The 3DayCar Logistics Study -
How to organise Automotive Logistics in a Build-to-Order Environment

by

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APPENDIX A – DEFINITIONS AND LITERATURE REVIEW .............................................................. 74
APPENDIX B – ENVIRONMENTAL IMPACT CALCULATION ..................................................... 78
BIBLIOGRAPHY......................................................................................................................... 80
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Executive Summary

- Logistics is the linking element in the supply chain and plays a critical role in supporting a 3DayCar system. Outbound auto logistics has to be achieved in 1 day as a direct part of the required 3 day lead time, from the customer ordering a car to be built at the factory through to it being delivered to the retail outlet. While inbound logistics is not part of the 3 day lead time it is vital in terms of achieving reliable supply of components to the vehicle assembly track without having to hold excessive stocks at or near the factory. This is a key aspect of vehicle build scheduling, which has been shown in previous Systems Stream research to account for a lead time of 14 days or 35% of the time delay of the total order fulfilment process.

This report investigates current practices and operational performances and identifies root causes for time delays and inefficiencies for both inbound and outbound logistics, including both road and sea transportation. The current situation has been assessed via process mapping, interviews, 3 case studies of inbound logistics and 8 questionnaires from outbound road logistics companies. Necessary changes to achieve a 3DayCar scenario are then detailed together with a demonstration that it can be achieved without any significant cost increase or detrimental environmental effects.

Key Findings on Current Situation

General

Key findings that apply generally across both inbound and outbound logistics include:

- Lack of information from the vehicle manufacturer, both in terms of frequency and accuracy, is the greatest operational constraint to logistics companies achieving efficiency in transportation. Planning information given on a monthly or weekly basis varies so much from actual movement requirement on a day to day basis that it is often impossible to use it in any detailed sense. Specific planning can thus only take place when in "real time". There is also considerable variation over time in the actual volumes transported. Some of this is due to seasonal variation in the market place, but much is due to delays in the passage of information across the supply chain caused in the main by bureaucratic decision making.

- There is often a lack of integration and co-ordination of information across the players in the supply chain. On inbound logistics, logistics companies can be given different information than component suppliers on required volumes. On outbound logistics, there is seldom co-ordination between the customer delivery date and the logistics company delivery target and on deep sea shipping, information on which vehicles are on a boat often only reaches the National Sales Company when vehicles arrive in the market place.

- Most supply chain systems from a logistics viewpoint are still organised in a way that reflects the 'mass production' car industry, geared at high load efficiency and equal treatment of all orders. The mentality is one of building vehicles for stock rather than for specific customers. Particularly in outbound logistics, this reflects in the current transporter and shipping fleet profile tending to be of a uniform large size. However, some companies are moving towards mixed size fleets, particularly driven by delivery to individual direct internet sales customers. Mass production mentality is also seen in the concept of a contracted delivery lead time for all cars irrespective of their priority or when the customer expects the vehicle.

- While a complete load from one supplier or to one dealer is the ideal, the increased frequency and shorter lead times demanded by vehicle manufacturers have led to "milk rounds" of increasing numbers of pick-up or delivery points, which demand more
sophisticated load planning systems. The use of these is restricted by the lack of accurate information.

- Nearly all franchises function on the basis of solus franchise road logistics for traditional "competitive" reasons, with few, although increasing, examples of multi-franchise or cross industry operations. These are more prevalent for inbound logistics since component suppliers tend to be more common than dealers between franchises.

- For road transport, the time restrictions on access to suppliers and dealers cause inefficiencies in transportation and delivery lead times, and peaks demand on particularly vehicle manufacturing unloading facilities. These restrictions centre around the opening times of components suppliers and dealers being for given hours during the day.

- There is a lack of data standardisation and its format across vehicle manufacturers, which leads to logistics companies having to cater for many different data translations.

- The environmental impacts of automotive logistics centre around the extensive use of HGVs: both inbound and outbound logistics each account for up to 100m miles per car produced. Environment considerations are very low on transportation in general, except where they coincide with cost efficiencies. This is not assisted by manufacturers only being interested in short term operating costs rather than any long term investment in the logistics industry.

- The automotive logistics industry in general has been diversifying from purely transportation into services such as storage, simple component assembly, pre-delivery inspection, and late configuration. In most areas it has the advantage of scale economies to do such operations, particularly in the market place. It is "received wisdom" that these are the areas of profit potential rather than the actual transportation of vehicles.

**Inbound Logistics**

- The leading edge logistics companies are capable of delivering parts within a time scale which would be sufficient for a 3DayCar system. While high value components require to be produced and delivered within 36 hours, the increasing use of supplier hubs make this feasible. In addition, there are currently a wide variety of typical UK parts for which delivery can be achieved with a 24 hour lead time. It is anticipated that 3DayCar will involve more frequent delivery in some cases and that without changes to the existing processes, this will involve extra cost above the current 2% of retail price.

- In general, reliable delivery is achieved on the transportation side due to the consequences of non-arrival. The greatest problem centres around the availability of unloading facilities and the wasted time spent by trucks and/or trailers in awaiting unloading, which is exacerbated by the opening hours at suppliers.

- There are a myriad of container sizes used, the most significant difference being between rigid containers and cardboard packaging. Cardboard packaging is inefficient because efficient stacking is not possible and therefore the capacity utilisation of trailers is severely diminished.
**Outbound Logistics**

- The average lead-time within the UK on the outbound logistics side of 3.3 days exceeds the required distribution lead-time of 1 day in a 3DayCar scenario, although there are companies operating on a 1 day delivery from distribution centre to dealer. Without changes to the current processes the cost of transportation will rise by 33%, from £60 to £80 per vehicle, although this represents less than 1% of retail price.

- Backloading is a vital part of both the road and sea logistics industry, since the level of achievement is core to the overall price charged for the initial movement of vehicles. For road transport an efficiency level of 54% is achieved in terms of vehicles carried on return journeys against an objective of 60%, but this is achieved only by informal co-operation between logistics companies over the phone. Such backloading arrangements can only be made after the initial outgoing load has been consolidated. With the poor information supplied by manufacturers, this means that there is a conflict between the achievement of delivery lead times and the planning of backloads. For sea transportation, back haul is much more related to the relationship between the global location of production and demand and only long term planning of routes to be travelled and contracts to be obtained can mitigate this situation overall.

- Damage levels average 1.5% of cars delivered, which is much more of a threat to delivery reliability than a financial issue, since the average cost of damage ranges between £1-£3 per car delivered.

- There is a movement in the auto shipping industry towards hub and feeder ports. Large deep sea vessels deliver to a relatively few hubs, and vehicles are then transported on to smaller ports by smaller vessels. This makes for greater efficiency and a wider spread of delivery by sea, and potentially reduces the level of land transportation required.

- Moving to a 1 day delivery lead time using current practices would increase the distance travelled in delivery by 20%, with consequent environmental effect on congestion and pollution.

**Logistics in a 3DayCar Environment**

**General**

The following major proposals are made:

- While long term forecasts should be given to logistics companies for general planning purposes, vehicle manufacturers should open their production planning system to all supply chain players so that they all share a common and real time information system. (See "The Order Fulfilment Process in the Automotive Industry" and forthcoming "Production Planning" reports from the 3DayCar research programme). Information can then be gleaned at the level and frequency required for each player to plan their operation in detail at a greater length of time before the actual operations take place. For instance, the precise hourly order of production will be available at component and dealer/geographical region level, 2 days before the vehicles come off the vehicle assembly line. In order for this to be reliable, vehicle manufacturers must concentrate on building individual vehicles in the correct order rather than be purely judged on an overall volume achievement level.

The passage of information on a real time basis throughout the supply chain should assist in reducing the variations in volume and mix movements required, although the innate variation in the market place will still cause significant variation.

- In order to improve the efficiency and flexibility of transportation the following should be considered:
The development of mixed size fleets of vehicles or ships to give greater flexibility while increasing capacity utilisation.

The implementation of multi-franchise or cross industry (for components) collection and delivery to increase efficiency, as long as this can be incorporated within required delivery times.

The use of dynamic route planning systems.

As necessary, opening times for collection from component suppliers and delivery to dealers should be extended to 24 hours to enable more efficient use of transport and ease congestion on vehicle manufacturers unloading facilities. As a result congestion will be reduced and transport operate much more efficiently on roads at night, as long as environmental considerations such as noise are taken into account.

Data and formats should be standardised across the motor industry to enable multi-franchise logistics companies to function effectively.

Standards should be set and implemented for all logistics companies transporting components or vehicles, whether they are directly contracted or sub-contracted. This would improve transit damage and environmental standards.

Performance measures should be introduced by logistics companies on a standardised basis which measure capacity utilisation, and the environmental effect of fuel usage and distance travelled.

Logistics Companies should be encouraged to invest in the future, including the environment, by operating "open book" contract negotiations. These would include consideration of logistics companies investment in fleet, systems, and the environment as well as just the price offer for movement of vehicles and possibly service level. This may also encourage recognition of the cost structure of transportation and assist in balancing the profit situation between the various "businesses" operated by logistics companies.

Inbound Logistics

The trend towards supplier hubs should continue and a review of the effect of long distance global suppliers should be carried out, to determine whether they are appropriate either for a build to order 3DayCar strategy or from an environmental viewpoint.

There should be a standardisation of containers and all efforts should be made to eliminate cardboard packaging. This is not only for the vehicle manufacturers convenience but would also have a significant effect on transport capacity utilisation.

The above general and specific actions should mitigate the extra cost and environmental impacts of an increase in inbound transportation frequency. This may be necessary to ensure parts are received within the production and delivery 36hr lead-time required for high value components in a 3DayCar system, while not increasing pipeline inventory levels significantly. Results from the 3DayCar simulation will assist in the quantification of any cost increase.

Outbound Logistics

In order for multi-franchise and backloading to be maximised, the following changes are required:

- A rationalisation of the number of ports for vehicle movements entering and exiting the UK and commonisation across franchises of the geographical areas.
they serve. These ports should be broken down as necessary between hub and feeder. Care must, however, be taken to avoid over-congestion of shipping and road transport at ports and joint action is needed between vehicle manufacturers and sea and land logistics companies.

- Agreements between franchises to allow joint storage of vehicles at storage compounds/distribution centres whether located at ports, factories, or regionally
- The formal acceptance by VMs for logistics companies to move vehicles of all other franchises on the same transporter load
- The recognition by VMs that backloading is a vital element in economical movement of cars and their assistance in ensuring that this is enabled
- The introduction of a trading exchange (on the Internet) to enable Logistics companies to effectively maximise capacity utilisation and backloading at minimum cost.

- In order for 24 hour delivery to take place, secure dropping compounds must be installed and changes in the transit damage inspection terms made to remove the necessity for immediate inspection of vehicles at the dealer. This will include the instigation of shared cost of minor transit damage/ factory quality differentiation between the logistics company and vehicle manufacturer on the basis of sampling rather than 100% inspection.

- The implementation of planned, multi-franchise, mixed fleet logistics will enable a 24 hour lead time within a 3DayCar scenario without additional cost, demonstrated by specific research using a sponsors computer simulation. In fact, savings of £20 per car can be made in nearly all franchises because the management of distribution centres will no longer be necessary in a stockless system.

- The environmental impacts of 24hr delivery under the above proposals would decrease the excess distance travelled to 10%. However, this would be achieved by using a much greater proportion of smaller transporters with lower fuel consumption and less congestion effect. An alternative environmentally friendly approach reduces the distance increase to 3%. It is believed that these effects can be mitigated to achieve a ‘zero-net-increase’ through a mixture of new technologies such as cleaner engines and non-quantified changes such as 24 hour a day delivery to dealers.

This research confirms that both inbound and outbound logistics can operate within the required delivery lead times for a 3DayCar to be achieved. This will only be achieved if there is a recognition by vehicle manufacturers of what is required to make logistics companies efficient and environmentally friendly, and then co-operation in the development of necessary processes and reliable information communication.
1 Introduction

1.1 Study Objective

The logistics function is the link between the subsystems in the auto supply chain. In a 3DayCar environment, any form of time delay or flexibility constraint in either the supply or distribution side is a potential barrier to achievement and thus this research has a focus on each detail of the logistics process.

The underlying report focuses on inbound and outbound subsystems, considering the evolution of the roles of logistics companies, from purely transporters of goods to providers of services such as inventory management, subassembly of components (inbound), and vehicle preparation and late configuration (outbound). Lead logistics partners are also organising and managing the complete logistics requirements of their customers.

This study forms part of the overall systems and environment work, in which all the subsystems in the automotive supply chain are being analysed:

- Order Fulfilment Process Analysis (OEM) – presented in July 2000
- Component Supplier Study – ongoing, forthcoming June 2001

Figure 1: New Vehicle Supply System

Systems research of the six VM sponsors has identified outbound logistics in terms of contracted delivery lead times from the factory to dealer as averaging around 4 days within a total lead time of 40 days in the order fulfilment process from order placement at, to vehicle delivery to the dealer. In a 3DayCar, the delivery time must be reduced to 1 day. Inbound logistics, while not being part of the customer order lead time, has been identified as a potential constraint on the scheduling flexibility in the order scheduling process at the vehicle manufacturer. The study of inbound, outbound and sea logistics is therefore a key area, with overall objectives defined as:

1. Detailing the current state practices, including comparative analysis of the inbound logistics operations
2. Analysing the root causes for delays & inefficiencies in the system
3. Defining the environmental implications of 3DayCar automotive logistics
4. Developing a process framework for automotive logistics in a 3 day “build to order” environment
1.2 Research Methods

The diversity and characteristics of the individual logistics functions did not support a common research approach. Thus, several different approaches have been used:

- The research into inbound logistics relies on three case studies. Due to the individualistic nature of different systems, a more quantitative approach such as a survey was not feasible. These studies involved process mapping following the ‘Big Picture Mapping’ methodology suggested by Rother & Shook, 1998, interviews and site visits.

- The research into outbound logistics involved an initial case study approach, whereby detailed process mapping and interviews were conducted for three different cases. Additionally, a quantitative survey method was applicable, since the vehicle distribution operation is sufficiently common in terms of its basic routeing (plant or port to compound, compound to dealer) and the ‘vehicle’ being a standard unit of freight. The survey covers 8 companies, a total of 3.1m annual vehicles movements, and a fleet of 1,537 car transporters.

- Due to its very specific nature, the sea transportation research consists of one in-depth case study – based on process mapping, interviews and several site visits, together with the opinions of several secondary sources. Both vehicle import and export operations were considered.

Scope & Limitations

The general scope of the research has been UK suppliers into UK assembly plants (inbound), and UK plants into the UK market (outbound). Continental European markets have not been studied in detail.

This report describes automotive logistics from the service providers’ point of view. No additional interviews were conducted at the vehicle manufacturers for this report other than those already reflected in the 1st year System report.
1.3 Outline of the Report

Inbound, outbound and sea transportation logistics are fundamentally different operations and hence are addressed in separate sections as defined below:

- Chapter 2 discusses the three case studies on the inbound logistics side and examines the implications of a 3DayCar system for inbound logistics. The chapter concludes with an outline of how inbound logistics would have to adapt in order to support a 3DayCar, taking into account environmental implications.

- Chapter 3 focuses on outbound logistics, discussing the results of the survey conducted amongst eight logistics service providers. In particular, lead times, operational constraints and the root causes for delays and inefficiencies are discussed.

- Following the findings of chapter 3, chapter 4 describes how a 24hr delivery of vehicles within the UK could be made possible. Both financial and environmental impacts are evaluated, with additional evidence presented in Appendix B.

- Chapter 5 gives both a general overview on sea transportation and a detailed discussion of import and export operations. The chapter concludes with recommendations as to how sea transportation could improve in general and for a 3DayCar system in particular.

- Chapter 6 concludes with the main themes that have arisen during the research, and summarises the key requirements for auto logistics in a build-to-order environment.

- Appendix A gives key definitions and a brief academic literature review on logistics and environmental impacts, and Appendix B contains further information on the environmental model used for calculating the impact of build-to-order. A bibliography is also appended.

Mainly due to the variety of aspects covered, not all of the data can be presented. We would therefore like to encourage contact with the authors to ask questions or make comments.
2 Inbound Logistics

2.1 Introduction

The costs for automotive assembly inbound logistics are not insignificant. They make up around 10% of the manufacturing costs (plant based costs), and so account for about 2% of the cost of a finished vehicle (cost at gate release). Any increase in these costs is seen as significant.

In a 3DayCar environment, if no changes are made to typical current systems, then more stock would have to be held to cater for day to day variations in demand from the market place. In order to ensure that the cost involved in this is not prohibitive, there are various changes that can be implemented separately or in combination as follows:

- A shorter lead time for production and delivery of components, within a 36 hour period prior to vehicle assembly, so that components can be produced in line with actual customer orders
- More flexible use of transportation capacity
- More efficient information systems

This chapter deals with the latter two points, as the first point relates to supplier capability, rather than logistics system efficiencies.

The overall objective of inbound logistics is to ensure reliable supply of components at minimum cost of stock, transport and ordering and invoicing processes. If transport capacity can be maximised within the desired frequency of delivery, then these cost aspects are likely to be close to the optimal solution.

The main drivers for efficient inbound logistics are:

- Reliable delivery of the correct components. This requires an integrated process between the vehicle manufacturer, component supplier and logistics company.
- Higher frequency of delivery to minimise stock. Such stock is required to cater for the time and variation in use of stocks between deliveries.
- Maximisation of transport capacity utilisation. The more frequently components are collected from suppliers, the more difficult it is to utilise capacity. While direct delivery of a full load from one supplier is the optimum, good route planning from several suppliers within an acceptable time frame will improve capacity utilisation significantly. If too many suppliers are collected from over too large a geographical area on the same load, then this is inefficient both from a time and cost point of view. More single source suppliers can assist in maximising the use of transport capacity, given that they produce more than one component at the same location.
- Backloading from the factory/cross dock assists with capacity utilisation, but this has limited scope for inbound logistics other than for return of packaging such as containers.
- The means of packaging is also vital to capacity utilisation. Standardised rigid containers can be stacked to give maximum use of available space. On the other hand, non-standard cardboard packaging does not allow efficient horizontal space utilisation or maximum height stacking, since it “collapses” if under too many layers of components.

1 based on Goldman Sachs estimates
- Efficient use of the receiving facility. This requires the minimum number of trucks delivering to the receiving point spread across the maximum opening times for the facility. Good integrated information and scheduling systems, together with maximum capacity utilisation, assist in this objective.

- Minimisation of fuel usage and transport distances (time, cost and congestion issues). While this may not be a strong driver at the moment, environmental considerations will make it increasingly important in terms of pollution and congestion.

Given this background, the following delivery elements have evolved in terms of inbound logistics:

- **Direct delivery - supplier to plant:** The supplier sends trucks with their specific components only to the vehicle manufacturer plant. This is the most efficient means of minimising transport costs as long as the capacity utilisation is good. As the frequency of collection increases, truck utilisation reduces, making the cost of shipping increase.

- **Milk round collections:** To make sure that smaller shipment size does not increase costs significantly and cause congestion at unloading points in assembly plants, vehicle manufacturers have introduced milk rounds. In these, the truck will visit more than one supplier to collect components for delivery to the plant or other in-transit points. Such milk rounds can take the form of collections for:
  - One vehicle manufacturer
  - Multi-franchise i.e. several manufacturers
  - Multi-industry i.e. including non-motor industry components and materials

- **Cross-dock consolidation point:** Once trucks have collected from suppliers they may not be completely full or may have components destined for several plants. Consolidation points allow the components to be unloaded at a cross-dock and then loaded in a different sequence together with parts from other milk rounds to the various vehicle manufacturing plants. This allows better vehicle utilisation just-in-time to the plant. The resulting increased frequency then allows for less or no stock to be held at the plant or line side.

- **Local warehouse:** In many cases VMs have a local warehouse holding a safety stock of parts from local suppliers, but more usually from European and global supply lines. This warehouse can despatch to the VM plant very quickly, in sequence when necessary. The warehouse will have to be replenished on a regular basis, using any of the methods described previously.

- **Supplier park:** Where the component requires build in sequence delivery, there is often justification for the supplier to move close to the VM plant, with an order lead time of less than two hours being common. Components which are suitable for such operations can be highly complex model specific, late configurable, or expensive to transport in complete form components. This is typically suited to modules, seat and interior trim suppliers and external painted parts such as bumpers or door handles.

This study is based on three in-depth case studies describing inbound supplier collection schemes. These are categorised in terms of the information processes utilised for the actual pickup, and are defined as **A: Non-integrated, B: Semi-integrated, and C: Integrated**. The study focuses on UK supplier collection, hence European and other overseas supply is not considered in detail.

In addition, a brief case study of the Saturn inbound operations is presented, as it demonstrates certain innovative practices potentially relevant to a 3DayCar system.
The above generic logistics map is used throughout the case studies to show:
A: The lead time for collection
B: The average number of suppliers collected from per load
C: The maximum time at the cross dock
D: The time for delivery to the plant
E: The percentage of components going through the cross dock
F: The percentage of components being delivered direct to the plant

A number of specific terms are used in the field of logistics which are explained here:

- **Line haul** - refers to the trunking stage between a consolidation point and the manufacturing plant, usually involving full load trucks (FLTs)
- **Pick up sheet (PUS)** - Carried by the collection vehicle stipulating what should be collected from the supplier
- **Advance shipping note (ASN)** - paperwork warning the receiving or collection facility that material is to be despatched or received
- **Advice note** - this is sent with the goods for confirmation to the receiver.
2.2 Case A - The Non-integrated Operation

General background

Company A has inbound logistics experience at a number of UK and European vehicle manufacturers and operates logistics functions around the globe for the VM. It operates as a lead logistics partner for several of these volume manufacturers operations, organising the total logistics operations and managing all transport contractors.

In this case study, however, the operation of collection and trunking to destinations is shared with two other logistics contractors and the customer's own fleet. This is mainly allocated by geographic area, with Company A being responsible for Midlands and South West collections, and the other logistics companies for North and South East collections. The company manages the cross dock facility in the Midlands.

The operation covers 300 suppliers and delivers to 39 destination points including plants in the UK and Europe. The delivery to the numerous end points is also shared with two other logistics providers.

![Figure 2: Non-integrated Supplier Collection Process](image)

Planning and operational information

The VM gives the component suppliers a weekly schedule of required deliveries one week before deliveries commence for the week, as well as a daily call in on an exception basis. The supplier then provides the logistics company with advanced shipping notes (ASN's), which state a ‘ready at time’ for each collection. Logistics company A's contract with the vehicle manufacturer states that the delivery to the VM plant should be within 24hrs of the supplier's stated ‘ready at time’. Most ASN's are received by 4 p.m. on the day before collection.

Collection

Trucks pick-up from 3-6 suppliers in one collection trip. Advice notes are issued to the logistics company at the pick-up. These can be different from the ASN in terms of material amount and type. The driver will check supplier presentation on the Advice note against the ASN, but it is possible the customer (VM) will have notified a change in material type and/or quantity to the supplier without notifying the logistics company. The collections tend to be before 5.30pm due to the closing times of supplier sites.
Up to 20% of collections run direct to the plant without entering the cross-dock operation depending on whether full truck loads are possible. The 80%+ remainder are delivered into the cross-dock operation in Central England. Consolidation occurs as soon as collections start to arrive, with many deliveries arriving from suppliers by about 5pm. Collection trucks are decanted into a number of areas at the cross dock operation dedicated to plant deliveries. The unloaded material information is recorded on the logistics company's information system. Data from advice notes will be used by the logistics company to register receipt on a customer (VM) shared system, confirming, or otherwise, the ASN. This system then books components onto delivery slots as required by the VM. Components can wait at the cross-dock operation up to 12 hours for the right time slot and space capacity is needed to deal with this waiting time.

Delivery

The loads are built into delivery slots on the basis of customer material requirements identified in the logistics company and VM shared systems. Trunking out of the cross-dock to the plant starts around 4pm and takes around 3 hours on average, to 7 delivery points at the VM plant. Some trucks will visit more than one point at the plant. The VM's operations staff unload the trailers and material is processed to the appropriate location by plant staff. As necessary, trailers will wait in a dedicated park until unloading facilities are available or required.

Discussion

The key problems are:

- This is a vendor push system - information to the logistics company is from the component supplier, not the vehicle manufacturer. This means that there is a delay in information passage from the VM source, and it can be distorted by the component supplier away from the VM requirement.

- The process is further distorted by the VM notifying component suppliers of changes to requirements on a daily basis that are not notified to the logistics company on his daily ASNs.

- Even without these late changes, the logistics company only has 12 hours notice of requirements and has no visibility of supplier or VM schedules - so there is no ability for the logistics company to plan ahead and maximise capacity by varying the number of suppliers picked up from per load.

- Variation in the actual to planned collections is also caused by component supply shortage, indicating lack of buffer stocks at the component supplier and dependence on stock already at the manufacturer. In addition incorrect packaging presentation causes problems. This appears to be largely caused by trailers being used as storage at the VM plant, tying up rigid containers and thus card board packaging having to be utilised as a shortage fallback.

- Little standardisation of advice notes across component suppliers increases administration time and sources of error.

- The process is limited by supplier opening times. 60-70% are closed after 5.30 p.m on Monday to Thursday and 1pm on Friday and are not open at the weekend. This limits the opportunity for optimising transport capacity utilisation and causes “bunching” of transporters arriving at the cross-dock with resultant queuing for unloading.

- Under achievement of planned vehicle assembly volumes can lead to oversupply of components at the vehicle manufacturer. This causes variance to the plan and so requirements are often changed before logistics companies are informed, meaning that planned volume is lost and load efficiency reduced.
Although delivery performance is measured in a systematic way (VM system), payment is on the basis of weight transported, not on a service oriented performance system.

Positive actions already taken:

- Fixed delivery lead times and high delivery performance within contracted times enable stable planning
- An increasing percentage of direct deliveries from suppliers enables a simpler system
2.3 Case B – The Semi-integrated Operation

General background

Logistics company B operates in a number of different industrial sectors in the UK with a fairly large presence in the automotive sector for both inbound and outbound components, the latter in terms of after market parts. The company operates 12 regional depots for the collection of material and parts across a number of industrial sectors, mixing different sectoral product to maximise capacity utilisation within the general category of industrial products. The company's contract involves 80,000 consignments per year relating to about 500,000 tonnes of material being transported for the particular vehicle manufacturer.

![Company B inbound logistics processes](#)

Planning and operational information

Company B receives information from the manufacturer on a weekly basis for the second week ahead in the form of a pick up sheet (PUS), which it sends to the supplier so that the supplier has the necessary goods ready for collection. This is in addition to plans which suppliers get from the VM on a monthly, weekly and daily basis. The PUS takes up to 5 days to reach the supplier, especially if in Europe, causing a corresponding delay before any planning can be carried out. Although volumes should correspond to the VM monthly plan, there is significant variation, and so company B only has time between receiving the pick up sheet and collecting the components to maximise capacity utilisation.

Collection

The logistics firm collects parts from 280 suppliers in the UK spread across 12 regions. Each region is served by a depot which cross-docks a mix of industrial products including automotive (known as "groupage"). The company uses Paragon route planning software to calculate collections across regions. At each depot, trucks trunk from the region to a central cross-dock serving the vehicle manufacturer. This occurs at regular daily intervals but can also be direct from the supplier to the vehicle manufacturing plant if full loads are possible (30% of volume is direct from a supplier). In general the collection is about one day before delivery to the plant. This allows around 12 hours to collect and decant at the depot, then 6 hours to trunk to the plant consolidation point. Figure 4 shows how regional
depots consolidate from local suppliers. 10% of the milk runs deliver direct to the plant without entering a cross-dock.

![Main regional collection points for Case B - Multi-Sector Collections.](image)

At the cross-dock point for the VM, trucks arrive from depots at about 5pm up to around 3am. As time slots at the receiving VM plant start at 4am, in some instances logistics may only have about one hour to decant and load onto the delivery truck to the VM plant. An IT system is used to manage inventory both at regional depots and cross-dock points.

**Delivery**

Delivery from the consolidation point to the plant takes about 45 minutes, leading to continuous line feed. Daily parts collections from suppliers may be split into 2 or 3 delivery slots; for example a shift’s worth of material per collection, so reducing stock held line-side.

**Discussion**

The key problems are:

- Non-shared routes and operations with the VM’s own fleet so that it does not act in competition (restrictive practices). This may not achieve the best utilisation possible. The VM fleet has been kept since before the time when transport was contracted out as ex-works. This allows some competitive tension, but may not give the optimum overall operational load efficiency.

- Many copies of paperwork are used along the chain. While 20% of deliveries are strictly not to the original plan, 80% of paperwork in certain areas could be saved since currently Company B still needs to use the pick up sheet. If an Extranet was used, it would be possible to only print by exception.
Positive actions already taken:

- Good utilisation given by consolidation points regionally and for line haul - but each point adds time.

The graph above demonstrates performance measurements that are used by Company B to analyse efficiency and trends and numbers of collections or consignments. For example, the graph shows that whilst the weight per consignments has stayed relatively steady, the number of full-load consignments has reduced compared with partial loads (milk run collections) indicating higher collection frequencies.

The company also uses other measures such as load efficiency (% weight and % volume utilisation), fuel use and delivery performance (% on time).

2.4 Case C – The Integrated Operation

General Background

Logistics Company C operates in a number of countries including the UK and the US. They have worked with the VM for a number of years and have developed the collection scheme collaboratively to fit developments at the VM. The operation involves collection from suppliers in the North and Midlands and has been expanded to include South Wales and the South East. The main drivers for the inbound collection scheme are:

- A reduced number of deliveries to the plant to reduce congestion, given increased production volume.
- Cost savings through consolidation,
- Reduced inventory at VM
Planning and operational information

Logistics receives exactly the same detailed information once per day from the VM as the suppliers, plus 2 other updates in the day as required, in the form of electronic advice notes (RANs as shown in Fig 6). This is fed into the Logistics IT systems and hand held barcode readers are loaded with the requirement before the driver leaves the site. This can be updated in transit by virtue of in-cab communications (mobile phone connected to hand held data device).

Collection

Company C collects from around 90 suppliers per day from various regions in the UK. 33% of components are supplied direct to the vehicle manufacturer plant from individual suppliers. The remaining 66% are picked up from an average of 2-3 suppliers per load and delivered to the cross-dock site. These milk-runs take 6-12 hours.

The collection runs generally arrive into the cross-dock managed by company C, 1-12 hours before shipment is required by the VM. The peak of arrivals is between 5 and 9pm, which is mainly due to the closing time of most suppliers being around 5pm. The loads are decanted into line-haul lanes for the relevant delivery slots, either directly on to a waiting trailer or into the lanes. Line-haul lanes are loading bays in the crossdock allocated to VM delivery time slots. The driver enters data on the material collected into the schedule planner system. There is usually little variance between the advised requirement call-off and the actual material collected.
Line-haul vehicles for delivery to the vehicle manufacturer are loaded 2-6 hours before
delivery to avoid build up of too much stock in the load lanes. When the delivery leaves
the cross-dock the next load will have been put onto a trailer as a safety measure if
problems occur in the short term.

**Delivery**

The delivery to the plant takes 3 hours and the turn-around time between arrival, decant,
loading with stillages and departure is 1.5 -2 hours. Line haul to delivery points now
occurs every 2 hours and stock on the line equates to about 3 hours safety stock in order
to cover transit to the plant if a problem occurs. The trailers are taken to a trailer park at 1
hour from the plant and then brought in as required (according to the specific, narrow
delivery slot or time window). This function is shared between company C and another
logistics firm which organises local supplier direct deliveries to the plant. Vehicle
manufacturer staff unload at the plant.

**Discussion**

The key problems are:

- Collection times restrict operations and cause peaks of stock build up during
  afternoon and evening. This is mainly due to supplier opening times.
- The short term changes in production mix and day-day volume variation causes
  problems for load planning. Daily collection can mean capacity utilisation is reduced
  and extending milk rounds to increase trailer utilisation can cause time problems to
  these collection runs.
- Significant trailer capacity is utilised in storage phases, such as prior to movement
  from the cross dock, and this implies excess trailers and containers.

Positive actions already taken:

- Good visibility through on-line access to vehicle manufacturer systems ensures that
  the logistics company is aware of any changes in the requirement and can plan
  ahead to maximise utilisation of transport.
- Highly standardised containers and low numbers of cardboard containers enables
  effective stacking and so trailer fill capacity can be maximised.

**2.5 Comparative Analysis**

**2.5.1 Introduction**

In this section the three supplier collection schemes are compared in terms of lead times
and efficiency. The intention is to determine potential enablers and inhibitors to a 3DayCar
arising from the inbound logistics subsystem. The supplier collection schemes analysed
do not manage inventory as such, they manage the efficient transportation of components,
and this is the basis for assessment.
2.5.2 Information and Response Lead Times

The table below shows the different aspects of requirement data for overall collection and delivery in the three case studies.

<table>
<thead>
<tr>
<th>Logistics case study</th>
<th>Case A Non-integrated</th>
<th>Case B Semi-integrated</th>
<th>Case C Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of data</td>
<td>VM to supplier, supplier to logistics</td>
<td>VM to logistics, logistics to supplier</td>
<td>VM same data to both logistics and supplier</td>
</tr>
<tr>
<td>Call off notice and response lead-time to changes</td>
<td>1 day (afternoon before pick up)</td>
<td>5 to 12 days</td>
<td>Online, hours</td>
</tr>
<tr>
<td>Response lead-time to change in route framework</td>
<td>1 day (possible)</td>
<td>5 days</td>
<td>1 month</td>
</tr>
</tbody>
</table>

Figure 8: Table showing main differences in data information

- Case C is seen as the most integrated collection scheme as logistics and suppliers receive exactly the same information at the same time. Case A is basically vendor push i.e. the suppliers notify logistics when to collect.

- The lead times to change the daily call-off quantities are roughly the same as the call off notice. In practice however short term changes often occur up to the time of collection and only in the case of the integrated system (C) is the logistics company specifically informed of these through an online updating system. The semi-integrated case (B) shows least flexibility, with long response lead times due to fixed schedules and routes. Pick up sheets are sent weekly through the logistics company to the supplier and the actual pick up can occur up to 12 days later. Despite this attempt at long term disciplined planning, call-off quantity changes are made informally, which again reduces efficiency.

- The non-integrated case A is the most flexible scheme in terms of changing route patterns, mainly because the supplier normally informs the logistics company what to pick up with one day's notice, leaving him to determine the routing. As the Case A operation is rather 'loose', changes can be accommodated with consequent efficiency loss. The integrated case C is also very flexible in terms of lead time for change of daily call off, as the online hourly updates determine the schedule. However, routings and collection times are only changed every month and the disciplined integrated nature of the process leads to high reliability but sub-optimised capacity utilisation.
2.5.3 Delivery Lead Times

<table>
<thead>
<tr>
<th>Time / Hrs</th>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>11</td>
<td>9.75</td>
<td>10</td>
</tr>
<tr>
<td>Max</td>
<td>28</td>
<td>30.75</td>
<td>27</td>
</tr>
</tbody>
</table>

Both Case A and Case C have similar maximum and minimum lead times (Figure 10). Case B has a higher maximum lead time due to the extra handling at regional depots, but lower min lead time due to the close proximity of the cross-dock to the plant.

- The difference between the call-off notice (Figure 8) and the maximum lead time gives flexibility on the pick up time from the supplier. It should be noted that some of the deliveries are potentially outside the call off notice time if planning is not efficient.

- The lead times will be shorter for those parts delivered direct from suppliers but the numbers of these vary by collection scheme (Figure 9). The non-integrated operation (A) has fewest direct deliveries partly due to the high number of suppliers supplying a large number of customer shipping points (potentially up to 80 throughout Europe). Since volumes do not justify full loads, then the number of partial or milk run shipments increases.

2.5.4 Load Efficiencies

Load efficiencies relate to the volume of product from each supplier, the frequency of collection, and the efficiency of packaging as well as the ability to plan routes effectively.
As the frequency of collection increases there are more partial loads which need inclusion into a milk run to reduce costs. However, despite Case C having the lowest call-off lead time there are fewer suppliers on each milk run (see Figure 11). This may partly be due to the effect of having suppliers only delivering to one plant, whereas collections are made to a large number of VM plants in Case A and so cross-docking is required to split loads between delivery points. Case A and B also collect from larger numbers of suppliers.

The efficiency of load carrying is also dependent on the use of packaging that facilitates optimal loading of trailers in terms of filling up space and meeting weight restrictions. Generally, volume is the main capacity constraint although weight limits can be reached when shipping components such as engines and batteries. If standard packing sizes are used, the ability to use capacity is better in terms of proper stacking and effective filling of space. Metal or plastic containers, a rigid box or frame used to store components, can be stacked if they have the same footprint or dimensions. Figure 12 demonstrates that this is not often the case, given the high number of container types and the proportion of cardboard packaging used. The strength of cardboard does not allow efficient stacking. Cardboard is often used by new suppliers whilst suitable packaging is developed or if rigid containers are not available due to them being tied up in the plant. It has a short life and thus the resultant recycling or landfilling also creates environmental problems.
<table>
<thead>
<tr>
<th>Case A</th>
<th>Case B</th>
<th>Case C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of container types used</td>
<td>N/a</td>
<td>276</td>
</tr>
<tr>
<td>Percentage of standardised containers</td>
<td>N/a</td>
<td>10%</td>
</tr>
<tr>
<td>Percentage of cardboard packaging used</td>
<td>30-50%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Figure 12: Comparison of packaging characteristics**

- Figure 12 also shows the percentage of standard packaging which enables modular load planning and building to maximise cube load efficiency. These figures demonstrate the complex nature of maximising the usage of transport capacity, and indicate the necessity for feasible standardisation.

- Case C is by far the best in terms of numbers of types and percentage of standardised containers, and the proportion of cardboard packaging used.

- The typical cubic load efficiencies for inbound logistics trucks in terms of the average for collection from suppliers and delivery to the plant are shown in Figure 13. This would indicate that despite Case C having fewer suppliers on each collection run, it operates at a higher capacity utilisation than Case B.

<table>
<thead>
<tr>
<th>Case B</th>
<th>Case C</th>
</tr>
</thead>
<tbody>
<tr>
<td>63-73%</td>
<td>70-80%</td>
</tr>
</tbody>
</table>

**Figure 13: Average range of load efficiency**

(No information available for Case A)

### 2.5.5 Conclusion

Case C demonstrates the best practice for outbound logistics of the three operations studied:

- Information is integrated in almost real time between the manufacturer, component suppliers, and the logistics company.

- The information systems are integrated into the vehicle manufacturer systems, so that reliable and fast information exchange is possible. Tracking of parts is also possible allowing greater visibility.

- It has fewer supplier locations to collect from with greater component volumes and has a high frequency of collection with a very quick reaction time.

- The scheme delivers to one manufacturing facility, which simplifies the system and allows direct delivery where full truck loads justify it.

- Despite the low frequency of routeing changes, it appears to obtain the highest capacity utilisation due to the standardisation of containers and the higher volume of components collected per supplier.

- It has achieved its objectives while not concentrating on the optimum routing for transportation. (Within a 3DayCar environment, the routeing should be reviewed on a...
daily basis, given precise component requirement being available 2 days before build from the assembly track, to see whether increased load efficiencies are feasible).

Key problems across the three case studies are

- Restricted opening times of suppliers causes congestion and loss of efficiency at the cross-dock.
- Inflexible delivery slots at the VM can cause loss of load efficiency.
- Short notice changes, although notified, affects load efficiencies. With a three-day car this would be minimised.
- Not all VMs collection schemes supply to one plant, so that complexity is added and direct deliveries reduced due to load splitting requirements. The lead-time is thus increased due to larger milk runs to cover more partial loads and cross-docking. Multi-franchise and multi-industry collection can, however, add to the efficiencies of logistics companies where suppliers to a VM are spread out geographically or are producing relatively small quantities, as long as the required delivery lead time can still be achieved.
2.6 Case D – Saturn Inbound Operations

Background

Saturn is part of GM, and is a testing ground for a number of innovative vehicle manufacturing ideas such as using painted plastic body panels. It was the first volume producer in the US to implement significant build to order strategies.

‘Saturn’ has produced small cars of space frame type construction with polymer panels at the Spring Hill, Tennessee plant since 1990. In the favourable US economic climate of the 1990’s, there has been a drift towards higher cost vehicles, principally SUVs. Saturn is responding to this trend by introducing an SUV in late 2001, and there was significant model changeover activity at the plant when visited recently. For the reduced small car market, Saturn have stayed true to the pull principle, opting to produce to order, requiring just four days production each week.

Inbound Logistics

The initial ‘Saturn’ inbound system was completely Just In Time with no stock holding facility on site. In these early days at the plant, the whole inbound operation was run to minimise stock. With the falling demand for small cars, cost pressure has increased in recent years, tempering this pure stock ‘economies of time’ mindset with transport ‘economies of scale’.

This involved dividing parts into categories A, B and C according to value and distance travelled to the plant; category A being the highest value usage parts.

For “A” category parts, there has been no compromise of the Just in Time philosophy. 70% of inbound parts by volume are delivered direct to the plant, with no adjacent late component configuration facility. As a result, the plant itself appears to have much higher assembly line side stock than comparable plants visited in the UK, and the housekeeping is of an average standard.

Three years ago, a third party on-site facility of 2000 square metres was added for “B” and “C” category parts, with three roles:

1. To improve the plant line side process, by cross-docking and sequencing parts.
2. To provide a small storage area (approx. 400 sq.m) for “C” category parts allowing less frequent supplier collection - weekly or bi-weekly collections for many parts in excess of 300 miles.
3. Reverse logistics involving return of packaging equipment.

The site was a drop-trailer operation feeding a facility that was simply a series of doors with visually controlled routings. "B" category parts were delivered and cross-docked to line side through this visual management system. "C" category parts were stored and drip-fed to the plant. This had provided a significant saving to the operation in terms of transport costs. All routings were regular daily collections with weekly exceptions on certain days - a major challenge in returning the correct packaging.

As each car exits final assembly an electronic "Kanban" of all parts is produced. Each "Kanban" is interrogated every 2 hours - only then does Saturn take ownership from the supplier. This is the demand signal for the supplier to expect to ship to refill the "Kanban". This can be more accurately described as a "Conwip" process 2, since all parties operate

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2 Like kanban, CONWIP (CONstant Work In Process) uses cards to limit the WIP of a system; unlike kanban the cards are allocated to a system of workstations instead of just one. The CONWIP system limits the amount of WIP in the system, with the benefits of reduced cost and shortened lead times.
on the basis of the off final-assembly line data independent of what is happening at interim points.

The manufacturing process delivers frames in one colour, namely black. Painted body panels are stored in an automated high bay store and attached to the "black" car late in the assembly line process - this has significant benefits in terms of reduced paintwork damage. Ergonomics in the plant are impressive.

The key themes of this system are conducive to effective build to order strategies and given the innovative vehicle design, may be applicable to a 3DayCar system.
2.6.1 Environmental Issues - Inbound Logistics

The fuel costs involved and distance covered in transporting material and components is relevant to environmental considerations when considering a 3DayCar, because of the extra vehicle kilometres which may be required to deliver more frequently.

A typical plant can have a total inbound logistics mileage of ca. 30 million miles per year, including European supply, which is currently increasing in UK manufacturing plants. This equates to around 6 gallons of fuel per car produced and around 100 truck transport miles per car produced. This is obviously not as significant as the impact of the driven car, which uses around 4000 gallons across its life cycle. Nevertheless, the cost and impact is significant and likely to increase.

It is thus important to review the options for reducing the environmental impact of inbound logistics relating to HGV movement. Other than the efficiency of transport factors such as less frequent delivery and optimum routing, these options can be summarised as follows:

- **Locate suppliers closer to the vehicle manufacturer:** This is an approach already taken in many circumstances in UK plants where suppliers have satellite works next to the assembly plant. This includes suppliers such as Bundy and Delphi, who manufacture parts in a short lead-time for delivery direct to the assembly line as part of a JIT system. Satellites still need to be supplied from a mother/central plant elsewhere, but loading efficiencies can be greater and deliveries can be less frequent to the site. This is generally only feasible for suppliers of components that require configuration in sequence with the actual vehicles produced or constitute a high proportion of the value of the car such as engines, transmission or seats. While a benefit to the environment, proximity of key suppliers to the plant is not essential in terms of effective JIT deliveries as long as good information visibility is given in time to meet delivery lead time requirements. This has been proven in other studies (Wafa et al 1996).

- **Use technology to reduce fuel usage, emissions and avoid congestion:** Technological solutions include the use of more fuel efficient trucks, fitted with the latest emission reduction equipment, such as particulate traps and de-NOx catalysts. Planning software and telematics can be used to avoid urban congestion hotspots and update drivers on problems and alternative routes in real-time.

- **Introduce standards to certify all logistics companies:** A significant problem for logistics is managing capacity. In most cases where capacity is exceeded, the logistics firm will use sub-contractors to take up excess material. Using subcontractors on a regular basis can increase the environmental impact because capacity utilisation, fuel efficiency and emissions standards may be lower on sub-contractor vehicles. Standards should be set by vehicle manufacturers to ensure reduced environmental impact from transportation. Contracts with logistics companies should contain clauses stipulating that all subcontract hauliers must meet the same standards as the main logistics companies. It is recommended that vehicle manufacturers should consider the use of only certified logistics companies for the collection and delivery of product, in the same way as component suppliers must be ISO9000 or QS9000 certified for quality and ISO14001 certified to maintain environmental standards.
2.7 Inbound Logistics for the 3DayCar

A detailed proposal for inbound logistics within the 3DayCar is encapsulated in the following:

- Components should be placed into various categories, for instance, A,B,C,D,E according to their value usage per annum
- These categories should be used to determine the frequency of collection from suppliers. i.e.
  - Category A: Hourly: real time sequence. This will largely involve the major components ideally supplied via a supplier hub. (Note. The engine, transmission, painted body, door modules, seats, cockpit, braking and ABS constitute 66% of the total value of componentry in a car.
  - Category B: Daily
  - Category C: Twice per week
  - Category D: Weekly
  - Category E: Two weekly

Ideally the frequency should be worked out to minimise the total cost of stock, transport, ordering, handling, and invoicing. Where the size of components implies more frequent delivery in terms of transport capacity, then components should be moved up to the appropriate category. Where components come from the farthest distances in the UK, then the efficacy of less frequent deliveries should be considered. Components from abroad will largely be defined by the available frequency of transport. (It should be noted that in comparing the price of components on a global basis, notice should be taken not only of comparative transport prices, but also relative stocking costs to cover frequency and variation of usage in the lead time concerned)

Information requirements

- The VM will issue a weekly plan for the next two weeks, updated weekly, and a weekly plan for the following four months, updated monthly, which gives all parties the anticipated volumes for each component for planning purposes
- Logistics companies and component suppliers must have the ability to respond to changes in volume requirements on a continuous and dynamic basis. The maximum frequency of change will be determined by the frequency of schedule generation at the assembly plant (per hour or per shift) and of component delivery. The key, however, is an online system that allows for information visibility to all parties. Component suppliers can interrogate the real time information systems to obtain the forward order requirement for their components and the actual stock in the pipeline from the supplier to the assembly track compared to the desired level. (See Production Planning at the Vehicle Manufacturer report to be issued shortly). This latter can also be determined by a “Kanban” information system from the end of the assembly track and knowledge of any changes to required stock levels. This knowledge will allow component suppliers to pro-actively adjust their production schedules to cater for batch sizes, etc.
- The VM will issue a delivery volume requirement 36 hours prior to production for all deliveries on a daily or more frequent basis to both the logistics company and suppliers. All other components on less frequent delivery should have at least two days notice of quantity for collection. Standard formats for information are required on
a multi-franchise basis, as currently inefficiencies are introduced by each VM demanding a specific format.

- Once the delivery volume is given, no changes should be made in the 36 hour time period, unless there are exceptional circumstances for which stock at the VM does not cater. For instance, this could be a major transport breakdown or quality problems with components at the VM. Resolution of such problems will be assisted by driver telematics and red light warnings from the information system (See Production Planning Report).

- Stock will have to be held in the system to cater for:
  - Component supplier batching and inefficiencies. The cost of these should be borne by the component suppliers.
  - Transport congestion and logistic company inefficiency. These could be borne by the logistics company, but recognised by the VM in price negotiations, or by the V/M if it is considered that the logistics companies should not be involved with stocking costs, which is currently the case.
  - Variation between the delivery volume requested and the actual usage by the manufacturer across the period between deliveries. This should be the responsibility of the VM. Whether these are held at the plant or in a cross dock warehouse.
  - Frequency of delivery. The cost of these stocks should be borne by the VM.
  - Standardised packaging and the elimination of cardboard are essential to allow efficient load building and recycling to suppliers.
  - An effective packaging tracking system is also required to ensure JIT packaging operations, so that suppliers always have the correct containers before the collection.

**Performance measurements**

- A measurement of transport efficiency should be introduced which best reflects the utilisation of capacity. This is defined as the number of miles per standard container ("m.p.c") carried in delivering parts from the supplier to the plant. This will be difficult for VM's who deal with a large variety of container sizes, since they will all have to be expressed as a proportion of the standard container. It will also involve different capacity utilisations at the various stages of delivery (collection/milk run/trunking/direct delivery/return trips). When these efficiency measures are quantified, the relationships between direct delivery and using a cross-dock consolidation point etc. can be calculated, taking into account the cost and availability of storage space at the different stages of the process.

- Depending on the total transport lead time allowed, the time required for load planning, and the time required to move components from the consolidation point to the plant, the time available for milk runs can be calculated. Dynamic routing packages should then be used to work out the optimum routes for each collection. Since for most VM's, the number of suppliers collected from will be of the order of 3-4 per milk round, alternative routings for collection will be restricted. The best combinations of routes can be evaluated quickly given the volume capacity required for each supplier collection. Where individual suppliers cause a significant increase in "m.p.c," then a decreased frequency of collection should be considered.

- The economies of a mixed capacity fleet can be determined using an evaluation of the effect on "m.p.c."

- Multi-franchise and cross industry collection can be used to improve capacity utilisation as long as the time frame for collection is not exceeded and "m.p.c" is at an
acceptable level. As shown in Figure 14 below, there is a considerable overlap of suppliers for different VMs, yet most collections are currently made individually. The figure shows the total number of suppliers across three VM’s broken down in percentages in relation to whether they are used by each VM alone, in combination with another VM, or by all three. The figures add up to 100% for all areas shown. To demonstrate the meaning of the percentages: 11% of all the suppliers for the three VM’s supply all three; 21% supply VM B and C, and 16% only supply VM C. Thus 50% of the total suppliers across all three VM’s supply at least 2 of the car producers.

![Figure 14: Potential Overlap of Supplier Collection Schemes (Source: Company A)](image)

- The opening times of the suppliers should be extended to allow the elimination of peaks across time in the overall process, especially at unloading points. Secure pick-up and drop locations at certain key suppliers could assist.

- A measurement of environmental efficiency should be calculated as fuel used per standard container delivered. This would allow for the assessment of mixes of different transport vehicle sizes. The process as defined above in combination with new truck engine technologies will be crucial to minimising the effect on the environment.

The concept of a Lead Logistics partner, which has already been used by several VMs would support the inbound logistics schemes, yet it is not seen as essential. This outsourcing of management functions seems part of a strategy to reduce the VM’s involvement in non-core areas, rather than to boost efficiency. However, it can assist in ensuring total transport capacity is fully utilised.

It is believed that transport will become increasingly critical over time because of increasing cost and/or journey time and variation. This will imply less distance between component suppliers and the assembly plant and better utilisation of transport capacity at the expense of additional stocks in the component supply chain. Since there is so much more value and space involved with 1st tier components, such transport effects will apply more at this level than at 2nd and 3rd tier component supplier level.
3 Outbound Logistics

3.1 Introduction

Outbound logistics is the process of transporting vehicles from the assembly plant to the dealership or even directly to the final customer. In the UK, as opposed to Continental Europe, this is overwhelmingly carried out by road rather than rail. This research has therefore concentrated on transportation by road, to investigate the feasibility of delivery in a time scale of 24 hours to meet the 3DayCar criteria.

Other than transportation through the Eurotunnel, rail hardly exists since it is not considered to be economic for distances less than 400 kilometres. Lack of infrastructure, vandalism and reliability have also played their part in the demise of rail. In order to have any chance of recovery, rail must realise that in virtually all cases road transport has to be used for final delivery to the dealers. It's pricing must therefore reflect the fact it is only one leg of the delivery chain.

![Figure 15: Standard Transportation Routes (UK average)](image)

The process by which vehicles are transported to the customer varies considerably, depending on the relative location of car plants, ports, distribution centres (DC's) and customers. The main volume routes are from the plant (or port of entry) into market compounds / distribution centres and then to the dealership or customer.

There is a difference between a market compound and a distribution centre. A compound is an intermediate stocking location where new loads are assembled for the dispersion routes and unsold stock held. This stock is used to replenish dealers as they sell their own stock. A distribution centre fulfils the same function as the compound but is used in addition to deliberately source new vehicles sales from the DC, with dealers being able to select from all unsold stock in the centre for their customers. This is usually accompanied by a large reduction in dealer stock.

Distribution Centres are called by several names such as Vehicle Storage Centres (VSC) or Regional Distribution Centres (RDC). There can be one or more DC operated per
country. Market compounds and distribution centres are often located near to ports of entry, railheads or factories.

Other vehicle movements include deliveries from the plant to the ports for export vehicles, and direct deliveries to local dealerships or to locations such as rental fleets. There are also deliveries direct to customer's houses from compounds. Unsold stock at the dealerships can be taken back to distribution centres after an elapsed period of time, in order to increase the chance of finding a customer for the vehicle. In addition, there is still a considerable number of vehicles being transferred between dealerships, at an average cost of ca. £120 / vehicle. In fact, a strong driver for the introduction of distribution centres in the UK during the late 1980s and early 1990's was that 45% of sales were dealer transfers.

However, even the current system using distribution centres is not free of transfers. Vehicles are transported between regional distribution centres on a continuous basis because of:

- Lack of availability in the local DC for the enquiring dealer
- Information that vehicles have been re-allocated to a customer during the production process reaching the logistics company too late; hence the vehicle is initially shipped to the wrong DC. Our research shows that in certain cases up to 20% of vehicles have to be transferred between DCs, which represents another potential for cost reduction of build-to-order.

Market Shares

The European Community vehicle transportation market accounts for c.12m sales within the market and 1 million vehicles exported per annum. The market is very diversified, consisting of many small players, none of whom account for more than 10%, as the following estimate of market share shows. As a direct consequence, logistics companies are forced to collaborate formally or informally in order to achieve backload efficiencies.

![European Vehicle Transportation Market Shares Chart](Image)

**Figure 16: European Vehicle Transportation Market Share Estimates, 1999**

(Source: Walon Autologic)
Please note that on 27 March, 2001, Autologic Holdings acquired Axial from Tibbett and Britten and also took a 40% share in Albateam, which has acquired CAT, the transport and logistics business of Renault.

3.2 Vehicle Distribution - General Issues

During the interviews, the following general issues for outbound logistics operations have been established:

- **Information visibility & load building.** Information reliability is the most often stated problem. The lack or inaccuracy of forward information provided by the vehicle manufacturer is criticised and blamed for the inability to conduct accurate forward planning. This lack is often quoted as the root cause for taking on average 1-2 days to build loads!

  Within this time period, the vehicle routing and scheduling takes least time. It is the time required for sufficient vehicles to become available to enable an efficient transporter load and then the organisation of a backload that is the key to reducing the delivery time in a cost efficient way. This is particularly so since backloading is generally based on telephone calls to other logistics service providers, who cooperate at a personal, informal level.

- **Backload efficiency.** Backloading is the process of obtaining vehicles to utilise a transporter after delivering its initial load, to ensure it does not return empty. It is an essential need for the logistics company to maintain the cost efficiencies demanded by VMs. Backloading can be built into the pricing at as high a level as 60% capacity utilisation. Payment is only by the volume of vehicle movement not by distance to deliver, hence there is intense pressure on logistics companies to achieve both capacity utilisation and short delivery times, otherwise the business is not profitable. However, there is no formal process recognised by vehicle manufacturers in order to achieve maximum backloading. Backloading is key to profitability, yet is based on unofficial agreement between companies, and is often not feasible if delivery times are to be achieved.

- **Dealer opening times** are seen as a constraint because they restrict delivery to the day time. Night deliveries are not only more time efficient, but would also reduce general congestion during the day.

- **Damage** is recognised as an area of continuous dispute between the vehicle manufacturers, dealers and logistics companies as to who is responsible for any damage. The difficulty in determining who caused the damage in the first place arises for two reasons. Firstly because checks often have to be conducted under difficult weather conditions and, secondly, different standards are applied at the vehicle manufacturer, the logistics company and associated contractors, and the dealer, as to what is acceptable. Nevertheless there have already been some schemes introduced whereby all partners in the system pay equal amounts into a shared fund that pays for repair work. On average this amounts to £2-3 per vehicle, which is found to be the average damage cost per vehicle shipped in the survey for this research.

- Current additional services include PDI, late configuration of parts and accessories, managing rental fleets, refurbishment of used cars, etc. and there is a clear intent to expand business into more services. These are the profit making areas for the logistics companies, not the core business of transportation.

- **Direct delivery** to customer homes/businesses is expanding, including the preparation of cars for customer delivery. So far, however, this service seems to be
limited to direct selling Internet companies and the preparation and delivery to large fleet customers.

3.3 The Generic Process

Figure 17 demonstrates a generic process map for an outbound logistics operation. Whilst the detail on how the requirements for transportation is generated and communicated between manufacturer and logistics company varies, the overall process is similar at all operations. In the same way, the IT systems used to plan the routeing vary between companies. Some companies have no formal system at all, others using software packages such as Paragon. No formal process for backloading exists for any operation studied.

The information flow generally originates from the NSC or a central system within the vehicle manufacturer, passes to the logistics company’s headquarters and is then sent to the actual site or local operation. There, based on the requirements received, loads will be built and trucks allocated. In some cases, the logistics company sends a request to the vehicle manufacturer to physically build the load, and then sends the truck to pick up the load. Once picked up, the vehicles are delivered to the dealerships, with delivery notes signed by the dealer staff. Additionally, the vehicle tracking system is continuously updated with regard to the loads and the individual vehicle status, including ‘estimated time of arrival (ETA)’ and possibly ‘estimated time of collection’ (ETC).

Figure 17: Generic Current Process Map – Outbound Logistics
3.4 Survey Results

3.4.1 Introduction

This section summarises the main results of the questionnaire survey of third-party logistics service providers in the new vehicle distribution sector. The study covers c.25% of the European total market volume in terms of players, but focuses mainly on UK vehicle movements from the factory to the dealership.

The sample covers 8 major logistics service providers, covering 1,537 trucks and 3.1m annual vehicle movements in 1999 for a total of 14 vehicle manufacturers. The survey was conducted in 2000, alongside the process mapping and site visits.

The objective of the survey was to understand current practices and identify the root causes for operational constraint leading to time delays, in order to define the key changes to outbound logistics required in a future build-to-order environment.

This section follows the layout of the original questionnaire and discusses fleet profiles, volumes, lead-times, efficiencies, damage, information and forecast reliability, operational constraints and additional services.

3.4.2 Transporter Fleet – Capacity Profiles

The vast majority of the 1,537 vehicle transporter fleets are high-volume transporters of 10 -12 cars capacity. A typical 11-car transporter is shown in Figure 18.

![Figure 18: 11-car Transporter](image)

The actual capacity profile shown in Figure 19 demonstrates the heavy reliance on large transporters. This is a consequence of past cost efficiency pressures on new vehicle transportation before delivery lead times started being reduced. The more cars there are on a transporter, the more economic the overall movement per vehicle. This inherently introduces time inflexibility into the scheduling, as the objective is for trucks to be full. The larger the transporter, the longer any potential waiting time for a load to be filled efficiently in terms of total distance travelled. With short delivery lead times, flexibility and delivery to individual customers becoming more important, many companies are now looking to adopt a more balanced fleet in terms of increasing the proportion of smaller sized transporters.
Direct Deliveries

So far, direct delivery to the customer is only carried out by a few operators, either for large fleets or for special operations such as independent Internet-based auto companies. For large fleets, direct deliveries can generally be operated on larger transporters due to the volume. For the internet-based companies, however, with mainly direct deliveries to individual (private) customers, smaller transporters are required because of delivering to residential streets and small volumes of customers in a given area. Currently, direct deliveries are operated by 1 to 3 car transporters; either simple trucks with an optional trailer, or two-deck transporters for up to 3 cars.

The investment in new small transporters in order to diversify the capacity profile of the fleet is generally perceived as essential to meet the requirements of more direct deliveries.

It is claimed that this involves an increase in operational expense, since drivers need additional training to interface with the customer. This can include vehicle checking and even conflict management. However, there is no general agreement as to what extent the utilisation of smaller trucks influences the operational costs.

Vehicle manufacturers are now considering direct deliveries to customers on a larger scale, yet so far only limited trials are underway, because of the significant political impact on the dealer network.
3.4.3 **Volumes**

Volumes by manufacturer considered in this study are shown below in percentage terms. The study is distorted in comparison with UK market shares, yet shows a broad coverage of the main VMs.

![Volume Split per OEM -](image)

**Figure 20: Volume Split of Survey**

Volume transported via rail accounts for only 3% in this study, as only one company operates its own rail cars.

3.4.4 **Lead-times**

The total lead-time involved in moving a vehicle from the factory to the dealer is considered in the following separate stages.

- **Lead times from factory to compound**

  The transportation lead-time from the factory into the compounds varies between 5 minutes and 12 hours in this study, due the geographical spread between the locations of 0.5 miles to 225 miles. These routes are generally high-volume routes.

  The lead-time involved was benchmarked as part of the order fulfilment process analysis. On average, 0.9 days are required to assemble a load. Adding the actual loading and

---

driving times, the total lead-time from factory to compound ranges between 23 and 35.5 hours. The data sample is not sufficient to give conclusive evidence here, hence a linear average of 30 hours total lead-time between factory and compound is assumed.

**Lead times from compound /distribution centre to dealer**

The spread of contracted delivery lead times from the compound to the dealership ranges from 1 to 5 days. In one case, the manufacturer guarantees vehicle delivery from the DC in 24 hours if the order is placed by the dealer the day before. The major element of this time is not the actual delivery to dealers but the load planning requirement for sufficient vehicle capacity. No general pattern emerged to explain the spread shown in Figure 20. The most common assumption is that this spread relates to the differential additional cost related to reducing delivery time. (Note: The other factors involved are the volume for each NSC and the pressure from the VM to reduce total order delivery time).

The actual delivery lead-times are on average well below the contracted lead time as shown in Figure 21, with the overall average lead-time from the compound to the dealer being just under 2 days.

<table>
<thead>
<tr>
<th>Lead Times</th>
<th>Actual</th>
<th>Contracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound to Dealer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1.96 days</td>
<td>2.31 days</td>
</tr>
<tr>
<td>Min - max average</td>
<td>1 – 3.9 days</td>
<td>1 – 5 days</td>
</tr>
</tbody>
</table>

*Figure 21: Actual v Contracted Lead-times*

The spread of average actual delivery times does not exceed 3.9 days as detailed in Figure 22.
The average percentage delivered outside contracted delivery lead-time is 3.2%, with a minimum of 0% and a maximum of 19% based on individual customer data shown in Figure 23. (It should be noted that the data set contract numbers do not correspond to those in Figure 22). Major reasons for these falldowns are lack of transporter capacity at sales peaks, failure to assemble a complete load in time, or a delay in order to achieve efficient backloading.

However, the reasons for high percentages outside the contracted delivery lead-time are only partially related to the logistics company. In some cases the vehicle manufacturer interferes with the process and re-prioritises the deliveries, causing vehicles which have already been scheduled for delivery to be delayed. Reasons for such interference range from unscheduled deliveries to meet shipping dates for export cars through to lack of space for stock requiring urgent additional transportation previously not scheduled.

The five data sets showing >5% of vehicles delivered late relate to different customers (both high and low volume) and to three different logistics companies. Hence no general pattern can be established in relation to ‘a particular bad customer’ or a correlation with overall shipping volumes.

It is not known what the average delay is on these late deliveries.

![Figure 23: Percentage of Vehicles outside Contracted Lead-time](image)

**Average days delivered to dealer and dealer drops**

On average, vehicles are delivered to dealerships for 5.5 days per week, with three companies delivering vehicles on Monday to Friday only, and one company delivering 7 days per week. An average of 3.1 dealers are delivered to on each delivery journey (1 - 5 average max / min, $\sigma^2=0.57$).

All respondents align their company holidays to those of the vehicle manufacturers, and therefore do not cause an operational constraint.
Lead-time to load / unload a transporter

The actual loading time of a transporter is around 45 minutes, based on 11 cars. The unloading time is equivalent but depends on the number of dealers visited per load. A relatively consistent picture can be seen here, including the times needed for inspection.

In this respect it does not seem that the actual loading and unloading is a major constraint for the 3DayCar. However, the data-sets include waiting time and inspection besides actual loading in the total loading time. These show that longer than average total lead times also show waiting times of up to 40 minutes at both compound and dealer, with all data-sets showing 5 minutes or more total waiting time. For instance, the data shows total loading time varies between 70 and 180 minutes, with an average of 113 minutes, showing that over 50% of total time is spent in waiting and inspection. Waiting time is an area of waste that needs improving.

Load Efficiencies

Table 2 shows the average load efficiencies achieved for the three main phases of transporter movement; namely factory to compound, compound to dealer, and backloading efficiencies on the return leg from the dispersion run.

<table>
<thead>
<tr>
<th></th>
<th>Average (weighted)</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory to compound</td>
<td>98.9%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>Compound to dealer</td>
<td>94.8%</td>
<td>66%</td>
<td>100%</td>
</tr>
<tr>
<td>Backload efficiency</td>
<td>54.0%</td>
<td>1%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Figure 24: Load Efficiencies

As can be seen, the efficiencies achieved on the primary stages are close to 100%, even for the compound to dealer stage. Given that backloading is achieved on an informal basis within the defined delivery lead time, it is surprising that a level of 54% efficiency is achieved. However, this figure shows the difficulties of achieving efficient backloading, considering that levels of 60% are entered into the pricing calculations and the extensive pressure under which the logistics companies have to operate.

Multi-franchise transport of vehicles from the compounds to dealers is only used at 3 of the 8 companies, and even then this is only for certain vehicle manufacturer customers for delivery in areas such as Scotland.
### 3.4.5 Transit Damage

Transit damage occurs to the car body in the vast majority of cases, with occasional instances of ‘dirty’ internal trim. Any scratch, dent or blemish, however small, is included as transit damage unless it can be proven to have left the factory in an imperfect condition.

![% of Cars damaged on Transit](chart)

**Figure 25: Damage during Transit**

Damage levels range from 0.4% to 2.0%, as shown in Figure 26, averaging 1.46%. Although fairly low, delays caused by vehicle damage are not acceptable in a 3DayCar environment.

The average repair cost is around £180 per car damaged (averages ranging from £110 to £250), equating to £2.63 per vehicle transported. It is much less a problem in terms of finance than as a potential failure to deliver 1.5% of the vehicles late to the customer.

![Causes for Vehicle Damage during Transportation](chart)

**Figure 26: Causes for Transit Damage**
The main causes of damage (see Figure 26) are physical damage during loading / unloading (66%), and damage during transportation such as that caused by low hanging trees. A low percentage of damage is caused by weather or bird excrement. Miscellaneous causes such as storage related damage occur very rarely.

There is, however, considerable confusion in the supply chain as to whether damage is caused in transit or is actually the condition of the vehicle on leaving the factory. The general issues related to this problem which were frequently mentioned in interviews are:

- Difficulty in translating a common quality standard in practice, because of the complex nature of painted body quality.
- Different quality ‘standards’ or perceptions of what is acceptable, generally depending on which company is checking the vehicle. For instance, the logistics company may perceive the vehicle quality of the factory to be sufficient and therefore accepts vehicles from the manufacturer which are rejected later in the distribution chain. On the other hand the logistics company may be persuaded by the manufacturer that the quality is OK and the vehicle rejected later in the process. Likewise, the dealer may perceive the quality of the vehicles delivered as insufficient and the fault of the logistics company. As a result, there has been a bureaucracy of inspection built up at each stage of in-transit. Vehicles being shipped through ports can be inspected on up to 8 occasions between factory and market compound, even if they pass straight through the process.
- Inspection results depend on circumstances, i.e. darkness, rain, etc.

3.5 Defining Information Quality

It is frequently stated that information received is ‘very poor’. To quantify this statement, there are four basic features of ‘information’ that need to be considered:

- The types of information available: i.e. forecasts or firm schedules. The most relevant aspect is at which point in time the information changes from a ‘forecast’ to a ‘firm or binding’ statement of requirement.
- The frequency of reception or submission. Is the information submitted, daily, weekly, or monthly? Also, the horizon covered is of interest. For instance, a monthly forecast could cover the next 3 or 4 months.
- The stability of this information. How much variability or seasonality is experienced from one period to the next? The more variability that is experienced, the more important the forward planning information becomes in order to accommodate these fluctuations.
- The consistency between the different types of information. This refers to the accuracy of the forecast: How much does the actual requirement deviate from the forecast requirement?

These different aspects need to be considered when discussing the quality of information submitted by the vehicle manufacturers to the logistics companies, each of which will be addressed in separate sections.

It is important to realise that with the advent of distribution centres, the demand for movement by logistics companies is not wholly generated by the VM. The trunking from factories/ports to distribution centres is defined by the VM production schedule but the movement from distribution centre to dealer is a combination of customer orders delivered into the centre from production and the demand of dealers from vehicle stock at the distribution centre. Since only 33% of vehicles are typically built for customers at the
factory, a more sophisticated form of forecasting is therefore necessary. However, with a 3DayCar, basically 100% of customers will have their orders built at the factory and therefore logistics companies vehicle movements will be totally defined by vehicles coming from the factory.

### 3.5.1 Type and frequency of Information received from the Vehicle Manufacturers

![Information Received from OEMs](image)

Figure 27 shows the types of information provided by the vehicle manufacturers, divided into forecast and firm order categories. In some cases VMs give forecasts or even firm information on more than one frequency (i.e. monthly and weekly). Monthly forward planning information is the most common frequency for forecast information, with 31% of logistics operations receiving weekly data; a daily forecast information is only given in 19% of cases. This means that at least 50% of logistics company contracts do not give planning information on more than a monthly frequency. In terms of firm order information, only 15% of contracts give any information at all before the actual shipping notification attached to the 'physical' vehicle arrives with the logistics company. Of this, 6% is given on a monthly basis, which must be highly questionable. This indicates both the difficulties in VMs of achieving a reliable production schedule and their lack of appreciation of logistics company requirements.

**Data Detail**

This information then splits up into the following detail levels:

- ‘Total volume’ information is received by all companies, generally on a monthly basis, but on a few occasions on a weekly basis.
- Volume split per market is received by all but one respondent, generally on a monthly or a weekly basis.
The reception of volume data ‘per model & body style’ and ‘volume per region’ varies across companies. One out of three companies do not receive any forward information at all, the remainder receive it on either a monthly, weekly or daily basis.

Overall the findings show that the forward planning information given by the vehicle manufacturers is insufficient to allow for detailed forward planning by the logistics company. Whilst monthly volume information is given, this can only serve as a capacity guideline, especially as the forecast itself tends to be inaccurate. This picture is reinforced by the fact that lack of information was also classified as second strongest operational constraint by the respondents (see 3.4.11).

3.5.2 Data Stability

Figure 28 demonstrates the variation in planned and actual throughout the year, caused by the two seasonal sales peaks in March and September. It shows two examples of forecast volumes versus actual volumes for two UK assembly plants.

3.5.3 Data Consistency: Forecast to Actual Volumes

Forecast variability analyses the consistency of the information by comparing different types of data relating to the same time intervals, e.g. compares the forecast given in January for March with the actual volumes in March. The actual volumes shipped tend to be smaller than forecast at these peaks, which could be either due to capacity constraints or forecast errors. In general, forecast volumes are always higher than actual, in line with the general industry tendency to be optimistic and "macho" in sales expectations.

![Forecast v Actual Volumes](image)

**Figure 28: Forecast versus Actual Shipping Volumes**

Due to the limited sample it is not feasible to compare multiple data-sets for the same customer in all cases. Nevertheless, within the 11 vehicle manufacturers analysed, a surprising picture emerges as shown in Figure 29. Here the range of forecast error for individual UK zones is shown in terms of the minimum and maximum error ranges for the logistics companies operating for each manufacturer. One would expect that the highest percentile error in the forecast would relate to the smallest volumes, yet there is no volume related correlation. This is a similar finding to an earlier one in relation to the lead-
times. In the same way, no pattern can be found in relation to the cultural background of the manufacturer in terms of being European, American, or Japanese.

The reason for this great variability in almost half of the cases was identified in the earlier Systems research. Due to the unpredictability of the scheduling process, the actual volume per zone cannot be predicted further ahead than the actual build schedules. The unknown split by region is also mentioned as one of the main operational constraints, see section 3.3.10. Yet even in cases where the forecast is accurate, the throughput unreliability of the assembly plants, which varies from 50 to 70% efficiency in terms of individual orders produced on the correct day, results in unpredictable delays before vehicles can be ‘gate-released’.

Figure 30 further elaborates on this issue by showing the regional fluctuations for seven delivery zones in relation to the original forecast in total number of vehicles. Variations are shown in terms of units +/- to the forecast for each month and zone. Whilst there seems to be a general trend across the zones of over or under achievement in a specific month, in some cases there is significant exchange of volume between the zones.
In conclusion, these fluctuations make any forward planning of vehicle scheduling and load building almost impossible, particularly since much of the current demand for vehicle movement from the distribution centre is defined by dealers and that backloading also has to be organised. This is one of the main reasons why the actual delivery lead-times within the UK average over 3 days, whilst delivery itself hardly exceeds 10 hours.
3.5.4 Operational Constraints

In this perceptual question, logistics companies were asked to rank factors in relation to the extent to which they pose constraints on their operations. The top four constraints were all related to forward information.

- The highest-ranking constraint was perceived to be the fluctuation in overall volume (including general seasonality). This matches the findings of the actual fluctuations found in the volumes, as shown in the previous section.
- The second highest ranked constraint was the lack of information provided by the vehicle manufacturers, which was discussed in section 3.4.8.
- Difference in size of cars was mentioned as the third major constraint, as it has an impact on the load building ability. This however has to be seen in conjunction with the information quality provided.
- The fourth major constraint mentioned was the fluctuation in regional volumes.

Further constraints mentioned were the dealer opening times (which were also frequently mentioned in the interviews) and the manning at the DC was described as insufficient at peak periods.

![Operational Constraints Chart](image)

**Figure 31: Operational Constraints**

3.5.5 Additional Services Provided

Across the eight respondents, not all perform additional services to vehicles. Those that do in the main provide services such as vehicle preparation (including de-waxing, window edging and pre-delivery Inspections (PDI)) and configuration of vehicles (including fitting of alarms, CD changers, and body kits). In one case this is only performed for rental car companies. In a second case, the logistics company takes over all the preparation work of the vehicle (PDI, etc.), and delivers vehicles 'customer-ready' to the retail outlets. Other services include refurbishment of used cars and fleet management. It is interesting to note
that in general logistics companies make their profit from these additional services, not from their core business of transporting vehicles.

### 3.6 Environmental Impacts

With a one day delivery as required by a 3DayCar, without considering any changes to current situation using 11-car transporters, the impacts would be as follows

- **Fuel use:** The fuel used to deliver cars to their final destination in 1 day will increase compared to the current 3 day direct delivery from a UK plant as shown in Figure 32. The fuel use per car for delivery increases by 23% on average depending on the delivery zones investigated in this study.

![Figure 32: The increase in fuel use per car delivered due to 1-day delivery](image)

- **Distance travelled:** It is also important to consider the kilometres driven by transporters and how this is increased in a 1-day delivery scenario. This directly impacts on the potential for increased congestion and increases by 20% on average.

![Figure 33: Transporter kilometres driven per car increase due to 24hr delivery](image)

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4 The geographic zones used in this study are 1: North Scotland, 2: South Scotland, 3: Yorkshire, 4: North East and 5: East Midlands.
In this case the distance travelled by road can increase by up to a third in some areas.

- **Global warming potential:** The use of fuel has a direct impact on the amount of global warming gases. The total increase in CO₂ produced if all cars manufactured in the UK were delivered in one day is 12% as shown in the Figure 34 below.

![Figure 34: The total amount of CO2 increase by car transporters with 24 hour delivery](image)

- **Local air quality impacts:** This impact can be divided into 2 components: congestion and fuel use emissions. Figure 35 shows the estimated increase in urban/inter-urban kilometres driven by car carriers within a 1 day delivery scenario. It is the communities surrounding the urban/inter-urban roads which are most at risk from transport air pollution.

![Figure 35: Urban kilometre increase with 1-day delivery](image)

The impact of HGV fuel usage in urban/inter-urban areas results predominantly in health impacts from emissions, but also impacts on global warming, ecology and noise. Based
on a model which calculates the cost of combined environmental impacts from HGVs, it is possible to estimate the external environmental cost of 1-day delivery, as shown in Figure 36.

![Figure 36: Total environmental costs for 1-day delivery - (NERA 2000)](image)

Taking an average across the 5 regions, the incremental external environmental cost per year for the total UK can be estimated if a 1-day delivery system were to be adopted throughout the industry. The human health aspects contribute to an extra £1 external cost per car, with noise, global warming and ecology impacts raising this to a total of £2 per car. This brings the total external environmental cost of a 1-day delivery to £11 per car, or £22 million per annum for the UK. This extra burden would be met by future UK tax revenue on fuel, road taxes and various charges on road use.

It must be stated here that this may be an underestimate as the cost impacts on increased congestion have not been included in this cost assessment.

### 3.7 Summary of Current Situation

The average lead-time on the outbound side of 3-3.5 days (Factory to compound, and compound to dealer) exceeds the available distribution lead-time of 1 day in a 3DayCar scenario, although some 24-hour deliveries from the DC to the dealers are already in place. Once vehicles are received by the logistics company, further time is required to consolidate the loads and then arrange the backloading, which is vital to the economics of vehicle transportation and is built into the outbound pricing structure. A large part of this delay occurs because the information provided does not permit forward planning, to the extent that the backload can only be arranged once the dispersion load is fixed. A connection between the lack of reliable planning information, the need for efficient backloading, and the overall lead-time has been established.

The main inhibitor to both efficiency and responsiveness is the lack and quality of information from the vehicle manufacturer, which has emerged as a core theme throughout this survey. Whilst weekly or monthly planning information is generally given, this information shows a significant degree of variability in terms of accuracy. Detailed forward planning is thus rendered almost impossible, particularly as daily information is severely limited. Logistics companies identify both the overall lack of provision of information as well as the fluctuation of volumes as main operational constraints.
Other perceived operational constraints are the difference in size of cars and the dealer opening times. Transit damage is not financially significant, but could prove to be a major source of delay in a 3DayCar system.

Current outbound logistics is still organised in a way that reflects the ‘mass production’ car industry, geared at high load efficiency and equal treatment of all orders. This reflects not only in the current transporter fleet profile, but also in the concept of a contracted delivery lead time for all cars irrespective of their priority or when the customer expects the vehicle. This is unsuitable for a build-to-order system.

In the same respect, transporter fleets are driven by operational efficiency. The majority of transporters are of a 9-12 car capacity. In a flexible and responsive delivery system with a build-to-order system, delivery lead times and the ability to respond will be far more important than currently.

The analysis of increase in vehicle kilometres has shown that the fuel use and kilometres driven by car transporters will rise significantly if no mitigating measures are taken. The impact will be greatest in urban areas where the increase in distance travelled will occur and the impact on human health through noise and emissions is greatest. The quantification of this impact will depend on the exact location of each vehicle drop point.
4 24-hour Vehicle Distribution

4.1 How to achieve a 24hr Delivery within the UK?

The objective for a 3DayCar is to deliver all vehicles that are built to order:

- Within 24 hours of being passed to the Logistics Company at the factory of production
- At the same cost as the current situation
- Without significant environmental impact

There are a number of changes which can be made to the current situation to enable more efficient distribution and make a 1 day delivery feasible. These are as follows:

- Multi-franchise delivery
- Back loading of transporters after delivery to the dealer
- Mix of smaller transporter fleets
- Planned logistics
- 24-hour delivery
- Differential delivery dates
- Measurement of efficiency improvements

**Multi-Franchise Delivery:** In order for multi-franchising to work efficiently, some or all of the following actions are necessary:

- Rationalisation of the number of ports for vehicle movements entering and exiting the UK in order to enable greater multi-franchise distribution. Care must, however, be taken to avoid over-congestion of shipping and road transport at ports.
- Agreements between franchises to allow joint storage of vehicles at storage compounds/distribution centres whether located at factories, ports, or regionally
- The formal allowance by VMs for logistics companies to move vehicles of all other franchises (other than any stated exceptions) on the same transporter load
- The introduction of a trading exchange (on the Internet) to enable Logistics companies to effectively maximise capacity utilisation at minimum cost.

Multi-franchise delivery will allow much more effective capacity utilisation and reduced distance travelled per transporter delivery to dealers, due to dealers being closer together when considered on a multi-franchise basis. However, in the interests of time and cost efficiency, there could still be significant single franchise direct delivery to dealers in areas ‘close’ to factories.

**Back loading:** Back loading also requires full co-operation between manufacturers and logistics companies. Utilisation of back load capacity is running at around 54%, thanks to co-operation between logistics companies, but this does not include empty transportation between a final delivery point and the next pick-up point. While back loading is limited in respect to the location of UK factories and points of entry, co-operation between manufacturers on factory, port site and regional compounds can enable increased two-way bulk transportation between compounds. In addition, the increasing movement of used cars and the future legal requirements on manufacturers in relation to recycling, will offer vehicle transportation back load opportunities to logistics companies.
Effective implementation of multi-franchise delivery and back loading will have a positive effect on the environment through significant reduction in distance travelled in total vehicle distribution in the UK. This is a positive public relations opportunity for vehicle manufacturers.

- **Mix of smaller transporter fleets**: A mix of transporter sizes in a fleet enables shorter overall delivery lead times and better use of capacity if operated efficiently. While large transporters are innately more cost effective and travel less kilometres in delivering to dealers, the shorter the contracted delivery time, the less efficient is their capacity utilisation. It is easier to use the full capacity of smaller transporters.

- **Planned Logistics**: If detailed information of vehicles to be produced and their destination is made available two days ahead of release from the factory, logistics companies could plan transporter loads more effectively with the aid of sophisticated routeing computer packages (Note. Forward information on shipping arrivals could also be improved). However, this information can only be truly effective if VM's become much more reliable in producing and passing vehicles to logistics companies in line with their planned production schedules. While the 3DayCar does not leave much room for manoeuvring orders, there is still an opportunity to schedule vehicles in assembly to match distribution loading requirements.

- **24-Hour Delivery to Dealers**: Delivery of vehicles to dealers currently takes place during dealer opening hours, conditioned by any local restrictions on delivery accessibility. Moving to 24-hour delivery would reduce average delivery lead times and congestion during the daytime. However, under the current situation a dealer representative has to be present at the unloading of vehicles from transporters in order to check for transit damage and this generally restricts delivery to dealer opening hours.

In order to remove the barriers to 24 hour delivery, the following proposals are made:

- Insurance should only cover major damage, and notification of this to logistics companies should be accepted up to 24 hours after delivery. The incidence of this is absolutely minimal and, from experience, readily accepted by the perpetrator.
- Minor damage should not be insured, but an allowance included with warranty/PDI. This cost should be apportioned between the logistics company and the manufacturer Service department on the basis of periodic sampling of vehicles to determine the breakdown between ' quality out of the factory' and transit damage.
- Secure delivery compounds should be initiated at dealers, using the same concept as for overnight parts delivery.

While local conditions may not allow all dealers to be delivered to at night, it is considered that these proposals are feasible in the majority of cases and while an element of trust is necessary until the process is accepted, it can give significant benefits to all.

- **Differential Delivery Times**: One single delivery date should be used by all players in the supply chain, it being that agreed with the customer at the point of order. However, differential delivery periods can be introduced, i.e. one day for a 3DayCar customer and 3 days for dealer demonstrators. This will enable logistics companies to increase the efficiency of transporter capacity utilisation and route planning.

- **Measurements of efficiency improvement**: It is suggested that in order to measure the success or otherwise of outbound logistics operations the following three measurements are utilised, in line with those proposed for inbound logistics:
• **Capacity utilisation:** Miles per car carried. This is effectively the total mileage covered by a transporter divided by the total number of cars carried on a journey, whether on the initial leg or on backloading. The less miles covered per car delivered, the better the utilisation.

• **Environmental fuel effect:** Fuel used per car carried. This could be expanded to differentiate between different types of fuel or engine according to their environmental effect. This measurement will also reflect the effect of changes in the mix of capacities of the transporter fleet.

• **Congestion effect:** Average miles per hour travelled across the transporter fleet while on road. This will obviously be affected by the number of dealers visited per load, but will give a guide as to the effect of congestion and 24 hour delivery.

Measurements should be made over the total fleet on a weekly or monthly basis. Any change of contracts would entail an adjustment to ensure ongoing comparisons on an "apple with apple" basis. The alternative would be to measure each contract separately. In addition, seasonality affects may have to be taken into account as overall volume moved will change across the year.

• **Investment in the Future:** In order for the above changes to occur, Logistics Companies should be encouraged to invest in the future, including the environment, by operating "open book" contract negotiations. These would include consideration of logistics companies investment in fleet, systems, and the environment as well as just the price offer for movement of vehicles and possibly service level.

4.2 Future State Proposal

This section briefly outlines the future state process for the outbound logistics operation necessary for a 3DayCar as shown in Figure 37.

The main features are:

• Dynamic planning, whereby the logistics company would be integrated into the VM systems and have full visibility of the production slots. Load (and backload) planning can hence start as soon as the order slots are booked. On average it is assumed this happens 2-3 days before the actual transportation.

• An online freight exchange, which facilitates effective search for backloads and multi-franchise transportation. The format for this exchange is likely to be based on online auctioning of the particular loads.

• A transponder tracking system, whereby a passive transponder attached to the vehicle enables automatic notification when the vehicle leaves factory, compound or is unloaded at the dealer. This tracking system also enables customers and dealers to monitor the progress of their order on the web.

• Secure dropping locations at dealerships in urban areas, as well as out-of-town dropping points for congested areas to avoid inefficiencies in the overall transportation.

• Multi-franchise storage compounds at ports and for remote areas, which would be used by several franchises to consolidate their loads and achieve short delivery lead-times and economic transportation.
4.3 Figure 37: Outbound Logistics - Future State Map Cost Implications of a 24hr Delivery

Currently the average vehicle costs £60 to deliver in the UK, plus £20 per car being distributed via a distribution centre or £3.50 per week in storage from the point in any contract where a storage charge comes into play.

If the delivery time were reduced from the current 3-4 days to 1 day without any changes to current practices, then the transportation cost would increase by 33% or £20 per car given the following assumptions:

- 2.0 million UK sales per annum
- +0.5 million road-trunked exports
- Movement by 11 car transporters
- Re-active scheduling of transporters without knowledge of vehicle availability until passed to logistics companies.
- The same volume fluctuation across time as currently
- A reduction in back loading efficiency due to the time pressure of a 1-day delivery time.

While this increase only represents 0.2% of the total vehicle price, for the total industry it means an increase in annual cost of £50 million, from 150 to £200 million, according to analysis carried out by the research team using a sponsor model.
Potential Reductions in Cost

Delivery

The potential cost savings of the various feasible changes has been investigated and the analysis of one combination is shown here to demonstrate that a 1 day delivery lead time can be achieved with no increase in cost.

<table>
<thead>
<tr>
<th>Changes implemented</th>
<th>£ per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-operation between manufacturers and logistics companies</td>
<td>8*</td>
</tr>
<tr>
<td>Consolidation on 4-5 UK ports</td>
<td></td>
</tr>
<tr>
<td>Multi-franchise operation</td>
<td></td>
</tr>
<tr>
<td>Optimum backloading</td>
<td></td>
</tr>
<tr>
<td>Mix of transporter size</td>
<td>9</td>
</tr>
<tr>
<td>Planned logistics</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
</tr>
<tr>
<td>Excess 3DayCar Cost</td>
<td><strong>20</strong></td>
</tr>
<tr>
<td>Overall savings</td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>

*Further study is being carried out since it is believed that savings are actually greater than excess 3DayCar costs overall saving.

In addition to the £1 transportation cost saving, the operation of Distribution Centres will no longer be necessary in a 'stockless' system. These cost £20 per vehicle, making a positive potential overall saving of £21 per vehicle possible with a 3DayCar scenario.

Further work will be carried out to determine the effects of 24-hour delivery and the best combination of multi-franchise direct delivery and regional compounds.

- **Stock**

While this paper is only concerned with the cost of delivery, it is worth pointing out that ICDP has calculated the cost of stock is £170 per vehicle, including interest, space, security, maintenance and management costs.

It is also interesting to note that on average 200 cars are stored per acre. Given 2.2m new vehicles sales per year, 2 months stock level in the UK represents an average of 370,000 cars being held at any one time in UK compounds and at dealers. Considering an average space utilisation of these storage compounds of 70%, the total space covered with cars is close to an average of 2650 acres, 4.5 square miles, or 10.6 km². At peak periods of the year this is likely to increase by a further 50%.
4.4 Environmental mitigation of a one day delivery

The following points will help achieve a 1 day delivery with lower environmental impacts.

- **Mix of transporter types:** As shown in Figure 39, the fuel efficiency of transport improves with smaller carriers.

<table>
<thead>
<tr>
<th>Transporter type - car carrying capacity</th>
<th>Average consumption / mpg - in use consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 car</td>
<td>6.9</td>
</tr>
<tr>
<td>11 car</td>
<td>6.9</td>
</tr>
<tr>
<td>9 car</td>
<td>7.2</td>
</tr>
<tr>
<td>7 car</td>
<td>7.6</td>
</tr>
<tr>
<td>3 car</td>
<td>10</td>
</tr>
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</table>

*Figure 39: Average in use fuel consumption of transporter types*

As Figure 40 shows, the per car use of fuel increases with smaller carriers and this is especially marked over long distances (see regions 1 & 2).

*Figure 40: Amount of fuel in litres used by different transporter sizes by zone*

For these zones, the alternative of trunking to a regional compound with 11-car transporters and then distributing with a mix of smaller transporters is a better fuel alternative. This is also better from an overall environment point of view since the impact on health is reduced using smaller transporters for the urban leg of journeys, as shown in Figure 41 below.
Multi-franchise delivery: When multi-franchise delivery is considered, the reduction in health costs at an absolute level is most significant for larger transporters in a 1-day scenario, while the impact in terms of percentage is similar for all transporter sizes. The average increase in kilometres due to 1-day delivery using multi-franchise would be <10%.

To further reduce the impact which arises primarily because of the urban content of the delivery, out of town multi-franchise pick-up collection points could be introduced at which customers pick up the car without movement of HGVs into the town centre. However, this implies a trade-off between reduced urban congestion, pollution and health effects, and the use of land to hold cars waiting for delivery and the customer extra mileage on collection. However the space required may not be significant - potentially only enough to hold 20-30 cars assuming all cars delivered are collected the same day. This customer hand-over point could replace the urban stocking points for cars at dealers and could even include second hand cars for the collection of dealers. Given the requirement for further residential building in urban areas over the next
decades, this freeing of valuable land space may be seen as a politically good move even if legislation does not enforce it.

- **Rail:** The other major area where environmental costs could be reduced is through the use of rail. Rail is a common mode of car transport in Europe with Audi, for example, moving 65% of cars by rail out of German plants. Rail is used in the UK predominantly for export to and import from Europe. For example, PSA move about 40% of imports into and 20% of exports from the UK by rail.

Due to the general lack of infrastructure and confidence in the rail systems in the UK, it is thought by 3DayCar sponsors that this is unlikely in the medium term, even for trunking up to Scotland from southern plants.

- **New HGV technology:** The major truck manufacturers are currently developing hybrid, gas and fuel cell powered trucks. Given that the impact on human health costs are the most significant area of concern, any new technology which enables the reduction of the primary pollutants involved will be of benefit.

Developments which have significant potential to improve HGV emissions include:

- **Continuously Regenerating Trap (CRT)** - reduces CO, HCs and particulates by 80-90%. However, NO and NO₂ either remain the same or increase with this filter system.

- **Exhaust Gas Recirculation (EGR)** - returns the exhaust gas after the particulate filter, into the engine, reducing the oxygen content and consequently NO emissions by up to 50%.

- These two technologies will bring EUROII engines into the EUROIV compliance, not due until 2006.

- **Natural gas powered trucks (CNG)** - these are being trialled presently by a number of manufacturers. Operating on natural gas reduces emission (although not CO₂) and noise. They are especially useful for urban environments but not so applicable to trunking journeys at present. The application to inbound freight and outbound car carriers is limited.

- **Electric hybrid vehicles** - these are also being tested by manufacturers. However, the current application means that electric motors are used for enclosed space loading/unloading, internally to the plant, and for the main journey the diesel engine is used as currently is the case. These may be useful in a supplier park/hub transport situation where distances are short, but not for long haul trips.

It seems that in the short term the quickest option is to retrofit CRT and EGR to existing truck fleets or upgrade trucks that comply with EUROIV standards. The cost of retrofits is unlikely to be recouped since fuel efficiency can be worsened. Instead of retro-fitting, a quicker renewal of the truck fleet to Euro IV standard trucks with better fuel economy would be beneficial in the medium-term. There are a number of barriers to new technologies including legislative, institutional and cost (Evans 2000). By 2010 most vehicle fleets will have reached EUROIV level in any case. Figure 43 shows how adopting EUROIV technology would reduce the impact of 1 day delivery. However, congestion will continue to be a problem.
4.5 Conclusion

Vehicle delivery within a one day timeframe is feasible with the implementation of the defined changes. This can be achieved at the same transportation cost as the current situation, but overall cost can be reduced because of the elimination of distribution centres.

While there will be a base adverse movement of the order of 10% in terms of health and congestion costs, these can be mitigated by better capacity utilisation of transporters and by movement to more environmentally friendly power units.
5 Sea Transportation

5.1 Introduction

Vehicle transportation via sea traditionally provides the vast majority of movement of volume import and exports both on short sea (e.g. around Europe) and deep sea routes (e.g. intercontinental). In 1999 global car shipments stood at 6.9 million vehicles. Historically, new car shipments have been dominated by exports from Japan to Europe and North America, as well as to many smaller regional markets. Japan ships around c55% (3.7 million) of the world total.

Shipments from Europe to North America have also been significant. In the 1990s Korea emerged as a major exporter of new cars, again with Europe and North America as key destinations. It is important to realise the pivotal role of the European market in world car trades: it is the principal recipient of new car exports from the other major car-making regions. Figure 44 summarises the world trade in new cars by country of origin and destination.

A recent report from Hyundai Merchant Marine Co. and the Korea Maritime Institute, claimed that car transport vessels would continue to enjoy good results following the healthy growth observed in the late 1990s. The vessel shortage is not expected to end immediately, despite the spate of new shipbuilding. However, as the demand-supply situation approaches equilibrium, it is also expected to lead to increased scrapping compared with the present.

Due to the lead-times involved, the majority of vehicles on deep sea transport are unsold stock allocated to NSCs / countries, apart from some specialist makes which are carrying some vehicles already sold/allocated to the customer. The question arises how a large-scale move towards build-to-order will affect the shipping industry. Some sources believe that build-to-order will lead to more local production with a reduction in shipping requirements. While the introduction of Japanese transplants into the UK, and Japanese and European plants in the USA have been prevalent over the last decade or so, Table 2 would not indicate any significant change in total shipments around the world over recent years. It is therefore necessary to look at how vehicles can be supplied in a more efficient manner to customers when they are produced at a considerable distance from the market place. Since travel by air is not viable from a cost or environmental point of view in any volume, shipping will continue to be the medium for transportation.
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</tbody>
</table>

Figure 44: World trade of new cars (thousands of units),
Source: Beresford et al (2000), Note: Figures exclude used cars, machinery and heavy duty trucks
5.2 The Development of the Industry

**Major players**

The deep sea car carrier market can currently be divided into three convenient categories:

- The Japanese mega-carriers of NYK (Nippon Yusen Kaisha), MOL (Mitsui O.S.K. Lines), and KKK
- The Scandinavian specialists of HUAL (Høegh & Ugland) and WWL (Wallenius Wilhelmsen Line)
- The industrial carriers of HMM (Hyundai Merchant Marine), NMCC, and VWT (Volkswagen Transport)

These companies operate as members of conferences (i.e. Far East) or totally independently, visiting several ports on each continent. They also have interests in short sea movement, along with many other smaller operators. In many ways, the shipping industry has followed the wave of consolidation of the vehicle manufacturers, with aggregation into large players and several niche operators. As for vehicle manufacturers, the cost advantage of consolidated operations seems to be the driver.

**Mergers for total global service and maximisation of back haul (backloading) opportunities**

There has been restructuring of the industry in recent years. In March 1999, a merger between Wilhelmsen Lines and Wallenius Lines was announced. Lloyd’s List of 30 March 1999 reported this as a “perfect marriage”. A new 50:50 joint operating company has taken over the car carriers, Ro-Ro ships and forthcoming new vessels. The resulting fleet of 80 ships makes it the world’s largest specialist car carrying fleet accounting for around 35% of the world market. The “perfect marriage” stems from the complementary nature of each partner’s existing geographical coverage and existing fleet compositions, which will provide a full range of Ro-Ro vessels, PCCs and PCTCs.

The reasons for this merger highlight a major problem in the industry. Highly sophisticated car and truck carriers with large volume capacities of around 6000 cars can achieve high load factors in one direction but have more difficulty in arranging back haul cargoes. They may have to negotiate several different smaller contracts calling at different ports on the return leg. For example, MOL carry their main cargoes from the Far East to Europe and then have a contract with Mercedes Benz to carry their cars from Europe to the USA. It is quite common for back haul space to be used for cross trades in this way. However it has to be pointed out that there is always an imbalance in supply between the various continents, which is an unsolvable problem in terms of capacity utilisation. This is because it is not only production location which determines world trade, but wealth, exchange rates and product popularity. For instance, ballast, or empty running, is a persistent problem on certain routes e.g. US West Coast to Far East, US East Coast to Far East and Australia/New Zealand to Far East.

**Multi-purpose operations**

There are a number of directions in which shipping companies are moving towards multi-purpose operations:

- **New and Used Cars.** Although a number of lines do not or rarely mix new and used vehicles on the same vessel, other lines are happy to do so. In general used cars are shipped from the developed to the under-developed world and so, while this does not necessarily resolve back haul problems, it can be of considerable advantage in
maximising load factors, on certain routes. Examples of where this commonly happens are: Far East to Middle East, Far East to Africa, Far East to Persian Gulf and Far East to New Zealand. The niche market operator Grimaldi, based in Italy, operates a joint venture with Cobelfret over certain routes. For example, Europe-West Africa and Europe- South America routes provide a flexible service to cater for demand in those areas for both new and used cars – primarily European marques but also including US and Japanese models.

- **Vehicles and Components.** If a shipping company is to give total service to a vehicle manufacturer with widely dispersed plants and global component sourcing, then the shipping company must offer the same comprehensive coverage. This thinking is beginning to be applied in the shipping industry and is in line with developments in the automotive supply sector in general.

While for certain carriers there has been the facility to carry vehicles and containers for many years, there is a certain amount of necessary retooling taking place currently in the vehicle shipping trades in order for ‘pure’ car carriers to be replaced by rather more flexible ships. These will have the specific purpose of being able to carry a substantial load of car components and heavier commercial vehicles, as well as cars.

- **Lead Logistics.** There has been some movement towards shipping companies entering the field of lead logistics, whereby they become responsible for the movement of vehicles from the factory to the dealer. For instance, Wallenius took over Richard Lawson, a road transport company, in the 1990’s with the objective of operating an integrated land/sea operation in Europe.

- **Port Operational Services.** Shipping companies are also developing their port services in terms of such areas as PDI and late configuration. As an example of both this and lead logistics, Grimaldi is enlarging its network of port terminals by opening a new dedicated ro-ro/multipurpose terminal in Valencia and a land transportation company, Grimaldi Logistica España, to serve the Iberian market. Grimaldi sees the establishment of directly managed port terminals as a priority, especially since new fast car carriers will cut the delivery time of Fiat cars shipped between Italy and the UK, and other cars from UK to Italy, from 6 days to 4 days. Weaker Asian currencies have led to strong performance in car carrier trades and the cash from reefer sales could fund further development of shore-side facilities, of which Autoport on the US East Coast is a prime example. However, such facilities tend to operate on the basis of maximising their own capacity utilisation rather than on the speedy throughput of cars. For instance, if a ship only arrives every two weeks, they will spread the work over two weeks. The resulting bottlenecks in the port cannot be allowed to destroy time savings made on the sea leg.

The above developments indicate that shipping lines will potentially be involved in all aspects of motor industry movement and related services for both inbound and outbound logistics.

- **Hubs and feeders:** The practice of “feeder” occurs when deep sea vessels feed fewer large hub ports and then smaller vessels move the vehicles on to several smaller ports. Operators are trying to reduce costs and give a larger spread of sea access points to increase business; at the same time potentially reducing distances to be travelled by road. This involves the introduction of vessels of different sizes for different types of journey and is a practice which is likely to increase. A number of major ports are competing for hub status since the car industry not only provides considerable opportunities in terms of traffic but also for value added activities
stemming from the economies of consolidation. By concentrating such activities in hub ports, there is some cushioning from potential market and political fluctuations in the individual markets being supplied from the regional hub.

UECC (United Europe Car Carriers), jointly owned by Wallenius Lines and NYK Group, is prominent in the operation of advanced feeder ships for cars and recently accepted into service four 11,600 BRT car carriers.

5.3 Operations

The port import and export operations of the shipping company involve the loading/ unloading of vehicles from/into a vehicle storage compound within the docks, together with the administrative tasks of customs clearance and international freight paper traffic, vehicle quality inspection, and liaison with the manufacturer, NSC’s, and land logistics companies. The shipping company generally contracts out the unloading / loading of the vehicles to a stevedore company and quality inspection. Once in the compound, third party logistics provide further transportation.

In general, the shipping companies’ compound is limited, hence storage charges of up to £6 per day are imposed to incentivise vehicle manufacturers to move vehicles away. The vicinity of ports is often used as storage compounds. For instance, there are 60,000 vehicles stored in Bristol at any one time.

5.4 Shipping

While at sea, no work is being carried out on the cars. This is due to the lack of space and the specific layout as well as the unreliability of weather in terms of suitable working conditions. Below, a picture of two freight decks illustrates the space utilisation of a car carrier, with especially deep sea vessels having adjustable decks to cater for differing height cargo. The typical deck height is sufficient for a car, not necessarily a human being. The average deep sea ship carries around 6,000 cars, short sea carry ca. 500 cars.
Damage levels vary between 0.2% and 3.5%. Yet again, not all are transport related, since they might also refer to damage not detected on leaving the factory. Damage during transportation occurs mainly due to vehicle movement in heavy waters, and damage during loading / unloading.

The approximate price structure for deep-sea transportation is as follows:

<table>
<thead>
<tr>
<th>Route</th>
<th>Average price per unit</th>
<th>Loading efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA (East Coast) to Europe</td>
<td>$250</td>
<td>Low</td>
</tr>
<tr>
<td>Europe to USA (East Coast)</td>
<td>$350</td>
<td>High</td>
</tr>
<tr>
<td>Japan to Europe</td>
<td>$750</td>
<td>High</td>
</tr>
<tr>
<td>Europe to Japan</td>
<td>$500</td>
<td>Low</td>
</tr>
</tbody>
</table>

Figure 46: Price Structure

It can be seen that the cost of shipping is very cheap in terms of distance travelled compared with other forms of transport. This may appear surprising when considering that the docking cost is £16,000 for a deep-sea, and £1,500 for a short sea carrier. Short sea vessels only stay 5-6 hours in a port whereas deep-sea vessels will stay up to 24 hours. Unloading costs per car into the compound are typically £12 on deep sea, £10 on short sea.

5.5 Problem Areas

Besides the problems of back haul, the following problems exist in the current system that result in operational inefficiencies.

- **Information Reliability from Vehicle Manufacturers.** Shipping companies suffer from the same information unreliability as the other logistics service providers. The variability between the planned and actual volumes for boats leaving the UK can be very significant. For this reason, some shipping companies will take whatever is available for shipment at a given time rather than a stipulated volume, as long as appropriate customs paperwork such as bills of lading is feasible. In most cases, vehicle manufacturers have special arrangements with customs to overcome specific vehicles having to be on specific ships. This practise of shipping what is available means that vehicles at the last port of call for outward cargo must have some volume protection if the ship is likely to be full, or potentially lose out on space availability.

- **Lack of information communication and co-ordination** There is often a lack of communication between the players in the different markets, particularly between Europe and Japan. In some cases, NSC's do not know which cars are on a ship until after they arrive at the port of destination. The fault is often between the VM and the NSC or importer, but shipping companies could assist by giving prompt information to the markets. There is a need for a better overall tracking system, so that all players can see the vehicles on the ship. This problem arises from traditional mass production thinking, where cars are purely sold to customers from stock in the market place. All cars should be treated as personal imports, not as stock cars, and available to be allocated to customers at any point in the supply system. System integration is a major enabler. Communication technology has not been exploited yet, with some
transactions, such as bills of lading, which detail the vehicles on a ship, still relying on mail! These should be transferred via internet, etc. to create visibility.

- **Import delays at docks.** Import turnover times through the port are 2-4 days, of which customs clearance takes up to 2 days. This is certainly an area where operations could be improved in support of a 3DayCar. This will entail customs procedures being changed to ensure speed of clearance as well as security. If in future, vehicles go straight from the port of entry to the dealers, the distributor must organise the de-wax and PDI for vehicles in the import compound itself. Here again, quality standards vary between companies, so there are disputes between the various players in different markets.

- **Long delivery times**

  While shipping is very cheap, it is also a slow means of transport, exacerbated by the frequency of shipping. For instance, a ship travelling from Japan to Europe may have a travel time of 3 weeks. However, if it only travels once per month then the average car will wait two weeks before the ship sails and can spend several days in the arrival port or its vicinity before movement, due to the large volume to be moved. This can be weeks if PDI, etc. has to be carried out. The frequency is ultimately driven by the capacity of the ship and a 6000 car carrier can take a long time to fill.

  In addition, if ships are full, cars have to wait for the next scheduled departure. This gives very long delays. This might be an issue where short sea shipping could lose out to road or even rail transport, since both are more flexible in terms of capacity and therefore frequency, despite the fact that shipping by sea is the cheapest option and more environmentally benign for reasonable distances. However, as congestion on land increases, short distance shipping may become a viable alternative around the UK in the foreseeable future.

### 5.6 Implications of build-to-order on Sea Transportation

While a 3DayCar is obviously not feasible in the UK for vehicles arriving via deep sea shipping routes, there is no doubt that vehicle manufacturers will increasingly demand faster delivery times and the minimum amount of finished vehicle stock in the supply system. For Europe, the equivalent may be a 5DayCar demanding fast and frequent travel on short sea routes. This can only be achieved with a build-to-order mentality. With shorter shipping times it becomes more feasible to build to customer order at the factory, but the greatest opportunity area on deep sea shipping is to allocate vehicles to customers while they are on the ship. This cargo thus becomes a “virtual” production line. In order for the customer to be able to obtain the choice offered from such a source, the product specification range must be reasonably small, which it is on many long distance delivery production models. If customers want a greater choice then they would have to be prepared to wait for a specific vehicle to be built at the factory or late configuration can be introduced in the market place or in transit (See below). The following changes are therefore required for the motor vehicle shipping industry to meet these objectives:

- **More frequent delivery.** This implies smaller ships where capacity utilisation can be higher and more flexible in terms of routeings. This also implies less stock at ports at any one time, especially where port operations such as PDI exist. Smaller “packages” of volume make fast throughput time and facility capacity utilisation more compatible.
- **Mixed fleet sizes.** A greater mix of ship sizes in a fleet not only allows for entry into different types of sea movement and market sizes, it also potentially means some choice in size of vessel on the same route, depending on market circumstances.

- **Reliable and co-ordinated information.** Accurate planning information is vital to ensure that shipping lines can give the best service at minimum cost and that custom-built vehicles are shipped on the right vessel in order to achieve reliable delivery dates to the customer. Co-ordinated information will allow vehicles to be allocated to customers whilst on board ship, thus minimising the vehicle stock held in the market place.

- **PDI on board deep sea vessels.** Serious consideration should be given as to whether it is physically feasible to PDI on board deep sea vessels. If it is, the trade-off should be calculated between space and personnel cost on the ship compared to the port, and the value added of shorter delivery time and thus less stock. Where late configuration is applicable, this should also be considered.

- **Transporters on short sea vessels.** Shipping across the English channel has to compete with the EuroTunnel, not only in terms of cost but also time. A major delay is the unloading and loading of cars between road transporters and ships. Serious consideration should be given to the economics of fully laden transporters driving onto and off ships.

- **Rationalised port structure.** Whatever the eventual structure of hub ports and local feeder ports, it is necessary for vehicle manufacturers and shipping companies to get together to decide a rational approach to standardising ports to serve various regional areas. This will allow multi-franchise deliveries to dealers by road and rail.

### 5.7 Conclusion

Consolidation among major new car producers and their distribution networks will significantly reduce the number of potential customers for shipping. The main need is to create truly global networks in order to serve the logistics needs of global car makers in terms of vehicles. This will eventually involve component movements as well, and the transportation of both new and used cars will enable increased shipping efficiencies. As with logistics companies on land, this will lead to more polarisation in the shipping market between larger operators running the major routes between hub ports, sometimes acting as lead logistics companies, and smaller local operators engaged in regional distribution including “feeder” operation. At the same time there will be a move among major ports towards a concentration into fewer, but bigger hub ports and terminals. The hub ports in particular could develop increasingly sophisticated value added services on site in the area of pre-delivery inspection, late configuration, modification, etc.

Within this structure, shipping has to do all it can to reduce delivery time and assist the manufacturer to ensure allocation of vehicles to customers in transit is feasible. This will compensate for its major weakness of slowness of movement, and enable it to make use of its major strength, namely cost advantage. Unless it does, there is a risk that the current trend towards local regional production will expand, leaving shipping volumes, particularly on deep sea routes, in decline.
6 Conclusion

Research to date shows that a 3DayCar can be achieved without significant additional logistics cost, but this will only be fully quantified when particularly the inbound situation has been simulated within the 3DayCar simulation. This study, however, shows initial evidence that by using tools such as a mix of car transporter capacities and multi-franchised collection schemes and car delivery operations, the additional logistics cost can be largely compensated for in terms of increased efficiency. There will have to be significant changes in current processes, however, to enable the necessary improvements in efficiency.

The most prevalent topic that emerges from the research at all logistics providers, inbound, outbound and sea transportation, is the provision and quality of forecast and actual requirement information from vehicle manufacturers. This general lack of visibility is criticised at all levels in the supply chain and is a root cause for delays and inefficiencies in the system. As a result current lead-times, particularly on the outbound side, are too long to support a 3DayCar build-to-order system.

This lack of accurate information impinges on the ability of outbound logistics providers to plan the critically important overall economic backloading phase, since this can only be arranged once the dispersion load is fixed. In addition, dynamic route planning can only be effectively achieved if detailed vehicle build and destination data is communicated by the vehicle manufacturer, and if projected parts requirements are translated into supplier volumes in a co-ordinated fashion for both component suppliers and inbound logistics companies.

To achieve this flow of information, integration into the vehicle manufacturer’s system for other supply chain players is the obvious choice, and the benefits are clearly shown in the comparison of the non-integrated and integrated inbound logistics schemes.

Another common problem across the supply chain is hours of access to suppliers and dealers. Secure drop-off and collection points should be considered on a case by case basis, where opening times prove to be a strong constraint for collection or delivery overnight or at weekends. This could be the case for remote or high-volume suppliers and metropolitan dealerships. For outbound logistics, this needs to be implemented alongside changes in inspection procedures so that “out of hours” delivery does not require a dealer representative to be present.

Another key enabler is standardisation. This applies both to types of information and packaging, which facilitates the building of modular loads.

The combination of the above measures and the use of new vehicle technologies should alleviate the additional environmental impact of logistics in a 3DayCar system.

The logistical practices which will enable a 3DayCar can only be achieved if vehicle manufacturers, and to a lesser extent dealers, recognise the needs of logistics companies in obtaining greater efficiency and lower environmental effects. They must co-operate to ensure logistics companies have the necessary reliable information and conditions for success.
Appendix A – Definitions and Literature Review

Key Definitions:

**Backloading:** Backloading refers to utilisation of transport capacity on the way back from the initial delivery point to the original or next destination. Backloading aims at using transport capacity, which otherwise would have been an 'empty run'. In some cases the backloading might detour the vehicle from its original route, yet the overall journey might still be more efficient doing that.

**Dispersion Run:** The transportation of vehicles from the compounds to various dealerships, where the individual vehicles are delivered to. Dispersion needs to be seen in the sense of the scattered destinations on such a journey, as opposed to ‘straight run’ from a factory to a compound, with no interim drops on the way.

**Trunking:** Bulk-delivery on standard routes to one single delivery point, as for example a consolidated delivery from a cross-dock into the assembly plant.

**Inbound Logistics:** Inbound logistics is the movement of components, parts and materials from suppliers to vehicle manufacturers. In the case of this report is primarily focuses on movement of material from tier one or half tier suppliers to the vehicle manufacturing plant.

**Outbound Logistics:** Outbound logistics for the purpose of this study relates to the movement of finished (or near finished) vehicles from the manufacturing plant to the customer (in the UK in this case, although section does reflect on the implications for shipping). This movement includes the methods of transportation and any delay nodes such as holding compounds, distribution compounds and ports.

**Integration of operations:** The integration of operations refers to the degree to which logistics works in conjunction with other operations such as planning, scheduling, manufacturing, inventory holding, inventory management and other operations which occur at the vehicle manufacturer or supplier.

**PDI – Pre-delivery Inspection:** the inspection and preparation of vehicles before being handed over to the final customers. Tasks generally include testing, washing, cleaning, de-waxing, fitting of manuals and other accessories.

**Transport efficiency:** There are essentially 4 types of efficiency relating to the transportation of goods within the logistics function:

- **Initial load efficiency** - the percentage of the mode capacity utilised when leaving the first pick-up point (i.e. the supplier or vehicle manufacturer)

- **Integral load efficiency** - the sum of the percentage utilisation per kilometre of each leg of the dispersion distance (i.e. from dealer 1 to dealer 2 to dealer 3 reducing for outbound, or from supplier 1 to supplier 2 to supplier 3 improving for inbound milk-rounds)

- **Environmental efficiency** - miles per car (fuel efficiency and road usage), or miles/km per tonne shipped

- **Backload efficiency** distance travelled to backload point and (integral) load efficiency back to pick-up point

To accurately assess the efficiency of the logistics function in terms of transport all these types need to be accounted for.

**Damage:** Physical interaction with the product that results in loss of value in the product. For inbound logistics this can take the form of rust if stored outside for any length of time. For outbound this can take the form of scratches or dent to the body work, or surface damage from fluids.

**Accessories:** These are parts which are put on vehicles at dealerships as part of the dealers own package to the customer and may include alarms, radios and alloy wheels.

**Options:** These are parts which are put on vehicles at the factory according to customer specifications.

**Late configuration:** These are parts which are put on vehicles post assembly, i.e. at the DC or at the dealership. Several logistics service providers will fit special parts, i.e. body kits, etc. to the vehicles.
Definition of logistics

The formal study of Logistics originated during the Second World War when it was related to the movement and co-ordination of troops, armaments, and munitions to a required location (Slack et al., 1991, p. 529). Logistics is still regarded as a crucial military planning tool and was one particular reason emphasised by General Norman Schwarzkopf when explaining the success of Operation Desert Shield on August 7, 1990 to January 16, 1991, which involved the mobilisation of 550,000 troops and the shipment of 7 million tons of supplies (Pagonis & Gruikshank, 1992). This notion of movement and co-ordination of materials from one location to the other still seems to be the primary domain of logistics, i.e. physical distribution management.

Logistics has been defined as:

*The logistical process of a firm cuts across every internal organisational unit and reaches out to encompass customers and suppliers* (Bowersox et al., 1992).

Central to the logistics concept is the model of the so-called horseshoe, showing an information flow from customers to suppliers and a flow of materials going the opposite direction, as shown below.

![Figure 47: Flows in logistics Source: Bowersox et al. (1986).](image)

As indicated in the horseshoe model, logistics has traditionally been seen as focusing on the internal or to some extent the dyadic customer-supplier relationships. Persson (1989), however, argues for the need to broaden the internal perspective due to changing logistical technologies, control systems, and forms of organisation. Also Christopher (1992) describes logistics as 'an integrated concept spanning the entire supply chain from raw material through to the point of consumption'. Slack *et al.* (1995) compare recent versions of logistics with materials management, explaining that the difference is very subtle, but exists primarily in the fact that logistics focuses on the distribution of finished goods, whereas materials management focuses on manufacturing and movement of components.

Christopher (1992) discusses the key themes of leading edge logistics as the development of:

- process rather than functional (traditional organisational functions such as marketing, purchasing, production) thinking of organisations
- profitability rather than profit (resource management and asset utilisation versus margins)
- focus on customers rather than products
- building long-term relationships with suppliers and customers rather than short-term transactional exchange relationships
- information management rather than inventory management
The shift in focus can be illustrated in a triangular relationship model of logistics:

![Figure 48: The logistics triangle](image)

Logistics is the activity which places products where they are required for use. In its broadest sense this is all supply chain activity, but this report is primarily concerned with the physical transport of goods between providers and users.

Although some studies found that JIT did not always provide the results expected, JIT has the potential to offer a great deal for businesses that implement it systematically. Second, for some companies, as the geographic distance decreases, JIT success decreases. Third, JIT success is very much related to communication and informational linkages. Fourth, Impact of supplier proximity on JIT certification programmes for suppliers are the backbone of a successful JIT effort. There is no question that JIT works in some companies, but certainly there is still a question of whether or not JIT works in all companies. The investment in information technology and building trust with suppliers will bear fruit in terms of a successful JIT system. Such a system may be used to gain the business a strategic advantage in the marketplace (Wafa et al 1996).

In all these areas, firms with JIT are conspicuously more progressive. From a performance perspective, on-time deliveries have significantly increased and work stoppages owing to stockouts are down. Not surprisingly, many firms perceive that these changes in their inbound logistics function have improved their competitive position. What is surprising is that this has apparently been accomplished without increased logistics expense. JIT firms seem to be realising greater breakthroughs across-the-board than non-JIT companies regarding performance. These findings suggest several implications for purchasing/logistics managers. First, enhancement of the purchasing function is certainly feasible and will probably result in improved performance, both operationally and competitively. Second, advantageous results are possible without the implementation of a corresponding JIT programme. Finally, if the firm has implemented JIT or is planning to do so, the process of change will probably be accelerated and its benefits may be realised at a higher level and possibly more quickly. (Vonderembse 1995).

- Inbound Logistics Literature

This section describes the primary operational component of inbound logistics. These allow the flow of incoming materials using information from the production plan. The main essentials of modern JIT logistics are frequent, small delivery batches and reduced inventory (Gonzalez-Benito and Spring 2000). Although frequent is an ambiguous term the synchronisation of delivery shipments to the production schedule, so the part reaches the correct point on the production line at the moment it is processed, could be seen as the final objective. In most cases though, JIT leads to deliveries once or several times per day (Raia 1990). The practices affecting inbound logistics as regards lean or JIT are frequent delivery; reduced inventory; kanban systems; exact delivery times; EDI; geographical concentration and standardised containers.
The right frequency depends on the characteristics of the product. A Pareto type analysis is often used to determine whether a product should be included in a JIT programme (Ansani & Hechel 1987). In an attempt to reduce the impact of JIT delivery on component stocks at the supplier, many suppliers are adopting JIT production systems themselves (Golhar & Sarker 1992; Zhuang 1994).

Many companies use economic order quantity (EOQ) models to decide whether a component justifies JIT delivery on a cost basis (Baker et al 1994; Hahn et al 1983; Ramasesh 1990). Additionally, Hahn et al (1983) found that there were four types of leadtime: administration time to process the order; manufacturing time; transport and receiving and inspection. Order leadtime, manufacturing and transport can be improved through long term contracts, geographical concentration and JIT supplier production. Quality certification is required for the reduced of receipt and inspection leadtimes (Hahn et al 1983).

The required frequent exchange of orders means that efficient transfer of information is essential. EDI covers much of this requirement of information speed (Paulson 1993; Banerjee & Sriram 1995). Srinivasen et al (1994) found that EDI removes many of the problems resulting from frequent flow of information and products between companies in the automotive industry.

Proximity directly affects costs and leadtime due to the transportation aspect of the logistics operation. A number of studies find that geographical concentration is not a main objective of many manufacturers (Ahmed et al 1991; Vonderembse et al 1995). Wata et al (1996) also find reducing distance between supplier and customer does not significantly improve the success of a JIT system. The use of shipment consolidation through regulatory warehouses overcomes much of the problem of suppliers being located away from final assembly (Das & Handfield 1997; Handfield 1994). In the automotive sector in Europe though, there are many examples of concentration through supplier parks such as Saarlouis (Ford), Valencia (Ford) and this appears to be a continuing trend, for example see Ford's new Fiesta plant at Cologne (Automotive News Jan 2001). However of the typically 300-400 suppliers a VM might have, only a few will be based locally.

Environmental Management - Background

From the point of view of environmental management logistics firms are far behind vehicle manufacturers and suppliers i.e. those involved in manufacturing. This is supported by two major surveys carried out in the 1990s in Europe and the USA, that found that large manufacturing firms were the main proponents of environmental management and policy, whereas logistics firms, especially the smaller ones, had little activity on this area (Szymankiewicz 1993 and Murphy et al 1994). This is partly because the legal requirements are considerably less due to the relatively simpler impacts. Murphy et al found that the main obstacles to greening logistics were lack of resources and high cost of compliance (which suggests that legal compliance is at risk!). Pressures to become 'green' except at the most basic level are not apparent for most logistics companies (Miemczyk 2000).

Proper management and awareness of environmental implications of logistics activities can significantly reduce negative impacts (Dunn and Wu 1994). Traditional systems rarely encompass environmental issues and instead concentrate only on minimising costs and maximising profits (Daskin 1985). As social pressure continues to increase a third dimension, minimising environmental impact will also have to be integrated into the logistics manager's role. Logistics managers have no doubt that environmental pressures will increase and have more of an impact on their business, as demonstrated by both the Szymankiewicz and Murphy et al surveys. Although the traditional problems still exist such as transport versus inventory, inbound versus outbound, transport cost versus transit time and service over logistics cost (Copacino and Rosenfield 1987), the environmental costs and benefits must now start to be considered.

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5 Electronic Data Interchange
Appendix B – Environmental Impact Calculation

The logistics questionnaire provided fuel consumption data for outbound logistics car carriers of different capacities. To assess the global warming potential of the fuel used a conversion factor for diesel was used for CO2 emissions. See table B.1

### CO2 and fuel conversion factors - EU source

<table>
<thead>
<tr>
<th>Fuel density(kg/l at 15c)</th>
<th>Carbon Content</th>
<th>CO2 emissions (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per litre</td>
<td>per kg</td>
</tr>
<tr>
<td>Petrol</td>
<td>0.75</td>
<td>85</td>
</tr>
<tr>
<td>Diesel</td>
<td>0.86</td>
<td>86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transporter type</th>
<th>Consumption range/ mpg</th>
<th>Average consumption / mpg</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 car</td>
<td>7.0, 6.8, 7.0</td>
<td>6.9</td>
</tr>
<tr>
<td>11 car</td>
<td>6.9, 7.5, 6.9, 7, 6.68</td>
<td>6.9</td>
</tr>
<tr>
<td>10 car</td>
<td>6.8, 7.2, 7.0, 7.5, 7, 6.66</td>
<td>7.0</td>
</tr>
<tr>
<td>9 car</td>
<td>6.8, 6.9, 7.5, 8.0, 7, 6.84</td>
<td>7.2</td>
</tr>
<tr>
<td>8 car</td>
<td>7</td>
<td>7.0</td>
</tr>
<tr>
<td>7 car</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>6 car</td>
<td>7</td>
<td>7.0</td>
</tr>
<tr>
<td>5 car</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>4 car</td>
<td>12.3</td>
<td>12.3</td>
</tr>
<tr>
<td>3 car</td>
<td>10</td>
<td>10.0</td>
</tr>
</tbody>
</table>

- The fuel consumption by carrier type was taken from the questionnaire, with averages taken for multiple data sources.
- The consumption figures were converted to European norms (litres per kilometres from the British norm (Miles per gallon)).
- Based on the fuel economy data, the following calculations estimates the impact of a one day delivery regime for outbound logistics of new cars from a typical central England assembly plant to 5 major regions in the UK. The regions chosen were North Scotland (1); South Scotland (2); Yorkshire (3); North east (4) and the East Midlands (5).
- These regions were chosen due to the spread of distances and characteristics of the distribution network.
- The calculation can be repeated for all the UK regions to gain a complete UK picture of the impact of the 3DayCar.
- This example is for indicative purposes only.

Methods of calculation.

1. Outbound transport leg from factory/compound to first dealer drop point in region - distance in kilometres (O).
2. Average distance between dealers in town/area of region - based on distances between postcodes.
3. Number of dealers delivered to per load and number cars per load (C).
4. Multiply distance between dealers and number of dealers dropped per day (D).
5. Return Kms from last dealer drop point to factory/compound (R).
6. Total kilometres driven \((O + D + R)/C\) divided by the number of cars carried.
7. Total fuel used per car \((O + D + R)*F_{con}/C = FUEL_{car}\).
8. CO2 production per car - \(FUEL_{car}^{\text{CO2 factor}}\).

The estimation of average kilometres driven is based on sponsor proprietary route calculation software. Dispersion calculation uses postcode data and related distance with may introduce some sources of error.

Rationale: In the one day delivery there are more dealer drops per load (one per dealer on average), therefore the dispersion distance is greater. The dispersion or total number of drops multiplied by the average distance between dealers increased.
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