8 Steps for Managing Green Innovation in the Automotive Industry

By Breno Nunes, David Bennett & Duncan Shaw

The car is dead, long live the car! We are about to celebrate 100 years of Ford model T, the most iconic symbol of the popularisation of cars as the means of personal mobility. The automotive industry is going through an incredible journey of redefining its purpose and the traditional characteristics of its products. More than ever, car manufacturers will need to develop and effectively implement a meaningful green innovation strategy if they want to survive in the new automotive era.

The Crowded and Smoggy Road Ahead

There are approximately 1 billion automobiles in the world. In 2012, world production went above 84 million vehicles. With the increasing global demand for cars, it is estimated that there will be 2 billion of them by 2020. In fact, with 10 billion people living on Planet Earth by 2050, we could have around 6 billion cars registered if developing countries follow the same patterns of mobility and car ownership as the USA and Europe. When Henry Ford's assembly line was aimed at producing for mass market, his philosophical drivers included personal mobility and freedom. For 100 years, cars could deliver this – and they still do in many of the World's newly industrialised nations. However, nowadays cars are no longer synonymous with personal mobility and freedom. For people living in megacities (think of São Paulo, Tokyo, and Jakarta) the use of automobiles is not only reducing personal mobility and freedom but is also a reason for poor urban air quality, fatal accidents and increasing concerns about end-of-life waste and landfill availability.

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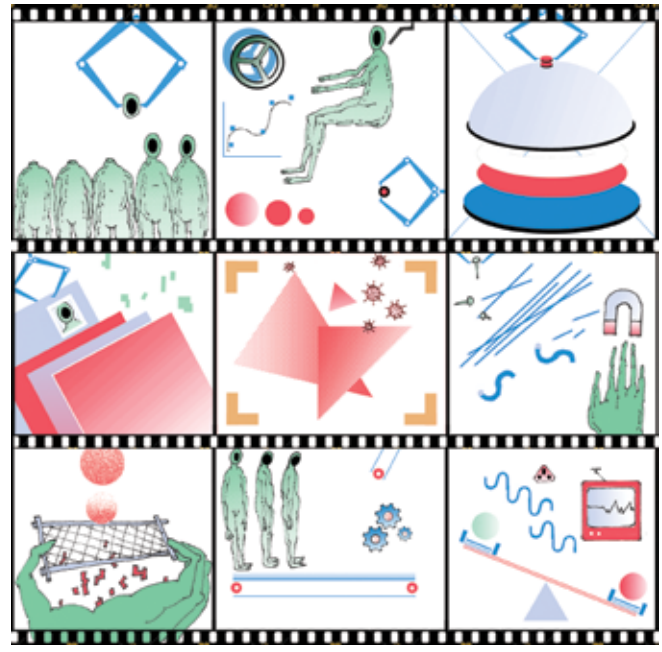
The question of "greening" the automotive industry no longer has a "yes or no" answer. The debate has moved on from "why" to "how" and "by when", such that the greening innovations support other business conditions including profitability, customer satisfaction, product safety, and reliability.

The 21st century brought new concerns and pressures to the way companies innovate. In the past, innovation was predominantly driven by the intention of exceeding customers' expectations or to create simpler and less costly processes, but now organisations are responding to environmental and social demands.



With regard to the environment, the major environmental concerns in this century are: atmospheric pollution (and its consequences for human health, global warming and ozone layer depletion), energy and food security, scarcity of freshwater and raw materials, and land availability. These environmental concerns have a profound impact on how companies manage their business, and so drive innovation. For instance, in Europe alone between 8 and 9 million tonnes is generated each year from end-of-life automotive waste[1]. As a consequence, the availability of land puts pressure on the prices for landfill disposal, which "forces" car manufacturers to innovate in order to reduce waste from their production sites and end-of-life products.

Conceptualising Green Innovation and Green Innovation Management

Within this new context for innovation management, we define **green innovation** as "those innovations in products, processes, or the business model that lead the company to higher levels of environmental sustainability". A higher level of organisational environmental sustainability is reached by minimising environmental impacts, mainly through creating positive impacts on society and its environment. This is aimed at enhancing the conservation of ecological resources, and maintaining or improving the equilibrium between human beings, other species, and their natural world.

Consequently, **Green Innovation Management** is defined as "the process to identify, implement, and monitor new ideas that improve company's environmental performance while enhancing its competitiveness". Identification includes understanding environmental demands (shortage of resources, new environmental legislations, public pressure, etc.), customer requirements, acceptance of environmentally-friendly products and competitors' actions, as well as other factors that need to be considered in the innovation of processes or products. Implementation refers to the development of ideas in the market. Finally, monitoring is the activity that should provide feedback to the company about its green innovation to enhance its learning about innovating in a sustainable way.

Green innovation can respond to local or global environmental concerns. A company may want to build its environmental leadership profile or simply stay within legal limits. Interestingly, green innovation can have an ecological or economical motivation, and as with other types of innovation it can be incremental or radical. Given these many facets, green innovation should be seen through strategic lenses. **Green Innovation Strategy** is a deliberate plan, focused primarily at the long term, aiming to respond to environmental and social pressures on business systems when creating socio-economic value. It better positions the company against its competitors within a sustainable development ethos by considering the availability of resources, impact on the environment, and social ethics for products, processes and business models.

Green Innovation in the Automotive Industry

Looking at environmental and sustainability reports from the World's major automobile companies, a convenient conclusion is that these companies are pushing to bring green innovations to market. But then why are we not yet driving zero-emission cars? Why are most cars still designed to be multi-purpose and carry a heavy all-steel body?

Despite the main focus on the product (the car), green technologies and initiatives extend beyond automobile design (fuel, engine, materials, etc.), to include car industry infrastructure (facilities), manufacturing processes (pressing, welding, painting, etc.), logistics and supply chain (efficient routes, packaging, environmental guidelines and selection criteria), end-of-life vehicles and parts (air bags, batteries, etc.), innovation using intelligent traffic systems, and other initiatives related to environmental protection, education programmes and green philanthropy.

Regardless of what has been done so far, the automotive industry has experienced an enthusiastic demand for higher environmental performance. The industry has enjoyed years as a principal source of employment and economic growth while still having a strong political influence. Despite this, its social benefits are currently diminished as it is one of the main contributors to air pollution in urban centres. Arguably the benefits of cars are clear. They provide a door-to-door transportation system, the means of gaining access to the necessities of life and employment, and a source of pleasure and social status[2]. However, these benefits bring environmental burdens: local air pollution, greenhouse gas emissions, road congestion, noise, mortality and morbidity from accidents, and loss of open spaces to roads, car parks and urban sprawl[3].

Looking at history, the automobile industry has had few radical changes over the last 30 years. The changes there have been were often remarkable and had a significant impact on practice and academia. Mass production, the Toyota Production System – "Just in Time" - and the modular consortium are important innovations from the production system perspective. Also, the transfer of assembly plants to developing countries and global outsourcing are obvious changes to the industry's business and operations strategy. In addition, the automobile industry was the pioneer in using robots and it is still the main user of robotic devices, still being responsible for 60% of their applications in the world[4]. On the other hand, on product innovation the changes have been less prominent and we continue to drive four-wheeled vehicles with an internal combustion engine running on fossil fuels similar to the early Ford days. In fact, car manufacturers are now locked to three technological paradigms (all-steel body, internal combustion engine, and multi-purpose design), which make radical innovations difficult due to the industry's complexity and extension[5].

The innovation strategy adopted by car manufacturers has not been sufficient to make the sector more environmentally sustainable. After two consecutive years of contraction (due to the recession), global production grew around 25.9% in 2010, 3.1% in 2011 and 5.2% in 2012[6]. This unquenchable global demand is creating a radical change in paradigm of green innovation. Automakers need to evaluate green ideas and select more environmentally friendly ways to produce, sell, use, and dispose of vehicles globally. This will need to be done in a cost-effective and strategic manner. Below, we offer a step-by-step model to help executives think about the green innovation processes. The steps in the model are explained through the automotive industry's green initiatives.

Step 1. Define the green innovation stakeholders: With the rapid urbanisation of societies, a re-definition

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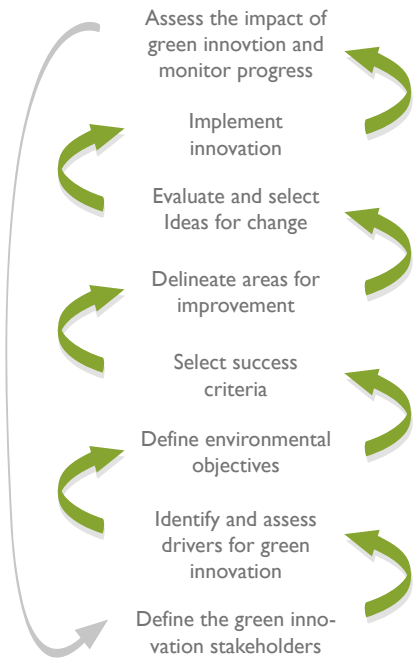

of users' needs and stakeholders is necessary. For instance, new demands to travel in crowded and polluted cities make regulators key stakeholders if companies still want to sell cars in megacities. For newer markets, there is a chance to involve urban planners to create smarter infrastructure that can communicate with cars to avoid congestion, accidents, and pollution.

Step 2. Identify and assess drivers for green innovation: By understanding and evaluating the stakeholders and their power, automakers may identify drivers for green innovation. For example, motorists and regulators have long pushed for higher fuel efficiency and companies adopted this as a successful strategy since it would help motorists to save money and reduce emissions. But to compete, companies will need to consider new motivations such as environmental reputation, green technology leadership, and resource scarcity as part of their innovation strategy.

Step 3. Define environmental objectives: After screening the drivers for green innovation, car manufacturers can define clear objectives for their environmental strategy. Historically, strategic environmental innovation mainly focused on the process within a reactive versus proactive dichotomy. We observe a transition in which companies will need to expand their innovation beyond processes towards products and business models. Thus, a clear set of environmental objectives is vital to direct efforts and implement effective green innovations.

Step 4. Select success criteria: The performance evaluation of green objectives is another fundamental issue. Success criteria will invariably include environmental measures (e.g. emissions, resource utilisation), strategic measures (e.g. image, position against competitors) and non-environmental measures (cost, speed, reliability).

Step 5. Delineate areas of improvement: Companies should delineate an unambiguous scope for action. Environmental beginners might prefer more controlled areas such as manufacturing, while environmental leaders can risk acting at supply chain level. In some cases, a broader or global approach such as a systems view or life-cycle analysis may be necessary; in other circumstances localised action may be preferred to avoid starting with added complexity and risk.

Step 6. Evaluate and select ideas for change: A number of techniques can be used to generate, evaluate and select ideas for change. The involvement of relevant and appropriate stakeholders in this phase is crucial as well as the use of robust techniques for idea generation and decision-making. Companies can evaluate ideas coming from universities, environmental protection agencies and groups, employees, customers, and even competitors through environmental benchmarking. The link to objectives should be observed here in order to select ideas that can create real and higher value according to the company's environmental innovation strategy.

Step 7. Implementing green innovation: Implementing green innovation may involve significant cultural and value changes in the organisation and its wider community (e.g. customers, suppliers). It may have implications for when and where top-down or bottom-up approaches are best. Commitment from top management is fundamental to support implementation, but the development of a team of environmental champions can have a lasting organisational impact, which transforms actions into sustainable competitive advantage.

Step 8. Assess the impact of green innovations and monitor progress: A comprehensive view of innovation should check whether green innovation has a significant practical impact. For example, improving the fuel efficiency of cars may simply increase car ownership (as the car competes with public transport) and encourage motorists to drive longer distances - offsetting the expected environmental gains. In the long term systemic assessment of green innovation will also prevent the transfer of environmental impact from one area to another.

A Future of Cleaner, Cheaper and Safer Personal Mobility

From the 8-Step green innovation management model, automotive companies can thoughtfully reflect on how they innovate. Indeed, new ideas are being put in place and soon we may have driverless cars. Meanwhile, the use of EDRs (event data recorders) can help companies to better understand driver behaviour and help to achieve lower emission levels (besides reducing insurance premiums!). Nanotechnologies are leading to new super-light and resistant materials, which may translate to the design phase. Alongside this, an upsurge of 3-D printing technologies can impact R&D, manufacturing, and after-sales service in the automotive industry. More than just implementing these techniques for cost reduction or product differentiation, companies will need to think how to link these technologies in a genuinely green innovation path. For example, the improvements in battery technology will make electric cars viable soon if an effective strategy is put in place. The delay in their introduction is still described by car companies as a cyclical systemic problem of no infrastructure leading to no cars leading to no infrastructure.

Notwithstanding with the systemic problem, the justification carries a lack of understanding about how the urban mobility systems work. In fact, the problem of introducing electric cars could be solved by considering the redefinition of stakeholders, the first step identified earlier in this article. Often the customer base is seen as homogenous, a rather a simplistic view of the behaviour and needs of automobiles owners and users. Cars actually have a heterogeneous customer base, which primarily comprises commercial fleets (rent-a-car companies, taxis, etc.), corporate fleets, and different private users. Further segregation can also give more details about subsystems within the car use system. Thus, one important customer such as a taxi company, due to the characteristics of car usage, can be the trigger of infrastructure. According to our investigation, taxis tend to be driven about 100 kilometres per day and typically in urban centres. For instance, according to the data of Transport for London (TfL), taxis are responsible for around 6 million passenger journeys each day in London. During each 24 hour period in central and outer London, around 25 million passenger journeys take place and these divide modally as follows[7]:

- 9 million Private Car (as Drivers)
- 6 million Private Car (as Passengers in above)
- 4 million Bus
- 2 million London Underground (Metro)
- 2 million Walking
- 1 million Train (Surface Rail)

Thus, taxis are an important stakeholder of environmental innovation. Our research has found that while they may comprise only 1% of the urban fleet, they can be responsible for 4-6% of greenhouse gas emissions in urban centres. The adoption of compressed natural gas converters (in Brazil and Thailand amongst other countries) and diesel engines (in Europe) was mostly triggered by taxi fleets. Converting taxis to electric vehicles could set up the much-needed urban infrastructure and mature technologies at lower commercial risk.

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It's the cab, stupid!

The fact that few companies are engaging in the leadership for electric vehicles is worrying. When a radical transformation is in course, companies that delay decisions may become laggards because of the delay in systems processes and the time required for learning and adaptation of new technologies. A new understanding of the 'whole' car becomes necessary because the core competence in internal combustion engines and the current production systems may not be sufficient to compete in the new era. For example, Toyota has partnered with Panasonic to produce hybrid vehicles in order to acquire a higher competence in long-life batteries. In addition, the decision to delay the introduction of electric cars is also explained by not analysing the true roots of the problem that impedes their commercialisation. By focusing on infrastructure alone, the relationship between consumers, cars and infrastructure planners was neglected as the main root or key catalyser for the introduction of electric vehicles.

A 100-year-old industry is on the verge of serious change. Managing and implementing innovative ideas strategically will make the difference between the leaders, the survivors and the ones who will be doomed to fail in the future of cleaner, cheaper, and safer cars.

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References

1. EC, European Community (2013). Http://ec.europa.eu/environment/waste/elv_index.htm
2. Nieuwenhuis, P., Vergragt, P., and Wells, P. E. (2006). *The Business of Sustainable Mobility: From Vision to Reality*. Greenleaf Publishing.
3. Vergragt, P. J., and Brown, H. S. (2007). Sustainable mobility: from technological innovation to societal learning. *Journal of Cleaner Production*. The Automobile Industry & Sustainability, 15 (11-12), 1104-1115.
4. The Economist (2008). Robots - Nothing to lose but their chains, *The Economist*. Jun 19th 2008, Munich.
5. Orsato, R. J and Wells, P. (2007), The U-Turn: The Rise and Demise of the Automobile Industry, *Journal of Cleaner Production*, Vol. 15, No. 11/12, pp. 994-1006.
6. OICA, Organisation Internationale des Constructeurs d'Automobiles (2013). Http://www.oica.net
7. TfL, Transport for London (2013). Http://www.tfl.gov.uk