, all which have to be analysed thoroughly, independent if the increase would be just adding length of 1–2 meters or substantially more, or increasing the height or weight:

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

All this together have technical as well as political aspects and all have to be thoroughly investigated before there could be a common view of the future technical solutions.

1 Introduction

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. What might happen is that the correlation factor can be supposed to change slightly.

The last decades, transport growth in Europe has been clearly focused on road transport and short sea shipping. Road transport stands for around 44% of European transport. The EU White Paper on Transport Policy released in 2001 predicts a further increase of road transport with 38% during 1998 – 2010. Other prognoses from the EU Commission claim that within the enlarged EU road transport will more or less double during the period of 2005 – 2030.This increase of road transport will not least increase the already existing problems with congestion in certain areas of Europe.

The logistics development and the needs for optimised logistics solutions mean that transport solutions and trucks must be optimised for their purpose. From an “economy of scale” view trucks should be as large as possible but there are also a number of other factors that have strong influence on truck sizes.

An approach for finding solutions must be based on a demand – supply analysis. When it comes to trucks load capacity the importance is either dimension, counted in lading area length or volume, or load weight.

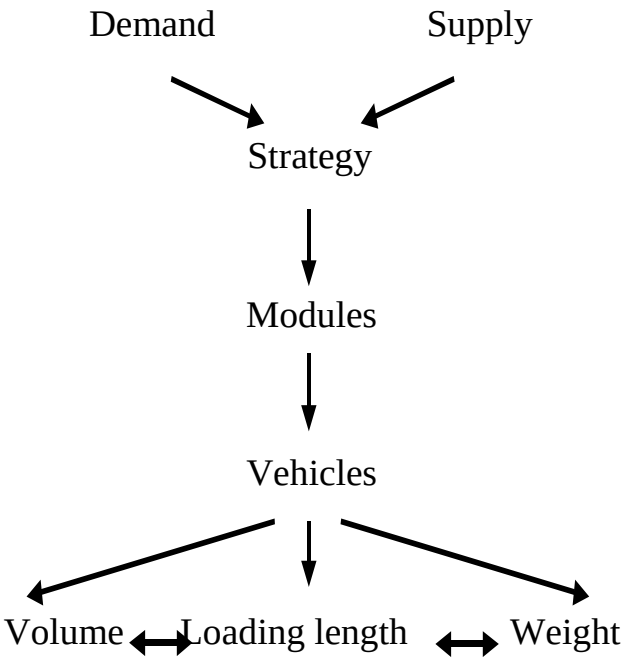


Fig 1. Approach for dimensioning of trucks

2 Development in society, demography and transport

2.1 Society, demography and city development

Logistics and transport development as well as transport demands are affected by changes in society and customers behaviour. Some important demographic trends in Europe creating more transports and new transport patterns are

- The **aging population** create needs for more service and related transports.
- **Immigration and people moving** for political or employment reasons.
- Increased focus on the **Information society** and **Quality of Life**.
- **Households with one or two persons** are relatively increasing.
- Development of cities with increasing number of **large supermarkets and peripheral shopping areas**.
- **Environmental concern** increasingly in focus.
- **Customer buying behaviour;** demands for products produced far away increase, e.g. Italian Parma ham is increasingly demanded in northern Europe.

In Europe urbanisation is ongoing but in a stage often referred to as "desurbanisation". Cities are growing but the pattern of the growth is changing.

United Nations has predicted a strong growth of megacities. Although most of the largest ones will be found in Asia and South America, also Europe will see growing cities. According to UN, in year 2015 20% of the world population will live in 225 megacities, each with more than 2 mill inhabitants. 85 % of the world population will live in cities wit more than 50.000 inhabitants.

In a European perspective cities might not grow too much due to a rather low population growth in Europe. But still, Europe will be even more urbanised and city structures will to change to some extent, a development that has already started.

A large city can be seen as consisting of a number of "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. Also restaurants, cafés, theatres and other amusements are more and more found in city centres as well as 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, jewelleries, as well as "show-rooms" for larger capital goods; cars, white goods etc. Centrally located department stores often develop into shopping malls consisting of many smaller shops. In these areas shopping and consuming is less cost sensitive.

Deliveries to city centres are smaller and so are distribution trucks that are 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 and populated by people with not that high purchase 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, for making it possible for the personnel to live within reasonable distances from their job.

Further out, attractive areas for shopping can be found. Supermarkets, hypermarkets, larger shopping malls etc. are located to areas outside city centres, with good infrastructure, high accessibility and good parking possibilities. Shopping often requires 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. Customers 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 hold offices and smaller industries, these also to be seen as rather low cost sensitive.

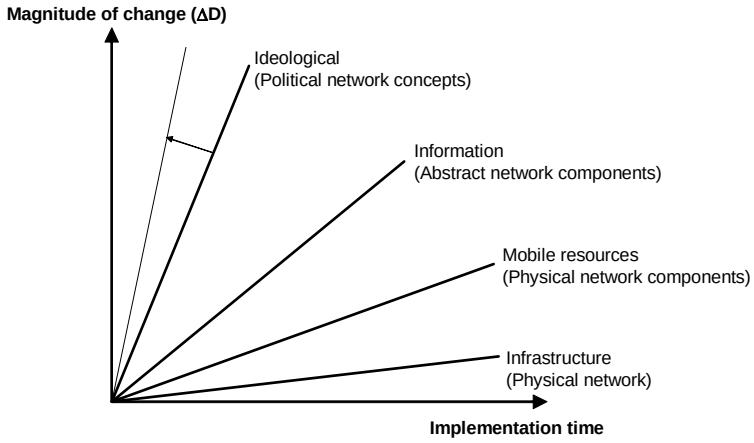
City planners try to locate new industries to specific **industry areas** located close to extended parts of the infrastructure network. Especially this is valid for transport intense industries.

All this development has high impact on goods distribution.

2.2 Transport development

2.2.1 Logistics and Transport Development

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



(Source: Lumsden, 2001)

Fig.2. Logistics Complexity – System Changeability, Implementation time differs for different kinds of changes

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 industry has concentrated their core business to 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 to 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
- Increasing transport distances
- More international transports
- Transports are carried out by professional transport companies
- Transparency in cost and environment

2.2.2 Transport work – definitions

For describing and calculating transport solutions and their utilisation there is a need for a number of parameters. Traditionally **tonnekm** has been the most used parameter. This is satisfying for describing the physical materials flow and the utilisation of a truck. In principal the parameter tonne can be substituted or recalculated into volume or load area length, to get "m^3km" or "mkm".

A disadvantage with 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 of the type of "transported capital value and distance" - "€km". However even this is not enough since capital tie-up is not related to the transport distance, only related to transport time. A parameter taking care of that should be in the form of "transported capital value and time" - "€h". But this can easily be regarded as artificial and can also be difficult to calculate.

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

2.2.3 Logistic Trends

Within transportation and logistics there exist a number of trends as well as new trends continuously develop. By stating this we also must emphasize that no summarize of trends can include all of them. We here just want to pin point a number of trends affecting logistics and especially international transport. In this context we want to analyse them out of different perspectives;

- Basic ideas within logistics,
- Customer,
- Product,
- Flow,
- Logistic company and
- Shipper.

The basic idea of logistics

There has been a lot of discussion about the influence of **IT solutions** on logistic performance. It was stated early in the development of IT systems that the introduction of IT would lead to a decentralization of most operations in the supply chain. What we have encountered is rather the contrary; most operations like manufacturing and stock keeping have been **centralizing** due to phenomena like economy of scale. This economy has been supported by the real time information created by a number of IT systems.

The manufacturing systems have focused on the demand for lean production and make to order. The prerequisites for this type of behaviour are **short lead times** through all kind of production systems. In spite of general public demand for longer lead times the tendency in all commercial relations is undoubtedly asking for continuously shorter lead times.

Out of the requirement of addressing each individual item or article towards specific consumer comes a need for **identification** of these individual items. This outspoken need arise very early in the supply chain for some products. When the customer order point is moved upstream this necessitate becomes more and more critical. Out of research done the benefits of identification turn out to be more financial obvious the closer the freight comes to the point of destination or even better the point of consumption.

There has been a rather clear tendency in the development of e-business towards inter company business, B2B. The growth in this segment has been high and is in whatever way it is being measured. However the coming challenge is within the **distribution to end customer** or end consumer, B2C. This development will open for heavy demands on the truck used in distribution. Trucks and loading units must be design to be used in different physical solutions like long haul and short haul in combination.

In almost every industrial segment today there is a tendency towards centralization of the physical flow. This change has two different line of development. First here is the **centralization of stocks** to decrease the capital tied up in any distribution chain and to improve the service of delivery given. Secondly there is a **centralization of distribution** in the form e.g. Hub-and-Spoke systems. Such system will increase the service given by logistics suppliers.

Normally there is a need for a number of different actors to build up a supply chain of any kind. This will put quite lot of competence on the shipper to have internal sources to build up such a chain. To reduce these company requirements and to acquire the best logistic solution an increasing number of companies prefer to rely on one actor. This behaviour could be defined as “**one-stop-shopping**” or “**Third Party Logistics**”.

As stated a supply chain consists of many actors. This also means that the freight has to be moved from one mode of transport to another mode, **intermodality**. This transfer creates problems such as increased handling costs and delays. It is an appropriate political approach to support any kind of intermodality to reduce the heavy load on the roads. The outcome of this is that the use of modular unit that can be moved between modes will increase in importance.

The Customer

Because of many reasons like creating value there is a sharp tendency towards focus on the customer. The demand structure will be the base of all distribution structures and will set up need for distribution trucks and truck combinations. The time to the customer from order being laid, **fulfilment time**, is of utmost importance as it directly connected to **time to cash**.

As we in the future will identify the demand for articles earlier we of course must satisfied it. This means that we have customized the products by individual item. An increasingly used method to accomplish this is by using **postponement**, which means that you will customize a bulk product in the supply chain just before the customer in perspective. The outcome is however that the trucks will handle a bulk flow almost, but not the whole way, up to the customer.

The product

A product is not just a piece of material; it is something that is to create value for the consumer or the buyer. Today and what happens in the future is that the **value of the products** is increasing. It is also the case that most industrialized articles are the **subcomponent** of larger or more complex articles. These subcomponents can even be defined as of **carrying a function** like a power line (car engine with components) line to the hierarchy more important component (car). All taken together concerning the product will in many cases require a unit load to use to fulfil the identified demands.

The flow

To fulfil the requirements from customer, supplier and the society the flow of resources must function in all circumstances. This does not mean that there has to be very rapid flow but rather a **continuous flow** of resources. The flow itself must also stand up for the increasing obligation to have **security** for freight and humans in the transport chain.

The time freight spends in any transport or supply chain is not only moving time, a lot of time is spent as **non-moving time to be reduced**. This inactive time is in almost all cases spent in some kind of terminals. We encounter today a focus on the interaction between the different actors moving items and **terminals** as e.g. in the concept of **Merge-in-Transit**. Here the different consignment will be put together in a continuous flow through the terminal. All this circumstance needs modular system solutions for their effectiveness.

Environmental impacts and aspects from individuals and the society will in the future play an even more important role for the logistics society. This imposed requirement will be looked upon as an interesting business opportunity in all solutions.

The distribution

Traditionally networks for distribution of goods to a large extent are built up by direct transports between the producer and the consumer. This kind of networks of distribution often result 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 of fast and frequent distribution from a manufacturer to a number of different customers with different location is the background to all distribution systems. The development is going from systems with generally direct transports with quick but low-frequency distribution towards hub systems with frequent but rigid relations.

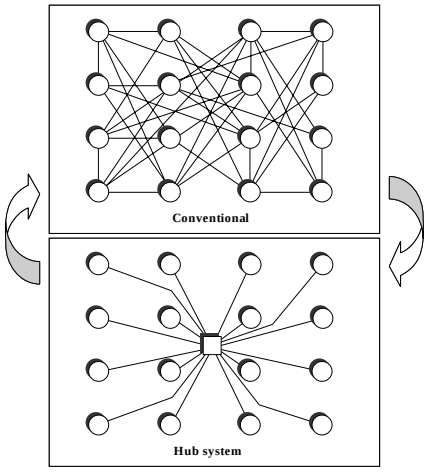


Fig. 3. Conventional terminal structure in comparison with Hub system

Hub systems basically do not distinguish producers and consumers but treat all equally. It also means a substantially reduction of the number of relations between customers and an increase in trucks' load factor and utilisation.

One-terminal networks use one 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 who are connected to desired terminals.

Hierarchic multi-terminal networks are based on a number of centrally located terminals and a number of sub-terminals. This hierarchic 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. Especially in this kind of networks it is 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.

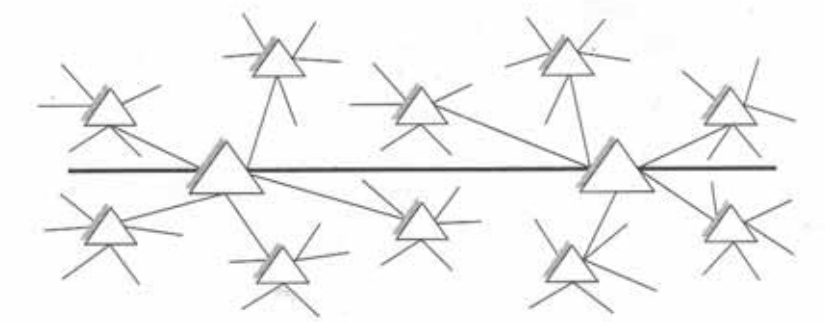


Fig. 4. Hierarchic multi-terminal network

The Logistics Company

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

The tendency of unit standardization also has its origin in the **globalisation** of the logistics market. The way to support and simplify international trade is of course to

use standardize units. However this makes it impossible to have or develop local solutions.

The shipper

The over all tendency of the shipper is an aggregation of the tendencies identified here. However the can be condensed into some simple and general terms:

- Improvement of transparency for cost and environment.
- Focus on costs and capital.
- Improved time and service performance.

2.2.4 Ongoing development

Transport growth in Europe the last decades has been mainly concentrated to road transport and short-sea shipping while rail has been shrinking. There are several reasons for this, with the most important being:

- The Just-In-Time philosophy strives towards smaller deliveries with higher frequency.
- Industry development with concentration of production to fewer locations serving larger areas increases the need of JIT-transports with high quality.
- Rail transport is most suitable for large volumes on limited numbers of routes, also for goods that is easily loaded and unloaded like mass goods, ore and liquids. The transfer of goods, especially general cargo like goods, between rail and other modes is rather expensive.
- Mostly only road transport companies have been able to provide real door-to-door transport solutions.
- Short sea shipping is to a large extent linked to the development of road transport and thus showing a similar development.

According to EU DG-TREN performance by mode of transport has changed as shown in the picture below, growth of road and short-sea shipping while rail has even decreased.

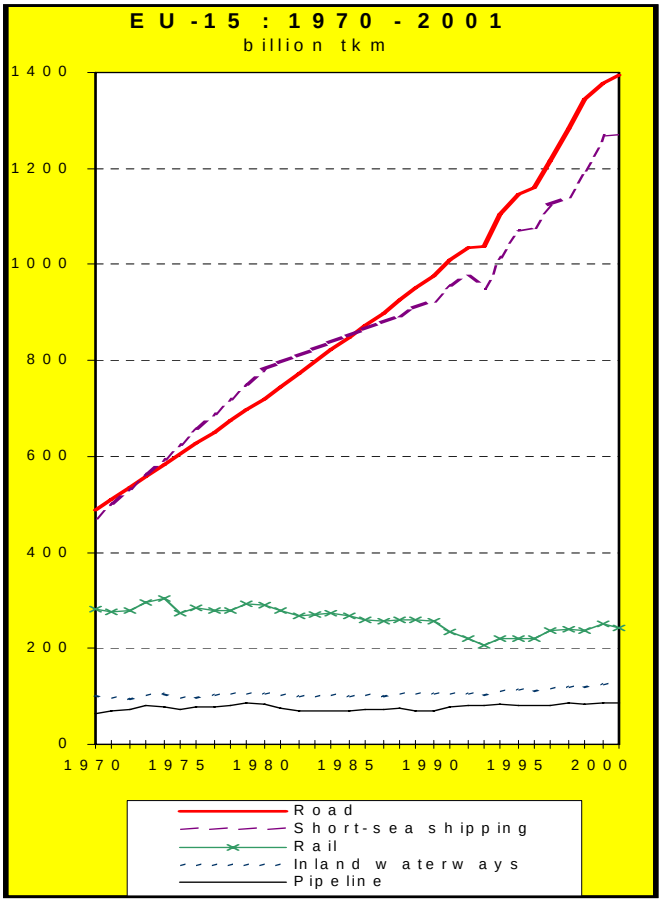


Fig. 5. Goods transport; Performance by Mode of Transport in EU 15 1970-2001. Source: EU DG-TREN.

Looking at this transport development and comparing it with GDP growth and heavy truck sales it is also shown that road transport has clearly improved in productivity since the sales of heavy trucks has had a slower development than road transport work development.

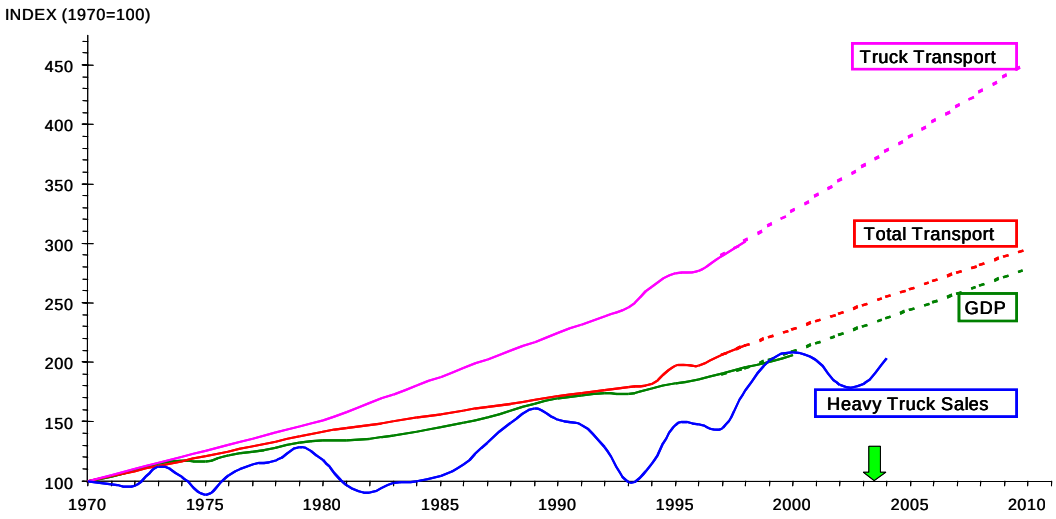


Fig. 6. Comparison of development of GDP, Transport and heavy truck sales (> 16 tonnes GCW). 1970 = Index 100. Source: EU DG-TREN White Paper 2001 and Volvo Trucks.

Reasons for truck sales not developing in parity with transport work are for example increased truck sizes, increased efficiency in logistics, the development of EU inner market, reduced time for border crossing etc.

However, this total increase of road transport has resulted in congestion problems in certain areas of central Europe.

All this development results in increasing demands of 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 as large trucks as possible.
- Extended use of IT/IS.

2.2.5 Transport work and truck fleet

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

- 65% of road transport (tonnekm) was at distances up to 150 km
- Only 20% of road transport (tonnekm) was at distances over 500 km.

Goods transports 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 belongs. 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 these surveys in five European countries (BEL, FRA, GBR, NLD, SWE) the use of trucks > 10 tonnes GVW can be summarised as below (based on which industry segments new sold trucks are intended to be used in):

Transport distance Type of Industry	Long distance (> 250 km)	Regional (50-250 km)	Local (< 50 km)	*Sum*
1 General Cargo	**28,1%**	4,1%	0,9%	*33,1%*
2 Transport of containers and trailers*				
3 Industrial transports				
4 Consumer goods / Retail, wholesale	**14,5%**	3,0%	0,7%	*18,2%*
5 Daily commodities, grocery & food				
6 Agricultural products & material	**7,1%**	3,4%	1,0%	*11,5%*
7 Building & Construction	**6,4%**	7,6%	5,5%	*19,5%*
8 Forest, Paper & Cork industry	6,4%	3,7%	1,3%	*11,4%*
9 Petroleum, Chemicals				
10 Ore, coal, mining				
11 Service transports	1,3%	2,4%	2,6%	*6,3%*
12 Waste & recycling				
Sum	*63,8%*	*24,2%*	*12,0%*	*100%*

* where the content is unknown or of no interest

Fig.7. Truck use in different industry segments. Source Volvo Trucks

Of these transport segments, long distance transports within segments 1-5 (marked yellow) and partly segments 6 and 7 (marked blue) consist of a kind of goods and has a transport characteristics that can be counted as potentials for the use of trucks that are longer and heavier than allowed today. This means roughly 42-45% of the 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:

Group of goods	% of total transport (tonnekm)
Cement & building materials	21%
Ore and waste of ore & steel	1%
Coal & other solid mineral fuels	1%
Petroleum & petroleum products	5%
Chemicals, fertilizers	8%
Agricultural products	31%
Machinery & manufactured articles	27%
Metal products	6%

The lower in the list of goods above, the higher degree of long distance transports.

The number of heavy trucks >16 tonnes GVW on EU roads is around 1,8 - 2 million. 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 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 indicates 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.**

2.2.6 Load size

Load capacity for trucks can be counted 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**

Most transports over longer distances are general cargo – like. In studies of some important European transport companies made by NEA and TFK, road transports on longer distances have been analysed.

A number of trips representing an average year for a company transporting general-cargo-like goods on longer distances in central Europe were analysed. The study showed that transports are most sensitive for the number of pallets = load area length.

- **Pallet wise: The average used 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 lower utilisation by no of pallets than 55%.
- **Volume wise: The average used volume capacity was 82%.**
  Half of the transports were loaded to around 90%. No trip had lower utilisation by volume than 38%.
- **Weight wise**: **The average used weight capacity was 57%.**
  Less than 10 trips were fully loaded by weight. No trip had lower utilisation by weight than 10%.

Similar other analyses have indicated the same result.

Conclusion:

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

This is by then a potential for increased utilisation of the trucks. By adding load area length, the used weight capacity can be increased.

The result above is also an explanation why the method to measure transports in tonnekm is not the best way. However at the moment there is no better alternative used. This is a potential subject for further research.

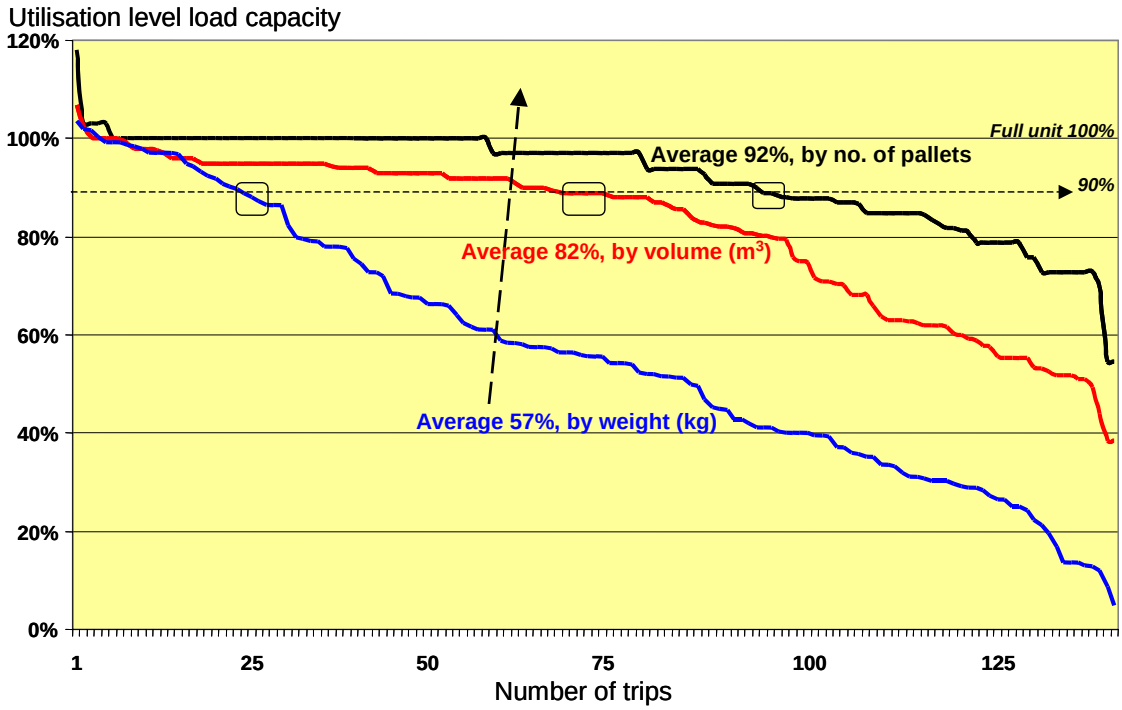


Fig. 8. Utilisation of trucks measured per no. of pallets, volume and weight for transport of General-cargo-like goods. Data source: NEA.

2.2.7 Adapting trucks to their use

Trucks should be used adapted to the real needs, especially when it comes to size.

As an example, supply of goods to cities by truck can be divided into three main categories.

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

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

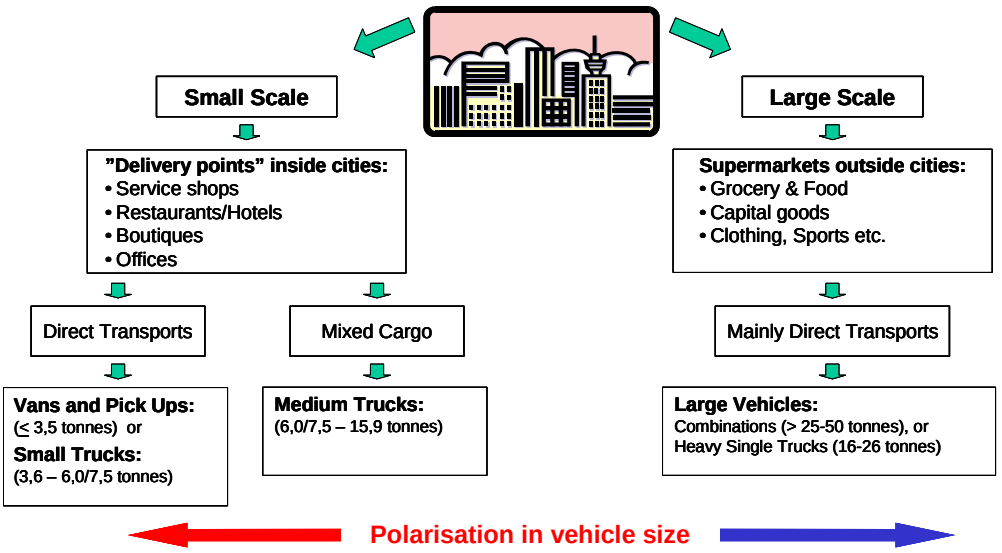


Fig. 9. Supply of cities; Truck size will be more polarised, as transports will need to develop more efficiency.

As a result of this development large trucks can be used even in some distribution to urban areas. Large trucks are not only intended for long distance transports.

2.3 Future transport needs

2.3.1 EU white paper prediction on transport development

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

At the same time it is said road transport may not increase its market share during the same period.

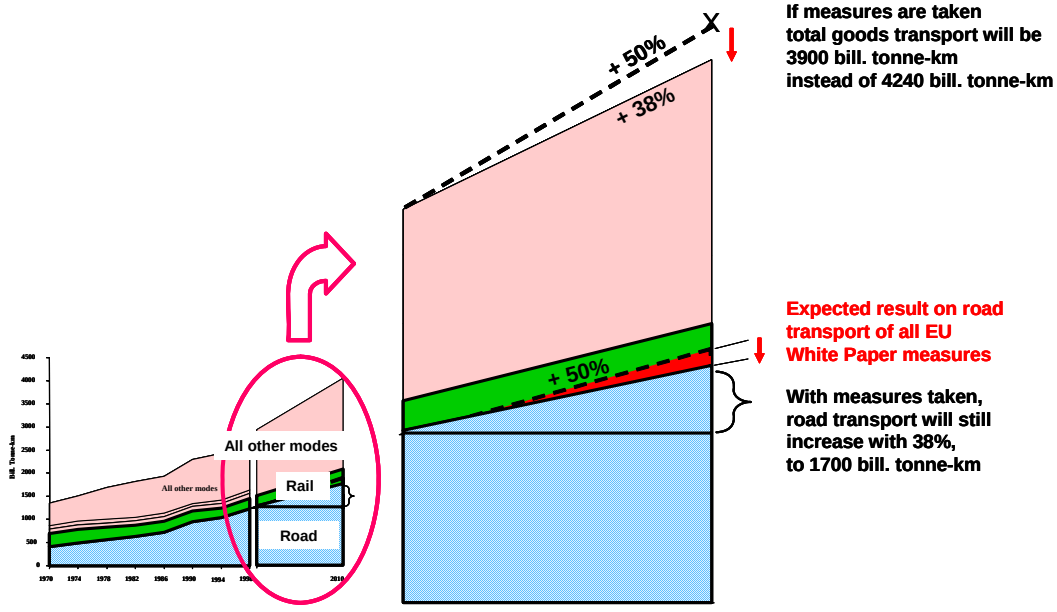


Fig. 10. Predicted goods transport development for EU 15 states 1998 - 2010. Data source: EU White Paper on Transport Policy.

2.3.2 Effects of predicted transport increase and possible actions

With this increase of 38%, in year 2010 road transport would reach 1746 bill tonnekm. This will affect, beside the goods volumes also

- The number of trucks on roads
- Transport costs
- Environment
- Road safety.

One possible way to decrease these effects is a wider use of trucks with higher load capacity than used 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.

2.3.3 Increased transport needs and impact on the number of trucks.

As shown earlier long distance road transport normally is volume sensitive. This might be one reason why statistics shows 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 gives the following result, based on Eurostat figures:

- 1998 total road transport was around 1220 bill. tonnekm.
- Counting on 60-65% as long distance gives around 770 bill. tonnekm.
- A long distance truck makes around 1000.000 tonnekm per year.
- 2010 total road transport is 1650 bill. tonnekm (+38%) of which long distance gives around 750 bill. tonnekm.

For different levels of improved productivity this gives as result:

Year	Increased productivity per truck, %	Total transport, bill tonne-km per year	Of which long distance, bill. tonnekm per year	Transport work per truck, tonne-km per year	No. of trucks needed	Increase of no of trucks
1998	--	1220	770	1000	770.000	--
2010	+/- 0	1680	1060	1000	1.060.000	290.000
	10%			1100	965.000	195.000
	20%			1200	885.000	115.000
	30%			1300	815.000	45.000

This calculation shows that to take care of the extended goods volumes there will be a need for around 250.000 – 300.000 more long distance trucks on European roads for the studied period if nothing is done when it comes to productivity per truck.

However, if the productivity per truck is increased, for example by using longer and heavier trucks, the need of additional trucks will be lower.

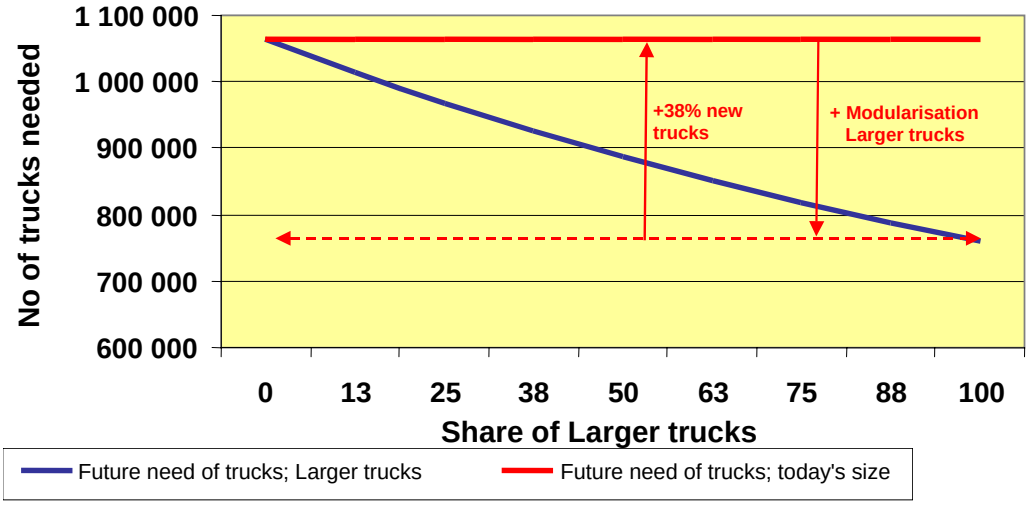


Fig.11. The higher share of vehicles with higher load capacity than allowed today, the less additional "new trucks" will be demanded.

2.3.4 Potentials 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 trucks GCW must increase. The idea with increasing truck length is to increase the utilisation level and by that reduce the number of needed truck km driven for a certain transport work. This is the main goal since reduced no of truck km driven reduces the risk for congestion. It is about moving the focus from weight to resources.

Weight => Volume => Resources

An increase of 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, increased productivity. The basic idea behind this argument is that trucks with very low loading factor concerning 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. The possibility to solve the transportation demands this more cost and environmental effective way is based on the use of longer trucks. This is in line with the development of use of hub-and-spoke concepts.

Principally this could be demonstrated through moving the goods of the last and least utilised trips to fill up other trips (see illustration below).

The exact potential and outcome need further deeper analyses.

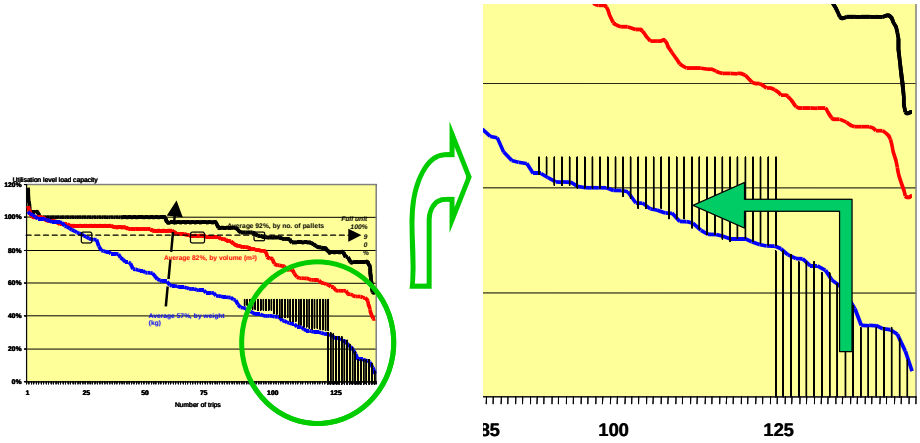


Fig. 12. Truck utilisation could increase by using trucks with higher load capacity and by that the number of needed trips could be reduced (compare fig. 8)

3 Truck masses and dimensions

Regulations can be of two kinds

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

3.1 Increasing size

The Truck

For improving productivity of trucks for long distance transports, one way is to increase truck size for increased load capacity.

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

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

Both of these *principle ways* demand changes in the present EU directives. This also includes some technical problems to solve, for example needs for steerable axles. Also, most European roads do not allow higher axle loads due to road wear.

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

The Load Unit

The focus must also include the possible expansion of the loading unit. As a result of the increasing value adding of articles and products they will in a continuous increasing proportion be loaded into units like containers because of security, safety, damage protection etc. (Lumsden, 2004). As consequences of these circumstances 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 are continuously increased up to the limits and restriction given by the technical solutions and the society. It is here important that the society consists of the entire global society.

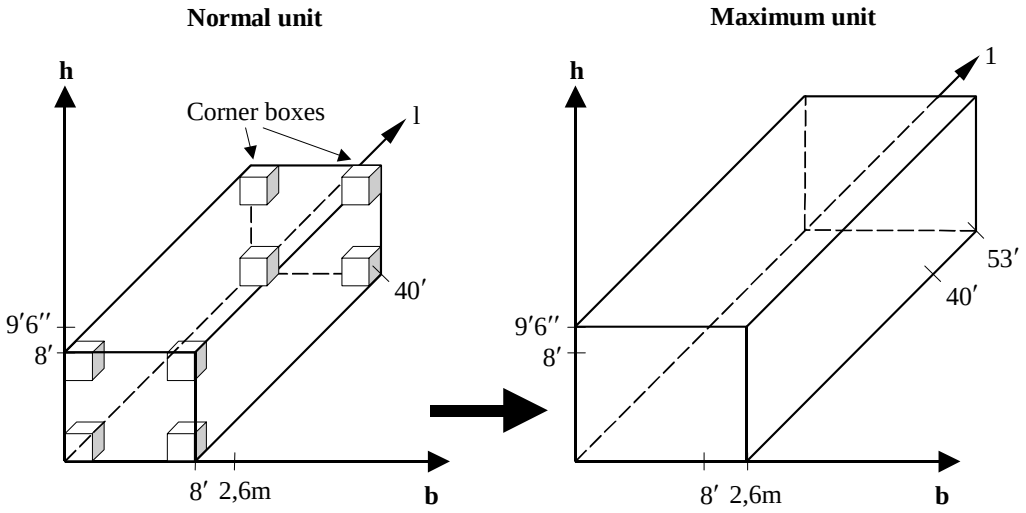


Fig. 13. Maximum possible size of loading units, scenario (Lumsden, 2004)

The **wideness** of the container (8´= 2,42 m) is not adapted to smaller modules like pallets. This will result in a poor filling rate. At the same time there exists space to widen the containers up to the maximal wideness of the road (8½´ or 2,60 m). This will allow EUR-pallets to be stuffed two by two in a container. The problems coming up are more related to the 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 expanding volume capacity. The limitation in an enlargement of the length of the containers is more or less related to what the infrastructure allows as of created delays. In some big cities (e.g. New York) there exist limitations as of the length (53´ = 16 m) to avoid traffic congestions. Today the commercial development is using containers with a length 45´ (13,6 m), 48´ (13,9 m) and 49´ (14,82 m).

The **height** of a container is limited by tunnels and different structures within the infrastructure of road and rail. The restrictions of road 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 of the container heights. The American railroad infrastructure has a tunnel profile dimension of 19´. With a double stacking service this circumstances will give the 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 handled by **unitised equipment** like 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 connected with the investment, cycle of the containers or to introduce adaptable handling equipments 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.

3.2 Present masses and dimensions

Length

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

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

12 m motor vehicle

12 m trailer

16,5 m articulated vehicle (semitrailer combination)

18,75 m road train (rigid truck with trailer) combined with a regulated max total load area length of 15,65 m (or 2 x 7,82 m).

Countries may on national level and for national transports decide on other limits.

As a result out of the directive, there are two "standard units" for load units, a short one max 7,82 m long as being half of the 15,65 m, and a long unit ~13,6 m (semitrailer length)[1].

Beside these, the Directive 96/53/EC also allows trucks in a "modular concept" based on use of a "short" module (max 7,82m) and a long module (13,6m). The allowance of the Modular Concept is depending on individual countries nationally accepting the Concept. So far Sweden and Finland have applied the Modular Concept by allowing one short and one long module in the same vehicle combination while the Netherlands test different combinations in ongoing tests, 300 trucks presently running. Discussions are ongoing in some other countries, for example Norway and Denmark.

[1] Semitrailer length is defined as 12,0 m length from king pin to the back plus 2,04 m radius from king pin and forward, resulting in a length ~13,6 m.

The Modular Concept trucks are built up by simply rearranging present European vehicle “components”; trucks, semitrailers and trailers. Consequently, modular trucks can simply be recoupled back to combinations of normal European length.

The Modular Concept trucks used in Sweden and Finland can be illustrated as follows:

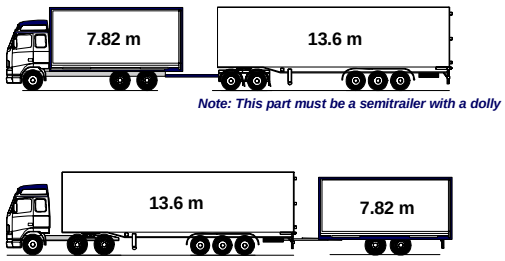


Fig. 14. Trucks for the Modular Concept according to the European Directive 96/53/EC.

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 UK are not regulating the height. The 4,0 m limit sometimes create problems since many transport buyers have demands for loading area inner height of 3 m, to be able to stack 3 pallets, and thus it happens that trucks are too high.

Masses

Trucks could be divided into several groups depending on Gross Vehicle Weight and Gross Combination Weight (GVW / GCW). 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, limit for coming German road fees etc.
16 tonnes	limit for heavy trucks in some official statistics
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.

Beside these there are several national limits (e.g. 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 the time GCW has continuously increased in European countries:

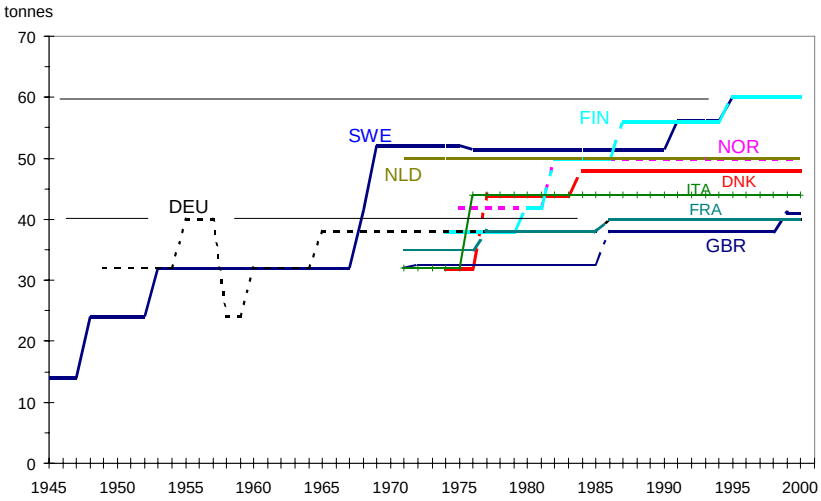


Fig.15. GCW development within some European countries. Source: Volvo Trucks

3.3 Efficiency and environment

The environmental impact of trucks can mainly be related to fuel consumption.

The regulated emissions from diesel engines in heavy trucks have been dramatically reduced and in a long run they are more or less negligible. Remaining emission is CO_2, which is directly related to fuel consumption.

The larger the truck, the higher fuel consumption per truck. However related to load capacity, the larger the truck, the lower the fuel consumption per tonnekm.

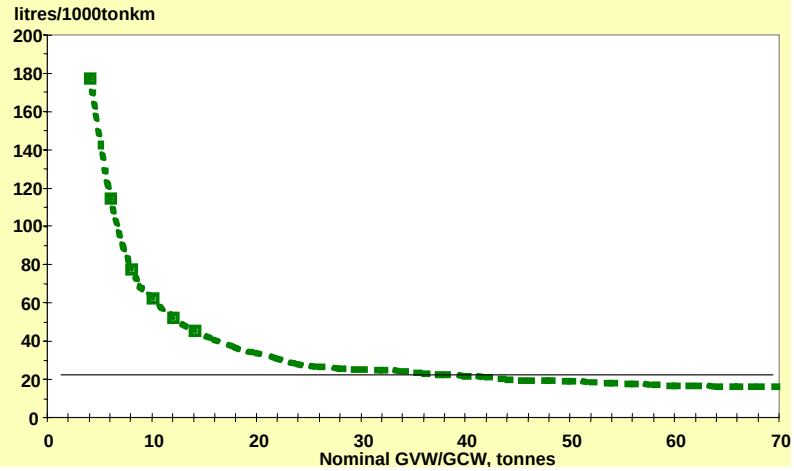


Fig. 16. Increasing truck size give lower fuel consumption per tonnekm, which also affects emissions

Efficiency can be measured as a “road efficiency index” and a “fuel efficiency index”. As an example of differences between truck sizes calculations can be made on different truck sizes where data is available; Modular Concept trucks, standard EU trucks (18,75m and 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 2½ x truck length).

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

Type of truck	"Pallet index" at 70 m safety dist.	"Pallet index" at 40 m safety dist.	"Pallet index" at safety dist. = 2,5 x truck length	"Fuel index"
Larger truck = **52 pallets/truck**	(25+70)/52= **1,83**	(25+40)/52= **1,25**	(25+2,5x25)/52= **1,70**	42/52= **0,81**
18,75 truck = **38 pallets per truck**	(18,75+70)/38= **2,34**	(18,75+40)/38= **1,55**	(18,75+2,5x18,75)/38= **1,73**	35/38= **0,92**
16,5 m truck = **33 pallets per truck**	(16,5+70)/33= **2,62**	(16,5+40)/33= **1,71**	(16,5+2,5x16,5)/33= **1,75**	32/33= **0,97**
"26 tonner" = **19 pallets per truck**	(12+70)/19= **4,32**	(12+40)/19= **2,74**	(12+2,5x12)/19= **2,21**	26/19= **1,37**

As seen from the table, the larger the truck the better index, both for "pallet index" and "fuel index". The larger the trucks, the lower the fuel consumption per tonnekm, which also affects emissions. Efficiency and environmental impact goes hand in hand.

3.4 Safety

Although the purpose with this report is not to deal with safety, some basic aspects on that issue must be raised. The use of longer combinations is one way to increase truck productivity. For getting a view of safety aspects related to truck size, experience from countries today allowing longer and heavier trucks than EU does can be used.

Truck driving stability

The intention is that the larger the truck, the more they are used on larger highways for long distance transports. This means that the most important areas from a driving point of view are driving stability (turn over stability and dynamic lateral stability), overtaking and swept path.

The turn over stability is depending on the height of the centre of gravity, width of track and flexibility.

The dynamic stability, measured as rearward amplification is dependent of the design of the truck, the number and position of articulating points, the distances 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-semitrailer combination has the highest stability while a standard 18,75 m road train, truck and full trailer combination has the by far lowest stability.

Driving stability in term of roll over 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 have studied overtaking of longer combinations. The meeting margin in seconds was used as measure.

No significant differences were found between 18 m and 24 m trucks. This is affected also 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 is braking on all axles and each axle is braking 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, with the intention of longer trucks than allowed today to be used on an adapted road network only, these roads can be adopted to the trucks. These longer truck combinations are not intended to be used in city centres or other highly dense areas.

Collision risk

The risk for collision is difficult to quantify. Experience however shows that the risk is much more connected 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 high responsibility and skilfulness of the driver. The need for extended driver education for larger trucks must be further investigated.

4 Conclusions

Road transport is expected to increase rapidly the coming years. Not least the EU enlargement will have big impact. This will put high demands on efficient transport and logistics solutions.

To achieve the best efficiency focus must be put on:

- Vehicle size must be adapted to local needs and circumstances.
- Flexible combinations based on modularity make it easier to use trucks in different traffic environment. There should be possibilities to rearrange longer trucks into shorter units for local adaptation when shorter units are required.
- Transports 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 transports 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. Trucks should be larger for large-scale effects.
- Intermodality must be facilitated, standardised dimensions of units is a prerequisite. Chosen dimensions must be stable over time and it is essential taking 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 means needs of 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. In contrary longer units even increase stability.