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**C a m b a s h i** Limited

## **“Going green” and the automotive product life cycle**

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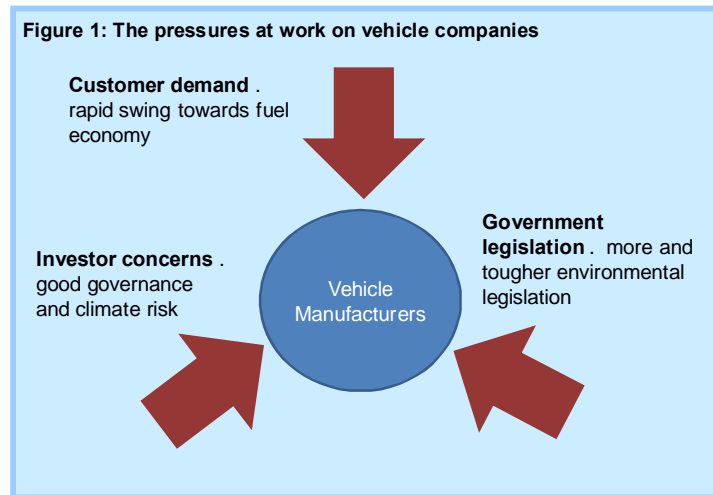
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## 1 Executive Summary

Three powerful market forces have come together to produce intense pressure on the vehicle manufacturers to develop new technologies and new vehicles. The first force is the rapidly changing demands of their customers. Over a relatively short time, and for a variety of reasons, a significant and growing proportion of car buyers has decided that they want to buy more fuel efficient vehicles. The second force is from investors and shareholders who have become increasingly concerned about ethical considerations, including climate damage, and the level of corporate risk present in their portfolios. Institutional investors have begun to ask major manufacturers, particularly those in industries with a significant carbon footprint, questions about how management teams will transition their corporations to a low carbon economy. While carbon disclosure is not yet a regulatory requirement, institutional investors increasingly regard the efforts of management to mitigate climate risk as an important indicator of good governance. For most executives the relationship between good governance and shareholder value has been established. The third force is regulatory. Governments around the globe have been enacting legislation to protect the environment in a variety of different ways and created a much more demanding compliance framework within which automotive companies must now operate.



This is not a new agenda . it is something the entire industry has been aware of and working towards for many years. However, the speed with which customer priorities and buying behaviour are changing has accelerated dramatically in the last year, driven by two recent phenomena - the dramatic rise in the cost of fuel and altered individual economic circumstances . the credit crunch. In the established markets where auto companies still make most of their revenue, the business impact of changed customer priorities has been considerable. In response, automakers are driving new sustainability initiatives and accelerating the pace of initiatives that are already in place.

Scientists may continue to seek irrefutable proof of the impact of green house gases on the atmosphere but this is no longer the main event. Similarly, it does not matter whether consumers are motivated by concern for the planet or simply driven by the

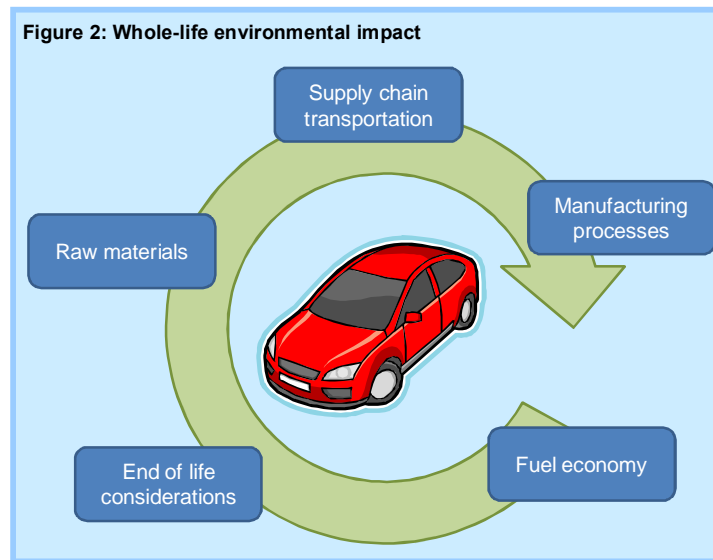


need for fuel economy, their priorities have unmistakably changed. Consumer buying patterns have changed much faster than most manufacturers can respond. Institutional investors consider carbon footprint trends as part of their risk assessment. Governments are acting in response to their national circumstances and the concerns of their citizens . both of which can vary by country and region.

This white paper assumes no ideological position but confines itself to the product, supply chain and manufacturing process implications of this new reality. In this paper we consider the broad implications for key automotive processes that follow from placing much more emphasis on issues of fuel economy in particular but also the broader environmental concerns that are increasingly important to customers. In particular we will consider how these changes may affect the individuals and teams engaged in design, development, engineering and production.

## 2 Sustainability issues

Pragmatism . the need to stay in business and make profits - is likely to dominate decision-making in the short term as the vehicle manufacturers (VMs) strive to adjust to these major changes in the market. Taking a whole life view of the environmental impact of the operations and products of VMs highlights a host of different issues . most of these are linked back in some way to design of the products and the processes by which vehicles are made. Some of the more significant issues are noted below.



### 2.1 Materials and logistics

Finding more environmentally responsible alternatives to current material and process choices is not easy. It goes far beyond the basic compliance issues associated with hazardous or prescribed materials. Environmental concerns have led to much more legislation to regulate the use of hazardous materials and manufacturing processes and forced the development and adoption of alternatives. At the same time a range of new materials continues to be developed that create new possibilities for substitution . for example to reduce weight. Use of new materials generally involves changes to the manufacturing process and requires consideration of environmental implications throughout product life. The use of composite materials may for example pose special challenges for material reclamation at end of life.

The rising price of oil has driven up both fuel prices and the costs of products derived from oil such as plastics and specialty chemicals. The oil price isn't the only factor driving a greatly altered landscape for VMs in terms of raw material availability and prices. Burgeoning demand from emerging economies is another major factor . driving up the price of steel and certain other commodities. Most energy prices are linked in some way to the price of oil, driving up the costs of materials, or components with high energy content, and influencing the selection and quantity of raw materials used.



## 2.2 Fuel choice, fuel economy and emissions

VMs want to deliver fuel economy for customers now, and offer a future vision of more improvements to come. This means looking at both incremental improvements to existing technologies and also the development of entirely new drive technologies. It is the single area of automotive technology that attracts the greatest scrutiny from environmentalists and, increasingly, the most attention from regulators. There are five big questions to answer when thinking about vehicle fuel:

- Does production of the fuel damage the environment?
- What additional delivery and storage infrastructure will be required?
- Is the fuel source sustainable?
- Does using the fuel release green house gases or other pollutants?
- Does recycling of the drive unit impact the environment?

The fuel and emissions area is one of intense activity for the automotive industry at the present time. Technical and the ethical arguments surrounding the various alternatives have become extraordinarily complicated. While some fuel alternatives offer the promise of ticking all the boxes they are still some way from being economically viable and deliverable to consumers.

A great deal of current development work is focused on refinement of petrol and diesel engines . driving up the overall efficiency of the engine. For conventional fuels, initiatives generally involve more sophisticated approaches to injection or ignition, potentially leading to more complex engine management systems. Another major focus for development teams is linked to designing engines capable of using fuels derived from renewable sources . the so-called bio-fuels. First generation fuels use food grade agricultural products . such as wheat or soya. Second generation fuels are also being developed that use non-food grade biomass. Government endorsements of bio-fuels have sparked debate about the extent to which switching land to the production of bio-fuel crops or competition for wheat or soya has been a contributory factor driving up food prices.

The industry is also looking at the full range of more radical, inventive and ingenious technical solutions ranging from hybrid technologies to fuel cells.

## 2.3 Manufacturing

Consideration needs to be taken of the energy and other natural resources consumed during manufacture of the product and operation of the manufacturing facility. And it is not just the factory. Also part of manufacturing activity is the environmental impact of the extensive logistics operations for the storage and transportation of components, sub-assemblies and finished products. Additionally, one must manage the discharge, disposal and re-use of pollutants, contaminants and scrap.

Automotive manufacturing is well structured, and this makes it possible to focus on individual areas. For example, the paint shop is responsible for perhaps 80% of water consumption and 40% of energy consumption at the assembly plant. A substantial part of the energy is used to run pollution management systems, which control the level of paint fumes and residues discharged into the atmosphere or into waste-water.



Collected residues are treated and aggregated into non-hazardous sludge, disposed of in landfills. This background makes improvements in paint shop operations particularly welcome, both on cost grounds (Ford<sup>1</sup> estimated their three-wet process improvement saved \$7 to \$11 per vehicle), and also on environmental grounds (significant reductions in emissions of CO<sub>2</sub> and volatile compounds).

It can be argued that initiatives on minimising utility bills have to some extent been tackled, certainly in newer plants and facilities. This is not necessarily the case throughout the supply chain. The next tranche of savings are likely to be more difficult to realise and will probably be the result of coordinated changes to both product design, choice of materials and adoption of new manufacturing processes. Continuous improvement manufacturing approaches such as six-sigma and lean manufacturing have delivered considerable improvements in recent years. However, lean manufacturing approaches deliver greatest results when applied to existing, relatively stable, manufacturing processes. and in this industry significant step changes are also required.

Future generations of cars are likely to use new materials, new fuels and new technologies. The changes to the product and the introduction of new processes highlight the opportunity for a radical re-think of all aspects of vehicle manufacturing activity. As the VMs move to embrace the environmental agenda more fully and more enthusiastically we should expect major, perhaps discontinuous, changes to established processes.

## 2.4 End of life considerations

There is a growing body of legislation to cover disassembly and disposal of vehicles. This is designed to ensure that cars do not end up in land fill at the end of life, raw materials are recovered for re-use and dangerous elements or substances are not released into the environment. The design team also needs to anticipate and eliminate problems associated with disassembly and facilitate the subsequent recycling of all vehicle components. This includes maximising the proportion of material that is available for re-use, capturing any pollutants, facilitating material separation and minimising the energy required.

The pressure on manufacturers to assume more responsibility for vehicles at end of life is likely to grow. This might be the catalyst for a more fundamental change to the sales business model. for example towards a lease rather than a sale model. There is some anecdotal evidence to support the assertion that manufacturers make better decisions in sustainability terms if the ownership of the vehicle is never transferred away from the manufacturer.

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<sup>1</sup> The details for new paint process example came from a Ford News release to be found at [http://media.ford.com/NEWSROOM/release\\_display.cfm?release=21798](http://media.ford.com/NEWSROOM/release_display.cfm?release=21798). There are many similar examples to be found throughout the manufacturing process and across the automotive industry.



### 3 Opportunity rather than problem

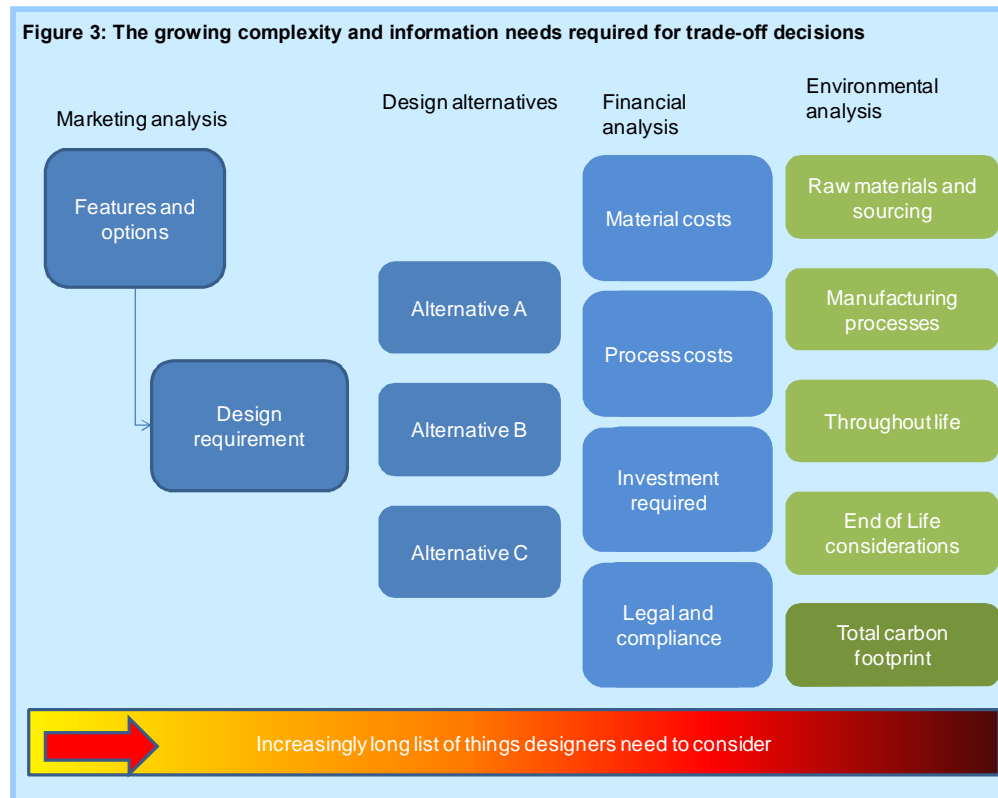
It would be easy to forget that the global automotive market is still set to grow. Much of the predicted growth will come from emerging markets in China, India, South America, Russia and other emerging economies in Asia. Customers in these markets do not want, for the most part, the current generation of vehicles. Similarly, one might be forgiven for thinking that the growing volume of compliance reporting obligations is an unnecessary burden for the industry. But the current demands of the regulators are likely in the longer term to prove far less onerous than the increasingly vocal demands of consumers and shareholders. While compliance remains a short term imperative, consumers will increasingly align with vendors who demonstrate commitment to values that they have already embraced. It is unlikely that compliance and PR alone will be sufficient to win market share and customer loyalty in the market. Automotive manufacturers need products with the right profile. Those who prove unable to respond quickly to this greatly altered market, face the prospect of losing market share to their more agile competitors.

It doesn't help that these major market changes come at a time when many of the established companies in the automotive industry have already been in difficulty for some years . with only a few manufacturers managing to avoid the general malaise. The list of challenges facing automotive companies covers everything from reduced customer loyalty to global imbalance between demand and supply. VMs are repositioning to address the environmental needs of customers whilst continuing to satisfy increasing customer expectations in areas such as quality, specifications and the opportunity for personalised product.



### 4 Finding the optimum design solution

In order to make an informed design decision, a whole new set of information and decision-making systems will be needed concerning the lifetime carbon impact of all the available alternatives under consideration. Information about the source of the materials, the processes utilised, the contribution to fuel economy, in-life servicing, parts replacement and eventual recovery and recycling all contribute to the lifetime carbon footprint. A defining characteristic of manufacturing activity is the need to make trade-off decisions . finding the optimum balance between conflicting requirements. The list of things that must be considered has become a whole lot longer! Since each decision has its own consequences and implications, the decision-making process becomes an order of magnitude more complicated. The regulatory environment means there are more constraints and additional boundary conditions, plus the associated reporting obligations, to consider. This is value engineering on a grand scale and will require fluency with the new language of sustainability issues.



The drive to develop more fuel efficient and sustainable vehicles is one of the factors contributing to the greatly increased complexity of today's vehicles. New engine and transmission technologies plus the inclusion of other advanced features such as anti-



lock braking systems have driven an explosion in the electronic content of cars . involving multiple microprocessors and control systems. These elements are a vital part of the tool-kit for delivering better fuel economy. In addition, moving control systems to software rather than dedicated devices offers VMs an opportunity to reduce overall product costs. As more of the functionality of the finished product depends on software, the product development and design process becomes truly multi-disciplinary and coordination between the various specialist teams becomes much more critical.

This multi-faceted technical design environment represents the perfect proving ground for Product Lifecycle Management solutions (PLM) to establish their value. Design has been something of a poor relation for some years, partly the result of isolation from many of the other key processes of the businesses. It is clear that design should be at the heart of all manufacturing businesses. The differentiation provided by the product itself is often the single most important factor driving competitive advantage in the market. Equally, success in almost every other part of the business depends on getting the design right . design for manufacture, design for serviceability, design for recycling and product quality. PLM systems provide an environment and a structure within which all of these variables can be captured.



## 5 Demand for much more information

Design and engineering teams increasingly depend on data supplied by specialists in many other parts of the company and the supply chain. The increased priority of sustainability concerns mandates a design environment in which ready access to all the relevant data is essential. In the automotive industry the outsourcing of manufacturing and design tasks is amongst the most extensive and advanced in the manufacturing sector.

The altered priorities of the VMs, and the pace with which change must be embraced, create a further challenge for the IT that supports the business. The collaboration environment needs, for example, to be able to promulgate design constraints, product philosophy and reporting methodology throughout the industry network and supply the more demanding information needs of the VM. The VM will ultimately be judged on the total performance of the green engineering+capability of their supply chain. They need to be able to demonstrate best-practice and sustainable decision-making throughout the industry network for which they are responsible. While we are currently enjoying some short term relief from the fuel price peak of July 2008, possibly the key catalyst for change in established markets, the likelihood is that these changes are not reversible . rather they will gather momentum with the passage of time.



## 6 Collaborative working and communication

The design, development and engineering teams are leading the automotive industry's effort to design and build more fuel-efficient and sustainable vehicles. These new vehicles may run on new fuels, incorporate new drive train technologies or control systems, make use of new materials and adopt new or altered manufacturing technologies. The scope and scale of the task creates a more demanding environment for the IT systems used by automotive makers to support their design, engineering, manufacturing and service activities.

All the vehicle manufacturers have outsourced their production activities extensively and their design activities to a greater or lesser degree. This industry operates within a well-developed legislative and regulatory framework in developed countries but suppliers, especially those in the lower tiers of the supply chain - may operate in countries with less stringent laws and control mechanisms. If the VMs wish to be seen as green leaders then they have to take a stand on driving best environmental practice down through their supply chain. Indeed it is a requirement of environmental management standards such as ISO14001 that they do so. The VMs ultimately must take full responsibility for the behaviour of their industry network and moving it towards a more environmentally responsible position.

It was not so long ago that design was something people did alone or in small teams. The shift to multi-disciplinary teams and geographical dispersed industry networks creates conditions in which the collaborative environment itself is able to communicate or even regulate issues such as design values and philosophy. The move to a more proscribed design environment is inevitable but is not a curb on the creativity of the individual. It simply ensures that all design effort is more aligned to achievement of the common goal.

Simulation tools are set to play an increasingly important role going forward. In part this is due to mounting pressure to shorten new product introduction processes. Simulation tools have already eliminated many time-consuming steps that previously involved the production of physical prototypes or even the creation of trial production lines. Perhaps more important, in terms of overall design efficiency of disparate teams, is the power such tools have to communicate, facilitate understanding and speed up decision-making in collaborative environments.



## 7 Governance and compliance

According to the old adage 'bad news travels fast' - and it has never been truer. We live in a world in which access to information is ubiquitous, instant and democratised. Everyone, from a journalist to an unhappy customer or an eco-warrior, who has a grievance or an agenda - now has an opportunity to publish their point of view and lobby for support. As a result automotive company operations are subject to higher levels of scrutiny than ever before. This is a direct consequence of our information society. Auto companies have their own excellent reasons to demonstrate transparency in their operations. It is a key aspect of good governance and it will become increasingly important as the means by which consumers validate companies' stated brand values.

Visibility, transparency, integrated reporting, traceability and auditability are vital for management systems that deliver governance and compliance. It is not possible to separate the good governance from the IT applications that support key business processes. The whole question of incorporating the principles of good governance goes far beyond the need to comply with legislation but perception across the enterprise does vary. In the boardroom of major corporations, the need for good governance - in the fullest sense - is no longer challenged. For staff and management throughout the enterprise however, the most visible aspect of good governance is often the need to deal with an ever increasing body of legislation and reporting. It is easy to see how the compliance task assumes priority - and is seen as a burden - while the principles of good governance may be quite remote.

Extending good governance into all aspects of operations - including design and engineering - has major implications for software applications. For example, intellectual property (IP) must always be protected. Equally, materials need to be traceable and design decisions need to be standardised, transparent and auditable. Lastly, decision-making criteria and processes need to be robust and able to withstand critical scrutiny. This is not a trivial task across a complex supply chain - the body of compliance legislation is already long and is still growing.



## 8 Conclusions

The challenge for the industry is to shift focus to a truly holistic view of the product and its whole-life environmental impact. In the short and medium term, consumer buying behaviour is the overpowering catalyst for change. VMs have made excellent progress on the cost saving aspects of good environmental management but need to address the green issue at a more fundamental level. They need to reposition their vehicle brands to be more closely aligned with the need for fuel economy and the broad environmental concerns of their customers . and all that this will entail in terms of changes to their operations. What is already clear is that compliance with legislation, suitable branding and focused PR is no longer sufficient justification for a VM to claim the high ground on the environmental debate. The VMs have to design products with differentiators that carry the green, sustainable, environmentally sensitive message.

Customer demand for economical and more environmentally friendly products is a powerful inducement for VMs to embrace the green agenda. In such a fiercely competitive market, the emphasis, for the next few years at least, will be on building new technologies into products that customers will buy . and doing so better and quicker than the next company. Engineers, scientists and designers will be the driving force of this renaissance. Making sure these individuals and teams have the best possible environment in which to work isn't just a high priority . it is the best possible way to minimise the biggest single risk the corporation is facing . loss of market share. Automotive companies are faced with re-engineering their future and they need software applications that are equal to the challenge and an environment within which innovation can flourish.