3DAYCAR PROGRAMME

Green Approaches to the Integrated Supply Chain

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Questions about the paper and this research should go to Joe Miemczyk at the University of Bath
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Summary

The 3DayCar programme aims to develop a process framework, through which a new car can be ordered, manufactured and delivered in just three days. In order to do this a number of changes are required in the current system. Of particular interest to environmental management are the changes required to the physical operations. These can be summarised as follows.

- The number of deliveries to assembly plants may increase to ensure that the correct materials are available without holding significant stocks.
- Batching for paint must not constrain vehicle assembly. If batching is to be reduced then pollution and waste from changeovers can increase from current painting systems.
- The delivery of new vehicles to customers in one day will increase the kilometres driven for delivery per car.
- Design factors can impact on the recyclability of the product, positively and negatively.

The environmental management of a 3DayCar process will depend on the approach taken by the players to control and improve the impacts. The approaches taken can be classified as either reactive, proactive or value-seeking. In addition, advantage can be taken of an integrated supply chain approach whereby organisations collaborate or form alliances to reduce the cumulative impacts of these environment affecting activities. Current options taken are diverse and depend on the position firms have in the supply chain.

- Vehicle manufacturers themselves are variably proactive, but this is driven by legislation and some pressure to perform as an environmentally responsible firm in the eyes of stakeholders.
- Suppliers are generally reactive in response to the customer, e.g. vehicle manufacturer requirement and legislation, with some action to reduce cost through recycling in situ. Collaboration tends to be led by the vehicle manufacturer in all cases.
- Logistics providers are at the beck and call of their customers (also the VMs), but their approach is hardly even reactive. The drivers for environmental action are almost non-existent.
- Other players in the UK distribution channel such as dealers are equally reactive in their approach to greening, so there is little environmental work being carried out here.

The next stage of research will focus on the following areas to assess how a 3DayCar could be implemented in terms of environmental management.

- Examine how the 3 approaches - reactive, proactive and value-seeking - may be applied to a 3DayCar and how integration of activities across organisations can be of benefit.
• Understand how the barriers to integration hinder the implementation of a 3DayCar under the 3 approaches.
• Identify which measures can drive change in these areas to align actions with goals, taking into account for the cost emphasis required by 3DayCar sponsors, and how these must vary depending on the approach taken.
• Focus on the main areas identified during the 3DayCar workshop session.

The output from this research will deliver 3 possible approaches to the 3DayCar that account for the environment in a reactive, proactive or value-seeking way.
1.0 Introduction

The 3DayCar is a research programme examining the feasibility of ordering, manufacturing and delivering a new car in just 3 days. Among a number of other research areas (including systems, finance and technology) the environment effect is being researched in order to understand how a 3DayCar strategy could have an impact, and what approaches may be suitable for reducing adverse impacts.

The 3DayCar requires a number of changes to the current systems which could affect the environment. They include more responsive supply of material to assembly plants, lean/agile manufacturing within vehicle assembly plants (working from very short planning schedules and only building what the customer has directly ordered from the plant) and delivering the car in one day from vehicle assembly to the retail outlet or even the customer.

1.1 The objectives

The specific objectives of this report are as follows -

- Provide an overview of environmental management approaches in the supply chain
- Introduce criteria used to evaluate management approaches to greening
- Describe the current approaches of different supply chain players based on preliminary research
- Discuss the implications for a 3DayCar based on preliminary findings and a conference workshop
- Set the framework for further detailed case study of green 3DayCar solutions

Clearly how a 3DayCar is implemented depends on the general approach of the parties involved in their greening initiatives. Those firms that purely act on reducing the impact of regulation will have a different approach to a firm that has environment as a core issue. In such a company, strategy may be developed to extract value from undertaking 'green' actions to raise the company's profile, market its products and gain efficiencies in its processes (Porter & van der Linde 1995, Wu and Dunn 1995).
1.2 Current approaches to environmental management

The management of environmental factors in the automotive sector has primarily centred round reacting to product specifications and standards, to limit emissions, improve fuel economy and reduce waste from scrap cars. There has also been a move, in recent years, to improve the green credentials of the firm with regard to its operations. This started as a demonstration of compliance to local regulations, but has now moved on to encompass complete site environmental management, with certification of their achievements commonplace through ISO14001 or EMAS and sectoral strategies such as that led by the SMMT.

These developments have not fully accounted for the far-reaching implications of an integrated supply chain and how the environmental performance of the value stream may be optimised by taking this view (Gupta 1995, Wu and Dunn 1995 & Sinding 2000). Research shows that there is little understanding of these implications for the complete supply chain, as most research is concentrated in the area of reverse logistics which only a small part of the whole at present (Van Hoek 1999). Considering the reliance on the huge number of players in the automotive supply chain from dealers, distributors, logistics firms, assembly operations to component and material suppliers, the impact of taking such an holistic approach is significant. So far actions have been limited to a few specific activities (McIntyre et al 1998). We shall demonstrate that this is predominantly ad hoc (particularly in the UK).

The approach taken to address environmental concerns can be categorised into reactive, proactive or value-seeking (Kopicki et al 1993) and these criteria (which are assimilated into the evaluation criteria shown in appendix one) are used to assess the activities currently being undertaken in the automotive supply chain.

- The reactive approach tends to reflect actions to avoid legal liability and reduce the cost incurred through environmental legislation by using abatement technology to reduce air emissions from boiler stacks or paint application, but the underlying cause may be left unchanged.
- The proactive firm will pre-empt legislation, take on product recycling activity and introduce environmental criteria into design of new products.

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The value-seeking approach relates to strong commitment to the environment through the business strategy, using alliances and collaboration throughout the supply chain. This enables costs (and savings) to be shared for improvements. Furthermore, these companies can gain customer and shareholder value from innovative, green products, and competitive advantage from such strategic commitment.

The scope of greening can also be classified as non-integrated on a purely site by site focus, or integrated. The integrated approach requires collaborative management of environmental impacts vertically up and down the supply chain or even horizontally across players of the same function through alliances. An example of this could be by sharing waste streams. According to Lamming and Hampson (2000), collaboration can mean helping innovation through sharing skills and knowledge; sharing costs and risks and improving the exchange of environmental information. Sinding (2000) describes the integrated approach as inter-organisational environmental management. He develops the idea that this is primarily related to activities such as recycling, life cycle oriented environmental management and industrial ecology (these have strong synergies with the value-seeking approach described above). There are barriers to implementing such an approach. These barriers can be classified as institutional, economic, organisational and informational, and the literature suggests that further research needs to concentrate on institutional problems and contractual arrangements required for such systems to be successful (Sinding 2000).

The following sections summarise the approaches taken by a number of players in the automotive supply chain and what implications this has for furthering an integrated approach to environmental management in the supply chain. The evaluation criteria shown in Appendix One were used to understand the general approaches used by the 3DayCar supply chain players. These were applied to information gained from year one interviews and publicly available information sources.

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2 As already occurs in the area of fuel cell development for reduced emission and higher fuel efficiency cars.
3.0 Approaches vary widely from company to company - examples

3.1 Vehicle Manufacturers

3.1.1 VM1
Like many UK vehicle manufacturers the operational site recently gained ISO14001 demonstrating compliance to regulation and continual improvement. Waste reduction targets are in place and water-based paints are being utilised to reduce the impact of VOCs on the local community. There is little or no activity relating to supply chain environmental management except for the need to deliver components in re-useable packaging and this is driven by cost saving and delivery standards more than green initiatives. Longer term views on environment are legislation driven and tend to concentrate more on the product than process, although monitoring of emissions legislation occurs to avoid risks of non-compliance. Overall the green activity is purely site based and has no significant influence over other supply chain players. They do not report except at a global level and this does not include performance at specific sites. This vehicle manufacturer has looked at the recycling of safety restraint systems through the CARE consortium. In this case the company appears to be reactive in its greening approach, although it is still in the initial phases of implementing ISO14001 and is likely to become more proactive once a few audit cycles have been completed.

3.1.2 VM2
In the case of this second vehicle manufacturer, there is a greater history of environmental management at the site level. The site gained ISO14001 4 years ago and has now started to demonstrate significant improvement in its operational impact. The amount of waste has been significantly reduced and the amount of recycling greatly increased. Water based paints were introduced on site to reduce VOC emissions. In terms of the supply chain there is evidence of some activity but this is primarily on the basis of information gathering to understand the main impacts of suppliers, their legal status and then how advanced they are in moving toward environmental management standards. Many of this firm's suppliers have now achieved ISO14001 (around 75%), but how they improve is really left to them with little involvement from their 'customer'. Co-operating with other industry partners has not been demonstrated even
through their trade body the SMMT. They contributed to the CARE project through examining re-use and re-manufacturing of recovered components and materials. A proactive stance is being taken although the emphasis is still very much on the site activities.

### 3.1.3 VM3

This manufacturer has taken environmental management a step further than most others have in the UK by adopting the EMAS standard, which differs from ISO14001 in that it requires a regular environmental report on performance to be published (and externally verified). Again like most other vehicle manufacturers they have undertaken large steps in reducing their environmental impact from paint shop emissions by using waterbased paint to reducing general waste and energy usage. Recycling at plant level tends to centre round packaging waste. The product has also shown significant improvement including the recyclability of their vehicles now estimated to be between 90 & 95%. Some of the new vehicles now also contain recycled material in high quantities. There has been little involvement in the supply chain for environmental improvement except in the usual case of gaining information from suppliers on their compliance status and whether they have gained any form of 3rd party recognition, but they are not requiring suppliers to become certified (only demonstrate they have systems in place). However, they have looked at the inbound logistics function and set targets on their own fleet for total inbound mileage to reduce fuel consumption and traffic pressure. They also require that trips be taken on motorways where possible to avoid local traffic problems and disturbance to urban areas. New trucks have been procured to achieve lower fuel consumption and reduce emissions levels to EuroII standard. It is important to note here that these initiatives are not followed through to their 3rd party logistics providers. They have contributed to the CARE work in terms of looking at dismantler standards. Again this firm could be said to be proactive in its approach to environmental management.

### 3.1.4 VM4

This UK vehicle manufacturer has taken ISO14001 on board and had all sites worldwide certified. Also as part of a global policy, energy management systems have been put in place in most sites. Policy is driven by compliance to regulations, but also reducing costs i.e. energy reduction. There has been an environmental report produced but this is focused on best practice globally and not individual site reporting of performance. The environmental planning tends to be

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3 Consortium for Automotive Recycling
short term for sites but long term for product. The role of logistics is not significant at this company in forming or implementing green initiatives. Suppliers have been asked about their environmental credentials and are now required to obtain ISO14001. There are few examples of alliances or joint ventures for environmental reasons. They have contributed to the CARE consortium work looking into further use of materials and tyres and elastomers, particularly with one their daughter companies. In terms of the product, materials are being included in the new car which are both either recycled or more recyclable. Some vehicles are reaching 84% recyclability in some markets. This area of recycling is becoming both compliance and profit driven with integration of recycling companies being examined although not in the UK. The approach taken here could be viewed as proactive for the most part especially in terms of research into recyclability of product, aiming for the '100% recyclable' car.

3.1.5 VM5
The auto producer in this case has not yet undertaken ISO14001 at the UK site although this is being adopted elsewhere and is likely to follow in the UK. Activity at the production plant is centred round the specific issues of reducing air emissions, waste reduced through recycling, water use and discharge reduction and other site specific issues. Employees are given incentives for green ideas and environmental performance is publicised on the web and through annual reports. There has been a widely established network for the return of EOL\(^4\) product from used cars to return for reconditioning and re-sale into the aftermarket segment. Recycling activity is primarily being driven by the cost saving aspect this offers. In the country of origin there is a far more developed system for returning EOL product using existing networks and in joint venture with the dealer network. It is likely that this will be expanded to the UK in the near future. Recycled material is incorporated into some of the products such as wheel arches and air ducts. The UK operation, still fairly reactive, has yet to catch up with the main group which could be said to be proactive in its approach, almost value-seeking.

3.1.5 VM6
Many of the manufacturing sites are in Continental Europe, which has more stringent waste management laws. The sites in Europe have EMAS and regularly report on environmental performance. Third party consultants externally verify these reports. Logistics is included in the environmental reports. Activity to reduce the impact of its operations centre around

\(^4\) End of Life - when the product would normally be disposed of at a waste site
manufacturing sites, emissions, wastes and the like. There is significant evidence to suggest co-
development with suppliers occurs to reduce the impact of the VM product in terms of weight
saving, emissions and recyclability of parts. In addition existing logistics networks are utilised to
recover EOL products from the service activity and maintenance as well as the end of life vehicle
itself. Much of this activity is largely driven by strong legislative regimes this company operates.
Also, products are now being placed in the market to directly appeal to green-minded consumers.
This firm would certainly appear to best fit the value seeking approach as detailed by Kopicki et

3.2 Logistics companies

3.2.1 Logistics Company 1 (outbound)
As with most car transporter companies, this organisation is at the mercy of its customer, the
Vehicle Manufacturer. The main impacts of such an operation are the use of fuel and the impact
on congestion of the transporter fleet. The company is not required by customers to address any
of its environmental impacts except to ensure compliance to regulation. Therefore the company
has no environmental policy. Although the parent company does have one there is little or no
onus on this division to address the policy. The approach here is hardly even reactive, as only the
most basic recognition of environmental impacts has been made (except in fuel use reduction to
minimise costs).

3.2.2 Logistics company 2 (outbound)
The second car transporter company is also not required by its customers to address
environmental issues. The company does not have an environmental policy and there is little
action it can take in the area of environmental improvement without compromising customer
requirements or its own margins. Any environmental improvement which does occur is mainly
driven by other factors such as the need to reduce fuel consumption or other costs. Again the
approach is clearly reactive, based only on compliance to regulation and related cost burdens.

3.2.3 Logistics company 3 (inbound)
The 3rd logistics company operates inbound transport functions from material and component
suppliers to vehicle assembly plants in the UK. It does have an environmental policy and this has
primarily been driven by the requirement of one of its customer VMs to attain ISO14001. There
is now a recognition of the benefit of having environmental management systems in place to help
with compliance issues and reduce some costs. Implementation is on a site by site basis and not across the whole business. However there is no emphasis on the VMs' or suppliers' environmental elements and performance is only measured in terms of the company's own activities and not how it affects any other players' performance. Although fuel consumption is the biggest impact affecting them, there is no joint activity to reduce it. Despite the apparent lack of activity, this is the most environmentally forward logistics company so far encountered although its approach to greening is still, strictly speaking, reactive overall.

3.3 Component Suppliers

3.3.1 Supplier 1
The supplier produces fluid management systems for vehicles, supplying to the main vehicle manufacturers in the UK and elsewhere. The company operates satellite plants near factories to be more responsive to VM requirements. While this is not driven by the need to reduce transport, such a result occurs due to the difficulty in transporting the spatially large product. The company has ISO14001 at most sites and therefore has an environmental policy. Again it is driven by the VM customers. Recycling of material within its own production facilities occurs, such as re-ground plastics, but takeback of EOL product does not, except in the case of warranties. Typically, improvements are centred around the company manufacturing sites, an example being the reduction of solvent usage. VM customers have for some time imposed design criteria restricting material use, requirements for material labelling (particularly on plastic recyclability), and packaging. These requirements are likely to increase as the recycled content improves (for example, banning hexavalent chromium and mercury from components) and further weight reductions are needed. Interestingly, discontinuing the use of chromium meant that a new process had to be developed. This used no water and was more economic for the business. Like most suppliers they are reactive in their approach as they provide the service/product tailored to their customer's requirement. Recent requirements for their own suppliers to gain ISO14001 demonstrates that they are becoming more proactive.

3.3.2 Supplier 2
The supplier produces a variety of different products for VMs and as with other suppliers has been asked to implement ISO14001, which it has done successfully. The scope of its activities has been based around on-site impacts and not other supply chain elements such as logistics. In fact where the boundary has been crossed in terms of sharing waste management resources, legal
problems have placed a barrier on collaboration. Although some site improvements have been made, the main effort has been on compliance and meeting the customers requirements only. This makes the overall approach reactive in nature.

### 3.3.3 Supplier 3
The third supplier is another example of a player with a dominant global position. As such it has central resources to successfully implement environmental management in a 'best fit' way. The company developed a policy manual in 1989 and sees the implementation strategy dependent on the likely risk and size of the site. No environmental report has been produced as yet although global targets have been set and met over the last few years. From a supply chain perspective this company supplies components which are crucial for environmental performance direct to VMs, and has been able to deliver weight saving solutions to new vehicles. A collaborative approach has not been taken though, and interviews demonstrated that customers were not willing to bear the cost for environmentally benign products and even co-development has been resisted with the customer rejecting LCA\(^5\) on a cost basis. Design for environment criteria have been used but again lack of interest from the customers has meant that this is not now central to the design function. Logistics functions have been outsourced and the perceived lack of control has meant that the environmental impacts are not addressed. Some action has been taken to measure logistics/transport impacts, but the results are pending and action therefore further removed (the difficulty in gaining information is a serious barrier to action). Shareholder queries are beginning to drive a positive external-reporting stance. Overall, this supplier could be seen as proactive due to the work on LCA, design for environment, internal reporting and target setting, but the lack of enthusiasm from customers means that the work does not reach its potential, which real collaboration would achieve.

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\(^5\) Life Cycle Assessment
4.0 The approach depends on the position in the supply chain

It is possible to summarise the approaches of the players in the UK automotive supply chain in the following table.

<table>
<thead>
<tr>
<th>Supply chain player</th>
<th>Approach</th>
<th>Logistics role</th>
<th>How What</th>
<th>Supply chain Collaboration</th>
<th>How What</th>
</tr>
</thead>
<tbody>
<tr>
<td>VM1</td>
<td>Reactive</td>
<td>x</td>
<td>-</td>
<td>x</td>
<td>(Design criteria for recycling)</td>
</tr>
<tr>
<td>VM2</td>
<td>Proactive</td>
<td>x</td>
<td></td>
<td></td>
<td>Ask suppliers to consider ISO14001. Design criteria for recycling</td>
</tr>
<tr>
<td>VM3</td>
<td>Proactive</td>
<td></td>
<td></td>
<td></td>
<td>Supplier to report on EMS although certification not required. Design criteria for recycling</td>
</tr>
<tr>
<td>VM4</td>
<td>Proactive</td>
<td></td>
<td></td>
<td></td>
<td>Suppliers to gain ISO14001. Design criteria for recycling</td>
</tr>
<tr>
<td>VM5</td>
<td>Reactive (becoming proactive)</td>
<td>x</td>
<td>-</td>
<td></td>
<td>Parts for reconditioning being introduced. Design criteria for recycling</td>
</tr>
<tr>
<td>VM6</td>
<td>Value-seeking</td>
<td></td>
<td></td>
<td></td>
<td>Supplier award for achievements (co-development, Design criteria for recycling). Return of EOL products from aftermarket.</td>
</tr>
<tr>
<td>Logistics co 1</td>
<td>Reactive</td>
<td>x</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics co 2</td>
<td>Reactive</td>
<td>x</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics co 3</td>
<td>Reactive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier 1</td>
<td>Reactive (becoming proactive)</td>
<td>x</td>
<td>-</td>
<td></td>
<td>Work with customer to gain ISO14001. Suppliers to gain ISO14001 also.</td>
</tr>
<tr>
<td>Supplier 2</td>
<td>Reactive</td>
<td>x</td>
<td>-</td>
<td></td>
<td>Work with customer to gain ISO14001</td>
</tr>
<tr>
<td>Supplier 3</td>
<td>Proactive</td>
<td>x</td>
<td>-</td>
<td></td>
<td>Does occur, but limited by customer’s lack of interest</td>
</tr>
</tbody>
</table>

Table 1: Supply chain players’ approaches and application of green supply chain activity.
A brief examination of Table 1 shows that vehicle manufacturers drive environmental activity in other supply chain players. The key role of logistics in supply chain activity is largely ignored in the approach to environmental management. What supply chain activity there is tends to be driven by the VM as a 'bought in' dimension; not so much a collaboration, but a contractual requirement. Again this is largely driven by the legislative standards on material content (non-hazardous) and recyclability of products (End of Life Vehicle Directive). Although suppliers to some VMs are now required to gain ISO14001, they are rarely involved in joint waste reduction strategies at this level. Overall, activities are operationally based not strategic, and seem to reflect a sectoral perspective rather than a supply chain one.

European vehicle manufacturers are generally better than their UK counterparts. Renault for example has designed a network of material collection through dismantlers in France. Through collaborative agreements, Renault will allow other vehicle manufacturers to use this network to meet the required recycling levels in return for Renault vehicles being recycled in other country networks set up by other vehicle manufacturers. This collaborative approach is likely to be a key method to comply with the End of Life Vehicle Directive.

Another notable example is Volvo, always seen as the most environmentally innovative and forward thinking of VMs. In particular they have produced 'Environmental Requirements for Group Suppliers and Contractors' which are part of the Group purchasing agreements for material suppliers and other contractors (authorised in 1998 by Arne Wittlov, Exec VP). All suppliers must have ISO14001 or EMAS with reporting of data to Volvo to allow environmental assessments to take place. Unique to Volvo, regular transport contractors must gain ISO14001 or EMAS and declare all vehicle data (type, age, fuel consumption etc). No other known automakers have gone this far yet, but are expected to follow.

The international dimension of these firms, especially the vehicle manufacturers shows varying degrees of action depending on the local regulatory framework within which they operate. Although this report presents a picture of UK practice, there is considerable activity on a global basis. At this level, all VMs can be seen as proactive, moving towards value-seeking in their approach to environmental management in some areas. As most environmental activity takes place on a site by site basis it is difficult to generalise about a whole group, which might have both good and bad examples of environmental management. In the end it can come down to the individual commitment and beliefs of the plant manager, head of design or marketing director.
5.0 Green approaches to a 3DayCar

The workshop event held during the June 2000 3DayCar Conference concentrated on what the issues were for the development of a 3DayCar in terms of likely environmental impacts and how these can be managed. A brief presentation was given of the current approaches to environmental management based on Year One research. Following from this, the workshop attendees were asked to comment on aspects of the 3DayCar supply chain which could be affected. These were recorded on 'post-its' and placed on the relevant areas of a large wall chart representing the supply chain. The main points are summarised below and in Figure 1.

Figure 1: Main areas likely to be affected by a 3DayCar - results from June 2000 Conference workshop.

These impacts are as follows:-

- A more responsive supply of material leads to the number of deliveries to assembly plants increasing to ensure that the correct materials are available without holding significant stocks.

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6 3DayCar should not hold significant stock levels
• Only building what the customer has ordered on the plant on a daily basis requires that a flexible assembly sequence be maintained and that batching for paint must not be a constrain. If batching is to be reduced, then pollution and waste from changeovers will increase given current painting systems.

• The delivery of new vehicles to customers in one day can have an adverse effect on the number of kilometres driven by car transporters. Each vehicle must drive to more dealers over a longer distance in order to get the product to customers in one day. This increases kilometres and fuel use by around 33%.

• Design criteria for recycling can impact on the ability to easily assemble vehicles and modular design can make recycling less feasible. Adhesives, material coatings and composites can all hinder recycling economics.

Taking into account the limitations of the research and understanding the approaches already taken by supply chain players, it is possible to suggest a number of directions that a green 3DayCar solution could take. This is along the continuum of the reactive, proactive and value-seeking and integrated/non-integrated approaches.

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8 Future of Outbound Logistics, 3DayCar mid-year conference presentation, June 2000, Bath.
The following table demonstrates the attributes of each approach and shows the possible implications for the 3DayCar solution.

<table>
<thead>
<tr>
<th></th>
<th>Reactive</th>
<th>Proactive</th>
<th>Value-seeking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attributes</strong></td>
<td>• Comply with regulations</td>
<td>• Comply with regulations,</td>
<td>• Design product with system in mind</td>
</tr>
<tr>
<td></td>
<td>• Reduce legislative cost burdens (reduce kms per vehicle and VOC per car)</td>
<td>• Increase scope of ISO14001 to cover all players including inbound and out bound logistics,</td>
<td>• Quicker assembly, more efficient recycling, extended life cycle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use EOL product to help balance loss of efficiencies.</td>
<td>• Design/Use modules to quick assemble, and efficiently recycle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partial integrated approach.</td>
<td>• Allow contractors to invest in green solution e.g. fuel efficient trucks or zero emission manufacturing processes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use modules to quick assemble, and efficiently recycle.</td>
<td>• Customers collect car from eco-friendly site - carried by prototype fuel cell vehicles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allow contractors to invest in green solution e.g. fuel efficient trucks or zero emission manufacturing processes.</td>
<td>• Offer low impact services.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Customers collect car from eco-friendly site - carried by prototype fuel cell vehicles.</td>
<td>• This is a total supply chain integration approach.</td>
</tr>
<tr>
<td><strong>Integration or inter-organisation</strong></td>
<td>• Likely to be little integration overall except to require suppliers to certify management systems</td>
<td>• Require suppliers to aid waste reduction programmes (reduce blank sizes &amp; substitute materials)</td>
<td>• Waste is addressed holistically from cradle to grave impacts with customers, dealers, logistics and suppliers supporting the material take-back infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Logistics take on environmental management functions - waste streams</td>
<td>• Closed loop systems and waste to raw material loops</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Suppliers provide updated products to support extended lifecycles (lighter panels, zero emission powertrain)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The integrated dimension is essential for a value-seeking approach to be successful</td>
</tr>
<tr>
<td><strong>Implications for a 3DayCar</strong></td>
<td>• Least short-term cost option; some trade-offs between vehicle kms and fuel use mainly cost and legislation driven</td>
<td>• Can be seen as raising green profile -</td>
<td>• Smart/Spaceframe/modular -</td>
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<td></td>
<td></td>
<td>• PR exercise -</td>
<td>• Design for delivery, recycling, extended life-cycles.</td>
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<td></td>
<td></td>
<td>• More holistic approach to managing effects</td>
<td>• Regional multi-franchise assemblers?</td>
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<td></td>
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<td></td>
<td>• Low cost/impact transport due to hybrid trucks.</td>
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<td></td>
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<td></td>
<td>• Customer collects (Autostadt type).</td>
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<td></td>
<td>• Manage vehicle use through leasing - best fit vehicle for use.</td>
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<td></td>
<td>• Longer term benefits and marketing advantages</td>
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</table>
6.0 Conclusions

Overall, the current situation in the UK automotive supply chain indicates that an integrated supply chain approach has not been taken so far, but site focused actions do tend to be mainly proactive. The greening approach taken by the players in the automotive supply chain varies greatly depending on the position in the supply chain. VMs show the greatest activity, followed by suppliers, with players in the physical distribution/logistics upstream and downstream coming last.

- Vehicle manufacturers themselves are variably proactive, but this is still mainly driven by legislation and some pressure to perform as an environmentally responsible firm in the eyes of stakeholders. Taking a UK picture is somewhat restrictive since this country is not leading edge. Taking a more global perspective allows better consideration of proactive activities that are leading to more value-seeking approaches.

- Suppliers are generally reactive in response to VM requirements and legislation, with some action to reduce cost through recycling in situ. Collaboration tends to be led or even directed by the VM in all cases. This includes labelling of parts, re-useable packaging, adopting ISO14001 and designing light-weight, recyclable components.

- Logistics providers are at the beck and call of the VMs, but their approach is hardly even reactive. The drivers for environmental action are almost non-existent.

- Other players in the distribution channel such as dealers are equally reactive in their approach to greening, which is almost non-existent (mainly due to the perceived low impact of the operations) although different approaches are taken in Continental Europe.

Although complex LCAs have been produced by many car companies the resulting information is often inconclusive and generally involves comparing one material with another and not the benefit of different supply chain activities. However the use of LCAs suggests that integrated/inter-organisational environmental management as described by Sinding should be implemented, with suppliers (of materials or services) working with VMs to reduce LCA costs and improve their effectiveness.
7.0 Further research
The next stage of research will further develop these ideas and apply them to the implementation of a 3DayCar. The following actions will be taken:

- Examine how the three approaches - reactive, proactive and value-seeking - may be applied to a 3DayCar and how integration of activities across organisations can be of benefit (see Figure 2 showing current position of 3DC activity).

- Understand how the barriers to integration - institutional, economic, organisational and informational - hinder the implementation of a 3DayCar under the 3 approaches.

- Identify which measures can drive change in these areas to align actions with the goals, accounting for the financial costs and benefits, and how these vary depending on the approach taken and impact on the life cycle of the vehicle (production, use, maintenance, repair, disposal and recycling).

- Focus on the main areas identified during the 3DayCar workshop session.

Figure 2: Current position of relevant 3DayCar activities and potential direction of change.

The output from this research will deliver three possible solutions to the 3DayCar that account for the environment in a reactive, proactive or value-seeking way.
References


Logistics Company 3 - Environmental Policy Statement


Supplier 1 - press releases.


VM2 Environmental Statement 1998.

VM3 Environmental Statements 1998.


Appendix 1 - Evaluation framework for green supply chains -

<table>
<thead>
<tr>
<th>Approach of greening</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product differentiation; integrated with product position, willingness to pay, credible information and barriers to imitation</td>
<td></td>
</tr>
<tr>
<td>Managing competitors; economies of scope, cost distributed</td>
<td></td>
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<tr>
<td>Cost savings; existing technologies and facilities or fresh look</td>
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<tr>
<td>Redefining markets</td>
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<tr>
<td>Managing risk and uncertainty</td>
<td></td>
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<tr>
<td>Supply chain perspective</td>
<td></td>
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<tr>
<td>Product design involved?</td>
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<tr>
<td>Procurement involved?</td>
<td></td>
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<tr>
<td>Manufacturing and assembly involved?</td>
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<tr>
<td>Logistics and distribution involved?</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization</th>
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<tbody>
<tr>
<td>Players and activities involved in the supply chain?</td>
<td></td>
</tr>
<tr>
<td>Logistics characteristics; Volume of flow handled</td>
<td></td>
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<tr>
<td>Proximity of end markets of green operations</td>
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<tr>
<td>Sorting of recycled materials involved</td>
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<tr>
<td>Transportation density of return flows</td>
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<tr>
<td>Formal or written environmental policy available?</td>
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<tr>
<td>Greening policy driven by perceived profit opportunities?</td>
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<tr>
<td>Greening policy driven by legislative direction?</td>
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<tr>
<td>Long-range planning policy?</td>
<td></td>
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<tr>
<td>Is their a role for logistics in formulating environmental policy?</td>
<td></td>
</tr>
<tr>
<td>Is their a role for logistics in implementing policy?</td>
<td></td>
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</tbody>
</table>

| Project drivers and challenges                            |         |

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<table>
<thead>
<tr>
<th>Role of communication among players?</th>
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<tbody>
<tr>
<td>Examination of joint ventures?</td>
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<tr>
<td>Role of government?</td>
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<tr>
<td>Role of strategic alliances?</td>
</tr>
<tr>
<td>Analysis of cost and benefits? How? Are environmental concerns included in investment decisions?</td>
</tr>
<tr>
<td>Analysis of where to locate? How?</td>
</tr>
<tr>
<td>Benchmarking and cross-channel analysis?</td>
</tr>
<tr>
<td>Perceived quality of inputs relevant?</td>
</tr>
<tr>
<td>Incentive and reward system for management green?</td>
</tr>
<tr>
<td>Redesign of logistics system components for greater environmental efficiency needed?</td>
</tr>
<tr>
<td>Reject suppliers who lack environmental concerns? Are suppliers involved in environmental policy making?</td>
</tr>
<tr>
<td>Increase education and training of company personnel?</td>
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<tr>
<td>Publicize environmental efforts and accomplishments?</td>
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<tr>
<td>Promote industry cooperative efforts?</td>
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<tr>
<td>Construct environmentally sound performance measurement system?</td>
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<tr>
<td>Conduct environmental audits? Are operating practices reviewed for their environmental impact?</td>
</tr>
<tr>
<td>Use outside third parties to manage environmental issues?</td>
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</tbody>
</table>

**Impact level**

- Pollution control programs and technologies
- Disposal in landfill or with energy recovery
- Recycling
- Reuse
- Resource reduction and substitution