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Green Operations Strategy of a Luxury Car Manufacturer

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Abstract

This paper investigates the strategic environmental decisions of a luxury car manufacturer. Through case study research, the investigation sheds light on why and how the company is adopting green technologies. Being pressured by different stakeholders to become greener, luxury car manufacturers carry significant opportunities for environmental improvement given the nature of their manufacturing processes and products. Because of their low-volume production, manufacturers may be able to increase output and still reduce overall emissions when compared to high-volume manufacturers. In the case study company this was found to be possible only because of new ideas brought by a change in ownership. Luxury manufacturers may also be a test-bed for the development and experimentation of green technologies as part of a strategic approach to environmental initiatives. This paper contributes to the fields of green technology adoption and operations strategy in automotive manufacturing groups.

Keywords: *green operations, sustainability strategy, luxury cars, environmental decision making*.

Sustainability of the Automotive Industry

In the UK, a car manufacturer brings significant contributions to the regional economy by creating jobs and enhancing exports (SMMT, 2009). But in contrast to the socio-economic benefits, there are significant negative environmental impacts from car production, distribution, use, and end-of-life. Due to its topicality and perceived environmental burden, the sustainability of the automotive industry has been studied by several researchers (Cohen, 2012; Orsato and Wells, 2007; Vergragt and Brown, 2007).

The sustainability of car manufacturers is scrutinised continuously given their high vulnerability to economic instability, overcapacity of industrial systems, impact on traffic congestion and urban air pollution, and finally, deaths from accidents. Several authors have attempted to conceptualise what a sustainable car industry would be. For many, it could be described as “a provider of clean solutions for effective personal mobility”. Such a change of ‘philosophy’ would impact dramatically on manufacturer’s strategic environmental initiatives and the way cars are built, run, and disposed of.

The industry’s strategic agenda includes use of lighter and less toxic materials, alternative fuels, and integration of information technology in product design. However, it will depend on innovative manufacturing systems to reduce cost and make cars safe and reliable when seeking higher environmental performance. All these issues are emerging at a time when there are new entrants to the industry, with Google’s driverless car and Tesla’s electric roadster being among the future competitors without any automotive heritage.

This paper discusses the environmental initiatives in manufacturing operations of a luxury car manufacturer based in the UK. There has been little work in exploring the strategic importance of greening luxury brands and its consequent challenges and opportunities for the operations function, so this study discusses the strategic side of environmental drivers and decision making processes used in luxury car production.The study’s scope is limited to the environmental initiatives and decisions relating to the manufacturing processes of one British luxury car company.

Green Operations Strategy as a concept

Studies in the 1990s, showed that environmental decisions for pollution prevention technologies were superior and better aligned with business goals than pollution control technologies (Klassen and Whybark, 1999; Shrivastava, 1995). Nevertheless, there is a need to advance knowledge on how better strategies can be made within the operations function beyond the dichotomy of pollution prevention versus control. With little done on the conceptualisation of green operations, most existing work was undertake tactical and operational decisions. At a strategic level, the main findings are about the drivers for greening businesses and their influence on operations performance. The main drivers identified are the same as in corporate sustainability studies (Hall, 2000; Hoffman, 2000), namely: legislation, customers, internal policy, competitors, performance gains, and corporate image.

In this paper, we define Green Operations Strategy as “a deliberate plan, focused primarily on the long-term, which aims at responding to environmental pressures on products and production systems when creating socio-economic value”. It is intended to better position the company against competitors under the view of sustainable development by considering the availability of resources, its impact on the environment, and social ethics for both products and transformation processes. Green operations strategy widens the scope of sustainability analysis beyond manufacturing, which increases complexity and uncertainty in the decision making process.

Two main approaches have emerged from the literature on green operations management. The first is focused on the decision making processes. It aims to enhance sustainability performance by adding sustainability criteria to strategic decision making in the operations function (Gupta, 1995; Sarkis, 1995; Stonebraker et al, 2009). The second is based on the adoption of (so-called) sustainable operations practices, which can be understood as the combination of green operations practices and corporate social responsibility initiatives. Various authors have tried to identify and classify the different sustainability and environmental operations practices. From recent compilations on these initiatives (Kleindorfer et al, 2005; Nunes and Bennett, 2010), sustainable operations practices are seen as comprising seven main initiatives that cover all areas of the operations function (see Figure 1).

The implementation of these initiatives is difficult for operations strategists given the number of stakeholders and important trade-offs. Consequently, questions such as how a company should implement sustainable operations practices still remain e.g. there are still gaps in the literature on how to make environmental decisions, select green technologies or implement sustainability initiatives across brands in the same corporate groups.

Undeniably, these decisions are influenced by established drivers (Sarkis et al, 2010) and involve the allocation of resources in the seven sustainable operations practices shown in Figure 1. Historically, the main strategic response from car manufacturers has been reactive (Orsato and Wells, 2007) and limited to legislative pressures. Companies that have moved from reactive to proactive behaviour and expanded their initiatives from process-based only to incorporating product environmental interventions (Nunes and Bennett, 2010; Martinuzzi et al, 2011) have incurred a business risk. Eventually, green operations strategy will inform why, when, where, and how to adopt improvements in the different areas of operations through a selected set of practices.

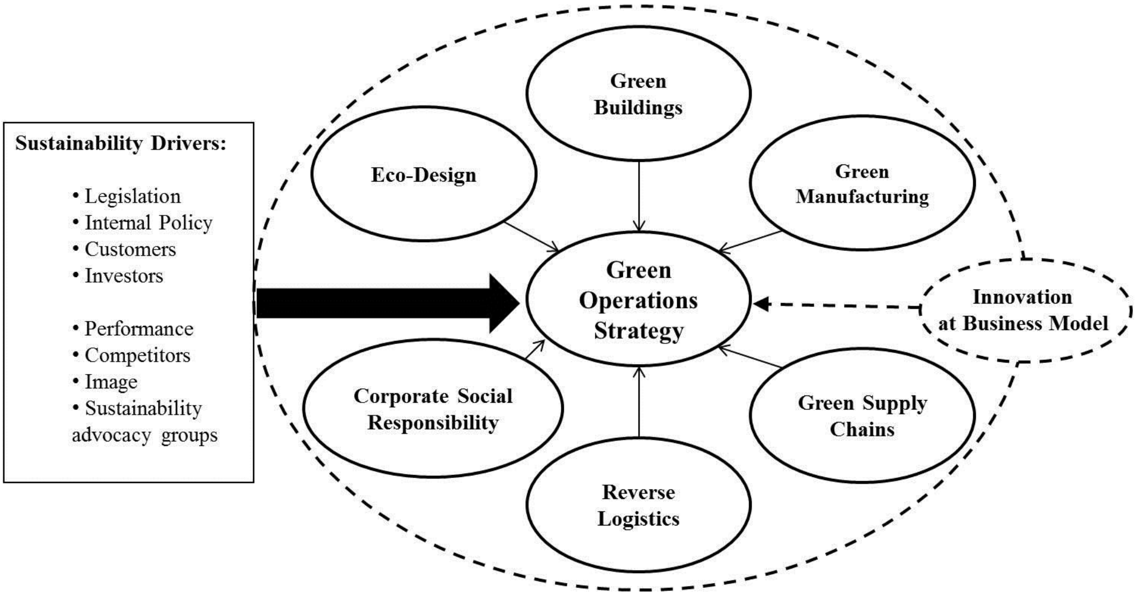

Figure 1 – Main sustainability drivers, sustainable operations practices, and green operations strategy.

Managing green technologies

A critical step for companies is identifying emerging trends and responding to them adequately (Vecchiato and Roveda, 2010). As green technology and sustainability have become key inputs to such foresight (Liu et al, 2011), trends such as stricter environmental legislation or increasing willingness to pay for green products should be considered when strategically developing environmental technologies.

Zhu et al (2007) advanced the understanding of the relationship between drivers, adoption of green practices, and environmental performance. However, knowledge in this area still remains superficial and the gap between the environmental challenges and how companies respond to them remains wide. A central competence necessary to successfully implement a green operations strategy is the management of green technologies. Management of technology is concerned with "the management of technological capabilities to shape and accomplish the strategic and operational objectives of an organization" (Cetindamar et al, 2010). Hence, management of green technology includes the identification, selection, acquisition, exploitation, learning, protection, and dissemination of technologies that enables an organisation to reduce its environmental impacts.

In the automotive sector, green technologies are used in all domains of the sustainable operations practices presented in Figure 1. For instance, by adopting eco-design as part of a green operations strategy, car manufacturers consider engine technologies that allow higher fuel efficiency, support fuel diversification, or reduced emissions. A well-known example is the Toyota Prius that uses battery technology in conjunction with an internal combustion engine. On production facilities (green buildings and green manufacturing), Nunes and Bennett (2010) report that both Toyota and GM reduced their plants' oil dependency by using landfill gas, wind and solar energy. Consequently, the use of "green power technologies" leads to better price stability, higher energy security, and significant reductions of CO_2 emissions. Green technologies are conceived from an economic-ecological motivation to seek win-win solutions (both private profit and public benefit through lower environmental impact).

The adoption of green technologies is nonetheless vulnerable to many socio-economic factors beyond the obvious technological feasibility analyses. The 'transition' to a greener economy has been studied by many scholars (Kemp, 1994; Geels, 2005; Schot and Geels, 2008; Steward, 2012; Wells and Nieuwenhuis, 2012), with much being published in the area of innovation management and policy studies. The concept of strategic niche management (SNM) is particularly relevant here and some experts believe that green technologies can penetrate markets and facilitate the transition to a greener future through strategic niches (Smith, 2007; Schot and Geels, 2008).

> "A core assumption of the SNM approach is that sustainable innovation journeys can be facilitated by modulation of technological niches, i.e. protected spaces that allow nurturing and experimentation with the co-evolution of technology, user practices, and regulatory structures" (Schot and Geels, 2008).

However, it is important to differentiate market niches from technological niches. Market niches are for a dedicated group of users (Bakker et al, 2012) and the context where technological niches interact with market niches is usually called a socio-technical *regime* (Geels, 2002; Schot and Geels, 2008). We now present the current car classification (market niche) as well as how luxury brands relate to sustainability issues and may become instrumental in the development of green technologies.

The market segments in the automotive industry

Automobile classifications use various different sets of criteria (e.g. body type, engine size, etc), but broadly they can be separated into two categories: passenger cars and commercial vehicles. Within the passenger cars category, vehicle classification remains important for many reasons. For example, it is useful for road tax purposes, to determine car rental prices, and for calculating insurance premiums. Car market segmentation is defined in European law through the use of classifications by The European New Car Assessment Programme (EuroNCAP, 2013) and the Association of Car Rental Industry System Standards (ACRISS, 2013). The USA's Environmental Protection Agency (EPA, 2013) uses vehicle classes that are closer to the classification of the European NCAP. A comparison of the EPA, the EuroNCAP and the ACRISS classification is presented in Table 1.

Table 1 – Car classification (USA, Europe and ACRISS)

US EPA Size Class (EPA, 2013)	Euro Market Segment (EC, 1999)	Car equivalent in the ACRISS vehicle guide
N/A Minicompact	A-segment mini cars	Peugeot 1007, Mercedes Smart Fortwo
Subcompact	B-segment small cars	Opel Corsa, Fiat Punto
Compact	C-segment medium cars	Citroen C4, Ford Focus 2.0
Mid-size N/A	D-segment large cars	Ford Mondeo, Alfa Romeo 159
Large N/A	E-segment executive cars	Audi A4 2.0, Audi A5 2.0
N/A	F-segment luxury cars	Chrysler 300, BMW 6 Series
Two-seater	S-segment sports coupés	Porsche 911 Carrera S*
Minivan	M-segment multi-purpose cars	Opel Zafira*, Ford Galaxy*
Cargo van		
Passenger van		
Small Sport Utility Vehicle	J-segment sport utility cars (including off-road vehicles)	Volkswagen Touareg Auto*, Land Rover Discovery*
Standard Sport Utility Vehicle		
Small Pickup Truck	—	--
Standard Pickup Truck		
Special purpose vehicle	—	--

*Cars not in the ACRISS vehicle guide, but were found in the vehicle guide used by companies that are currently ACRISS members.

In practice, the boundaries between these segments are blurred by factors other than the size or length of cars. As CEC (1999) points out, sub-categories of luxury cars may also be considered based on price, image, and accessories. Also, luxury car manufacturers have for a long time advertised their superiority in design and engineering as well as the usual characteristics of the elite market (Berger, 2001). The recently created models for the so-called “affordable” luxury segment create more difficulty in assigning modern cars to the luxury segment based on history, brand and technology.

To understand the concept of a luxury market, it is necessary to examine the ‘Theory of Luxury’. As a simplification, companies usually compete through three strategies: “luxury”, “premium”, and “fashion” (Kapferer and Bastien, 2009), with “luxury” companies focusing on customer desire, timeless products and design, exclusivity, and an almost religious cult among customers. Luxury companies set prices in response to the average affluence in society. They are very careful about increasing production capacity and output volume since their aim is to realise customers' value for exclusivity, refined taste, and of course wealth. In the automotive industry brands such as Aston Martin, Ferrari, and Rolls Royce are examples.

On the other hand, a "premium" strategy follows a path in which automotive companies compete to offer 'perfect' products where price is justified by performance and features of their cars; not by desire and exclusivity (Kapferer and Bastien, 2009a). Brands like Audi, Lexus, and Volvo are positioned within a premium strategy.

The "fashion" segment is concerned with short-term trends in order to sell products in high volumes. Timing is important to reinvent the brand with little or no recourse to company heritage or exclusivity. As a result, price is a factor in attracting new customers and increasing sales volumes. The main brands here include Toyota, Opel, Volkswagen, and Hyundai.

According to this logic, luxury cars are not intended to address only consumer 'needs' (mobility), but also to create a hedonistic feeling of indulgence (Kivetz and Simonson, 2002a). Luxury is defined as "a non-essential item or service that contributes to luxurious living; an indulgence or convenience beyond the indispensable minimum" (Kivetz and Simonson, 2002b). Although the role of technology is not mentioned in the definition, it is nevertheless key when analysing the automotive industry. This may be because cars are more complex and expensive products than other luxury items such as leather goods, skincare products, jewelry, and shoes. Technology may not be the order-winning priority for makers of luxury cars; however, all evoke their cars as a 'magic' result of art and science, design and engineering, style and performance. As a result, there is evidence of luxury companies being forerunners in the use of technologies such as aerodynamics, navigation systems, start-stop engines, anti-theft, and aluminum chassis.

In this paper, luxury cars are defined as "*the segment in the automotive industry which seeks to win customer orders through superior design, engineering, and image by offering differentiation beyond customers' standard mobility needs, and exclusivity in their products"*. Through superior design and engineering, luxury car manufacturers build an image of wealth and exclusive style associated with superior performance and the use of advanced technologies. Furthermore, the luxury car market may imply maintaining craft-based manual production processes in their assembly lines or using more sophisticated materials for some products that are based on an image of heritage or traditional values.

Luxury cars and sustainability

Most manufacturers of high-end products, such as luxury cars, tend to have low-volume production facilities, highly-aggregate value, and carry innovations that often are passed on later as standard features for the high-volume markets (Catry, 2003; Reinhart and Illing, 2003). Sometimes, being the cradle of such features means that luxury manufacturers also have an important role in developing expertise in engineering, and for the development and maturation of advanced technologies alongside the provision of high-skilled jobs. For instance, there is a path of technologies that starts with luxury cars and cascades to volume markets due to their high initial investments or production cost (e.g. airbags, ABS - Anti-lock Braking Systems, telematic devices). Luxury car manufacturers are therefore important for the development, testing and maturation of driver and passenger technologies before their migration to volume production. Thus, luxury cars can indeed be a strategic platform to introduce green technologies into the industry. For example, Axon Automotive aims to use Formula 1 technology to make cars light, safe and fuel efficient (Axon, 2009) while Tesla Motors develops electric roadsters (Newman, 2009).

Their unique nature in relation to the value of the product puts interesting issues onto the research agenda after extrapolating simple functionality for the customer. Although they have a significant individual environmental impact due to their high value and low volumes, they could score well when evaluated by their ratio of emissions per unit of economic value contribution. For instance, a novel approach has been developed by Hahn et al (2008) to assess 16 automotive companies based on the sustainable value methodology. Their results show BMW group as an environmental leader only behind Toyota on sustainability value.

Also, surprising, a research study shows that an average Bentley car travels approximately 11,000 Km per year, and emits 4.4 tonnes of CO_2 – the equivalent of travelling 23,000 Km in a medium size family saloon. In fact, the unique characteristics of luxury cars have been among the reasons that low-volume car manufacturers have lobbied to be exempted from EU legislation on CO_2 emissions per kilometre (Financial Times, 2009). Indeed, it is necessary to better understand the role and influence of this market niche within the whole automotive sector. For instance, they have played an important role in the development of engineering expertise, engine efficiency and power, alternative materials, and driver and passengers' safety features as well as other advanced driving technologies.

Accounting for luxury brands in automotive groups' sustainability strategies

Today, many of the luxury car brands belong to larger automotive groups (e.g. Ferrari is part of Fiat Chrysler Automobiles) and must contribute to increasing the group's business sustainability. Such strategy could positively impact on socio-economic performance and build better products for sustainable personal mobility. For example, the use of strategic niche management can be instrumental for maturing complex (green) technologies (Schot and Geels 2008; Smith 2007). The luxury automotive market niche is considered as an application to trigger the infrastructure of a *hydrogen economy* (Ekins and Hughes, 2009) and hydrogen powered vehicles (Ekins and Hughes, 2010). Geels (2005) discusses the transition pathway from horse-drawn carriages to automobiles showing how the luxury market niche was important in adopting electric and fossil-fuel engines technologies.

With the emergence of "BRICS" countries (Brazil, Russia, India, China, and South Africa), there are new markets for luxury products. Companies that explore these markets can substantially improve profitability and contribute to a group's financial performance and home-country economy both through exports and high-skilled jobs, which are two important socio-economic benefits. Ijaouane and Kapferer (2012) investigated the synergies between luxury brands and their groups on various facets of their business: financial, market, operations, and corporate spheres. The same needs to be considered when building on the sustainability of luxury brands including experimentation with new technologies (e.g. aerodynamics, new materials). If green technologies are included in the strategic plan, luxury brands can be the pioneers of sustainable mobility as they were for some safety issues (e.g. airbags, braking systems).

Lastly, luxury brands have a high individual environmental impact but a very low collective impact as fleets are relatively small, and production systems are based on craftsmanship. Figure 2 shows the established market segments and their characteristics for exclusivity, design and performance against individual and collective environmental impact. The size of the ellipses in Figure 2 indicates their relative production volumes.

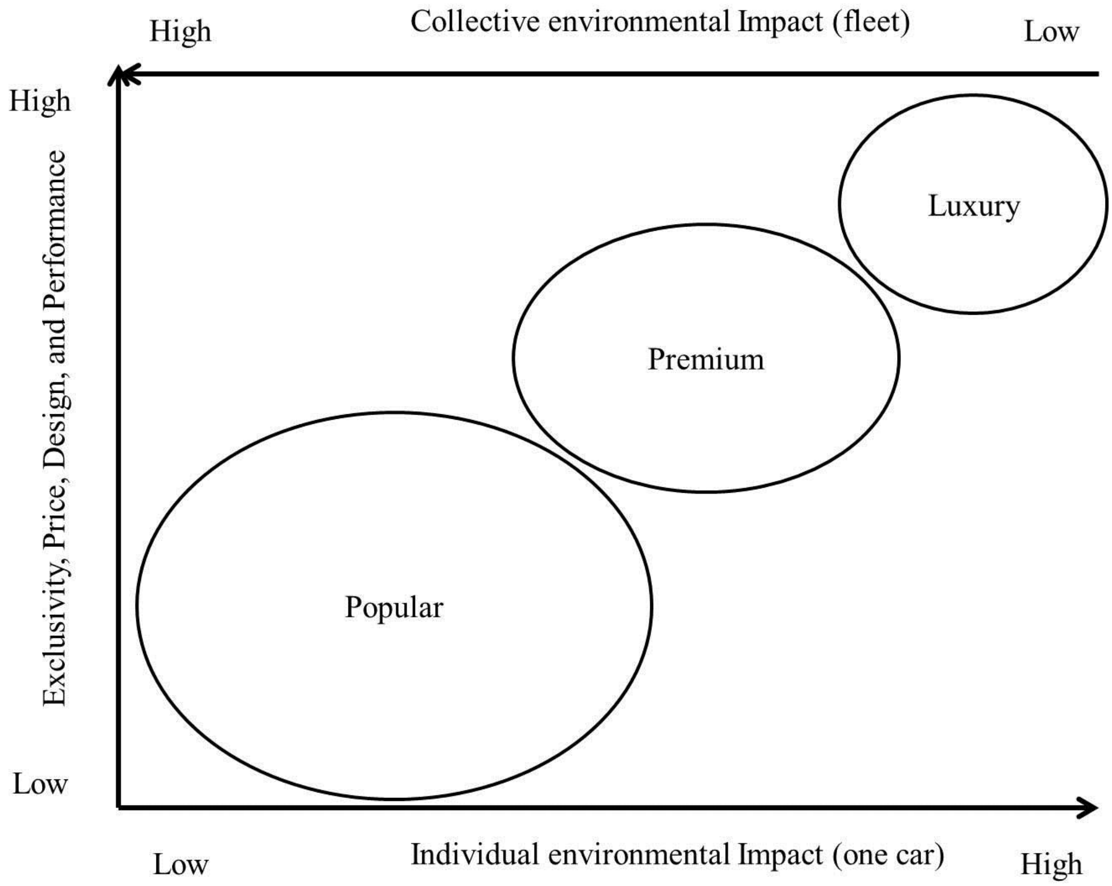

Figure 2 –Car segments characteristics and their environmental impact

Methodology

This paper addresses three research questions:

RQ1. Why does a luxury car manufacturer adopt green operations practices?
RQ2. How does a luxury brand compare to a volume car manufacturer?
RQ3. What is the potential contribution of a luxury car manufacturer for the environmental strategy of a larger automotive group?

The methodology used for this investigation was case study research and the scope of analysis was the manufacturing function, including materials and parts supply. The first phase of the investigation comprised the analysis of secondary data on the company's environmental initiatives which were collated in conjunction with items in the business press, in order to contextualise the external pressure and possible drivers for the green operations strategy. These were supplemented by two interviews with the Environmental Manager (EM) of the company. These interviews were guided by a semi-structured questionnaire covering company and interviewee profiles, environmental perceptions, the decision drivers, environmental performance measures, origins of ideas, and the process by which management makes environmental decision. The variables were adapted from previous studies on environmental management in automobile manufacturers (Zhu et al, 2007). An evidence-based approach was used to achieve a deeper understanding of strategic environmental decision making in the case company. We had access to the factory floor and internal documents to triangulate with information from interviews.

This study was part of a broader research project with 9 car manufacturers, in which the authors tested an environmental decision making model developed under the principles of systems thinking. Two other companies in the project belong to the same automotive group as the case company. This paper reveals only the primary data collected and the discussions arising from the exploratory research in the luxury company case, together with a comparison against the mass-producers of cars.

Comparing the case company with a volume manufacturer provided a understanding about the magnitude of change in the company as well as a qualitative analysis of green technology integration across brands. Furthermore, car manufacturers are subject to specific legislation in different places based on the average emission of their fleet. They have also been pressurised recently to disclose environmental performance in each manufacturing plant. So, why would an automotive group acquire a luxury car manufacturer given their traditional poor environmental performance? By comparing a luxury brand against the leading volume car manufacturer (Toyota), we were able to better understand their impact and roles within the whole environmental strategy of an automotive group. Toyota was chosen not only because it is the largest car manufacturer, but also because it is at the top of the environmental rankings in many environmental studies (e.g. Hahn et al, 2008).

As with most case study research there are issues of generalisability of the findings (Yin, 2003). In this investigation it relates to theory building about green operations strategy and environmental decision making for car manufacture rather than to the results from previous studies that have focused largely on the achievements of companies after the implementation of environmental initiatives.

Findings

Below we present the company and interviewee profiles followed by the main findings from the primary and secondary data.

Company and interviewee profiles

The case company is a luxury car manufacturer based in the UK that is part of an international automotive group. We have given the fictitious name of ***“Waltham”*** to the company and ***“Popular Cars Group (PCG)”*** to the automotive group it belongs to.

Waltham is a major employer in the region. At its peak in 2008, production exceeded 10,000 cars employing 4,000 workers. In the factory, the production of highly customised cars in low volumes creates a combination of factors that, together with the company’s employment benefits, keeps the attendance rate for employees to 97.7%. The level of customisation reduces the amount of repetitive work and the low volume, coupled with high quality, although requiring enormous attention, demands less physical work and pressure from the assembly line associates. The personnel turnover at Waltham is around 3% per year.

There are very few robots and most of the assembly work is manual. Car bodies are made and painted in-house, but the press shop is located in another city. The factory also produces two types of engine (W8 and W12).

The principal interviewee was the company’s Environmental Manager (EM). The EM had worked at Waltham since 1977 and had previously been responsible for several departments as maintenance engineer, plant engineer, and technical engineer. He became EM in October 2007.

According to EM, in the past Waltham had little to be proud of regarding its environmental performance. A combination of old facilities and infrastructure (mainly out-of-date equipment) did not help the company’s figures for harmful emissions.

Although a lot has improved, the plant is still close to the permitted emission limits of the local council.

EM believes that Waltham has greatly improved its environmental performance over the last 20 years. An Environmental Management System (EMS) is in place and the company has moved from a situation of simple legal compliance to a more ethical and environmental position. EM summarises the change:

> *"In the beginning, the main drivers were legal compliance and cost savings. Some of ethics and environmental issues were a motivation. Now, ethics and environmental argument has become top of the reasons for what we do".*

EM main responsibility is to make Waltham's EMS to meet the company's environmental objectives and goals.

Drivers, justification and support for actions

A milestone for the environmental initiatives taken by the company was its acquisition by the Popular Cars Group (PCG) in the 1990s. Although PCG's principles were only formally applied to Waltham in 2007, the initial investments (GBP 120 million) contributed considerably to plant alterations, and therefore to its environmental improvements. As Waltham is still repaying PCG for its investments, the parent group has a big influence on what Waltham does.

The justification for environmental initiatives includes the need for more efficient technologies to achieve better environmental performance, mainly to stay ahead of environmental legislation, ensure rapid return on investments, and achieve cost reduction. Being part of an international group its awareness was raised about environmental benchmarks and management systems standards. For example, the ISO14001 EMS was implemented in 1999 because it was the global standard and the best system for controlling environmental aspects in the plant. In the early 1990s, Waltham was producing 1,400 cars a year, mostly older models using an old infrastructure. Then, the company was facing financial problems so the environmental technologies and initiatives needed to have a good return on investment.

Further to the involvement of PCG in Waltham's strategic decisions, an important adjustment for environmental projects' payback time broadened the horizons for "green" investments. The payback for such investments was extended from 2 years to 5 years (although 2 years was still used for "normal" projects). This would play an important role as previous experience was used to assess an environmental investment over such a short period.

Process of environmental decision making

Decisions about environmental improvements are usually made by hybrid teams. EM says that these teams are composed of "appropriate people" (i.e. people whose department is related to the decision). For instance, maintenance, environment, small projects, and production planning are often among the departments that are represented. So far, there is not a structured approach for environmental decision making. However, an improvement model is being introduced for strategic and operational decisions.

The improvement model seeks to strategically integrate engineering and business plans. Also, the model should consider short term activities such as recycling, energy saving, and materials as well as long-term leadership action to make Waltham a credible green company.

Origins of ideas

The ideas that result in environmental initiatives at Waltham come from different sources: external consultants, in-house experts, local teams and a PCG "best practices database". External consultants are more involved with strategic decisions and highly specialised technical solutions for operations. On the other hand, local teams participate in waste minimisation challenges to identify potential savings in the plant regardless of their department.

Those local teams are involved in a programme called "environmental champions on site". In the production department, they have monthly meetings to present "ideas to save". According to EM, this changes peoples' behaviour, not only in the top administration but everywhere in the company. As a concrete result, it was estimated that GBP 120,000 per year was saved in energy costs due to the environmental champions' challenges.

Environmental Initiatives, performance measures, and benefits

EM took responsibility for Waltham meeting the Popular Car Group's environmental principles. He revealed that Waltham has recently joined the PCG group database for knowledge sharing and as a benchmark Waltham scored higher than some other PCG units.

Environmental initiatives in Waltham include ISO14001 EMS (implemented in 1999), and minimisation of CO_2 emissions, water usage, energy utilisation, and waste generation. Besides CO_2 emissions, energy, water and waste, there are other key performance indicators for the plant such as green travel and car parking.

More specifically relating to Waltham's manufacturing processes, the paint shop uses water-borne systems to reduce solvent use. Some key processes have individual metering to check their environmental performance e.g. those emitting Volatile Organic Compounds (VOCs).

Investments in boiler technology have proven effective in reducing fuel consumption by 31% from 1999 to 2006, even though a second shift was started in 2002. In addition, despite production having increased by more than 500% from 1998 to 2007, the total energy used was reduced by 28% and energy used per car by 86%. Following a similar pattern, absolute plant CO_2 emissions were reduced by 23% while plant emissions per car fell by 85%. Also total water consumption, water used per car and total waste produced were reduced by 28%, 86% and 86% respectively.

On Waltham's future strategy, its short term goals include a further reduction in plant carbon emissions per car by 20% compared to 2006 through continued cross functional energy team activities.

Waste management is important in Waltham's EMS. There is an environmental goal of making 85% of all waste go to recycling or for reuse whereas currently this is around 65%. Another example of waste management is provided by the recognition of the value of leather as a manufacturing by-product. All the leather waste is commercialised and sold locally. Also, total waste recycled has increased by 66%.

Waltham's Environmental Strategy 2008-2017 encompasses its long term goals under the aspiration to be a world-class sustainable manufacturer. Together with the environmental concerns, there are goals for health and safety – Waltham had an 85% reduction in incidents between 2001 and 2006.

Discussion of findings

Data analysis shows that Waltham is experiencing a positive change in its environmental awareness and attitudes. While in the past there was a lack of initiatives, the company has been investing with a more balanced view of environmental-economic concerns for more than 10 consecutive years. The main objectives for manufacturing and facilities management continue to be compliance with environmental legislation and cost reduction. Nevertheless, there is a better understanding of how low environmental performance can harm the company's image and the missed opportunities of higher manufacturing performance, cost reductions, and better productivity.

Being part of a larger international automotive group, Waltham had access to greater investment to improve the old infrastructure and (consequently) environmental performance. It prioritised green manufacturing and green buildings investments, and green supply chain management to a lesser extent. Indeed, triggered by a healthier financial status, it is clear that manufacturing operations have led environmental initiatives.

The group has also enhanced access to knowledge for greener manufacturing and provides environmental benchmarks. Waltham has recently had access to the database for sharing knowledge with other companies in the group. This increased environmental awareness applies pressure to be more competitive and to reduce costs further. The extended payback (5 years) benefits the adoption of environmentally-friendly technologies when they do not meet short-term return on investment goals. This is particularly important since win-win alternatives are not always easy (Orsato, 2006).

The primary data reveals that the company obtains help from consultants for strategic decisions, specialists and in-house experts for technical issues, mostly tactical decisions, and finally internal personnel contribute to operational decisions ("ideas to save").
The environmental and economic gains are impressive; but they are likely to be high because of the lack of initiatives in the beginning – similar to the high-volume manufacturers. Moreover, the relative gains per unit are also high due the low production volume. This demonstrates the potential for low-volume luxury goods manufacturers when implementing environmental initiatives in comparison to high-volume manufacturers.

As a parameter of comparison, Toyota is generally regarded as the most efficient automotive company and was rated with the highest sustainable value in the IZT study (Hahn et al, 2008). For this reason, Toyota has been chosen to illustrate the historical evolution in production and production emissions as the benchmark for high-volume manufacturers. From 1998 to 2007 Toyota increased its production by 84% and reduced total CO_2 emissions in production by 25% (Toyota, 2008). The production emissions per car were also reduced by 53%.

On the other hand, Waltham increased production by 506% (1998-2007), almost 60 times more than Toyota during this period. From 2000 to 2007, production increased by 383%, while total emissions reduced by 25% and emissions per car by 84%. Although having a similar reduction for total emissions, the luxury car manufacturer was able to reduce even more per unit in a shorter period of time than Toyota. The difference in the emissions per car between the two companies is explained by three major reasons: outsourcing of key manufacturing processes such as the press shop, level of automation, and finally, effluent and water treatment stations.

Despite having a similar reduction pattern in a shorter time, and even a higher reduction in the CO_2 emissions per car, based on their environmental reports companies such as Toyota have been implementing more sophisticated environmental initiatives than Waltham. These include the use of alternative energy (solar and wind power), as well as other types of relevant production technologies to reduce impact on main aspects of the environment such as: water, air, human health, and biodiversity.

The EM agrees with the above analysis. He thinks it will not be easy for its plant to be an environmental leader in the automotive sector. Literature on the car industry and sustainability shows that small plants working with a different business model (such as product-service systems) may be in the vanguard for green leadership in car manufacturing (Wells and Orsato, 2005). However, most conventional factories may need a bigger effort in pursuing this goal.

Conclusions and limitations

Manufacturing strategy researchers have identified the need to study environmental issues. In undertaking the investigations for this paper there was the opportunity of looking *in loco* at how a manufacturing environmental strategy was being implemented in a luxury car manufacturer. The change and role of company ownership was found to play an important part in developing and implementing a green operations strategy. Also, luxury car manufacturers may be able to increase production and reduce emissions simultaneously due to their low-volume production systems. It can be inferred from the history of technological development for safety and advanced driving features that luxury cars may play a strategic role in building greener vehicles. Luxury cars can serve for experimentation and maturation of green technologies, and therefore, test eco-materials, clean fuels, etc. Indeed, those possible changes in the product will affect manufacturing processes and this is where luxury car manufacturers could become a platform for process-based environmental excellence – perhaps including a new concept of small factories suggested by Williams (2006).

Nevertheless, the figures for reductions in waste, energy and water might not be replicated if another company in a different market segment tries to implement the same environmental initiatives, and this is a limitation of doing single case study research. The practical implications begin with the fact that manufacturers of luxury goods can benefit from environmental initiatives. Within the new competition context, luxury goods will also need to associate an environmental-friendliness image with their brands.

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