

# The Bourner lecture: Electric vehicles: can we get there from here?

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## 1. Introduction

Much has been written about the nature of the market for electric vehicles and a great deal more will be written before the majority of us have access to one ourselves. Therefore, I must justify making a contribution to such a well-covered subject. Certainly, this is not a scholarly lecture on the nature of markets. These are the thoughts of a semi-skilled practitioner who has the part-time task of unlocking a latent market.

What I shall present comes from my personal perspective of the story so far of the electric vehicle aspects of the Foresight Vehicle Programme, told from my standpoint as chairman of the group on Hybrid, Electric and Alternatively Fuelled Vehicles. I shall cover the strengths and opportunities that Foresight Vehicle has carefully built, that encourage us to answer 'yes' to my question, and I shall present an assessment of the barriers we must overcome, which are challenging enough to make the answer 'no' seem a real possibility.

The conclusion of the paper is hardly novel: that industry, academia and government must work together. It is the number of interests and the extent of the necessary interconnectedness that is quite extraordinary and breathtakingly messy. This 'messiness' has had an impact on the structure of this paper, but is more importantly reflected in the task of managing a change from the present to a scenario where electric vehicles have a natural share of the vehicle market.

## 2. The change to an electric vehicle market

Lord Simpson of Dunkeld gave the 1997 McLaren lecture at Aston University and dealt with the subject of organisational change. His CV as a practitioner of corporate change is such as to command attention to his views. McLaren lectures are unpublished, but my notes show that he listed seven requirements to achieve a successful cultural change in an organisation. Our concerns are not with

an industrial organisation but they are with cultural change, so let us consider what might carry over.

He told us that, firstly, there must be a compelling need to change. This need is then met through six stages, namely:

- an enabling vision
- a strategic framework, displaying vision and values
- get everyone involved
- focus on the process(es)
- benchmarking metrics, for 'stretch' targets
- continuous improvement

In my view, Foresight Vehicle has established itself well and is on course to deliver under all six headings. Its successes to date devolve from the, now universal, recognition that conventionally engineered vehicles must continue to improve in terms of energy efficiency and emissions. Therefore, the pre-condition of a compelling need is met, for conventional vehicles.

However, let us test the universality of this perception. Indeed, at the level of society and of the industrial sector, there is little dissent. Further mandatory reductions of emissions have been scheduled for some time and a challenging voluntary agreement on CO<sub>2</sub> between vehicle manufacturers and the Commission of the EU was reached last summer. But it can be argued that these actions are not based directly on individuals' wishes but are simply needed to maintain the present environment in the face of increased vehicle numbers in the future, because individual car users do not rate environmental concerns as highly as they rate their concerns about future congestion and about future costs of car use [1,2].

The interpretation offered is that individuals expect pollution and air quality to be dealt with by Government [1], and presumably the industry, only responding as individuals if lack of air quality were to reach levels directly injurious to health [2].

Electric vehicles score negatively three times by this analysis. Firstly, individuals do not appear to be motivated to select one type of vehicle rather than another in order to achieve environmental benefits. Secondly, type of vehicle has no effect on individuals' major concern, which is about

congestion. Thirdly, cost is a major concern and electric vehicles cost more.

Before concluding this section, let us note that an established need is not the same as an established market. The text book example [3] is that a poor man may need shoes but there is no market for shoes until he has money. So we have two problems with electric vehicles: namely that individuals do not perceive a need for them instead of conventional vehicles, which they expect to improve in environmental performance anyway, and, secondly, the cost.

The latter problem, of cost, is well known. But why should individuals change to electric vehicles even if costs are equalised? Where is the perception of compelling need, without which there will be no change?

### 3. The Foresight Vehicle Programme

#### 3.1. Strategy and structure

A Foresight Vehicle Programme was recommended in 1995 by the transport panel of the Foresight Programme [4], which was in turn a product of the 1993 White Paper 'Realising our Potential' [5].

Foresight Vehicle aims to meet strict environmental and safety requirements, to contribute to an enhanced quality of life and to help sustain the competitiveness of a major manufacturing sector. Two strongly related programmes were also recommended:

Clear Zones, to focus on the critical role that technology can play in improving the urban environment through intermodal interfaces, public transport technologies, access control, security and enforcement technologies, and environmental monitoring and control; and the Informed Traveller, to provide integrated real time information, ticketing, booking and payment facilities seamlessly across all passenger transport modes.

From the outset, Foresight Vehicle was structured into Thematic Groups assembled around a Steering Group. The Steering Group membership reflects the sponsors (namely DTI, DETR and EPSRC), industry, research and technology organisations, user groups and academic researchers. It includes the chairman of the thematic groups.

The Steering Group has worked since the outset to refine its aspirations, in terms of vision and mission, to articulate a strategic plan and to establish its structure and processes.

The Steering Group's vision is of *A globally competitive UK industry that meets the aspirations of the customer and society for mobility in the 21st century*. Its mission is: *To secure the vision by developing and demonstrating and promoting the adoption of the technology and the pursuit of the knowledge to design, manufacture and deliver to the market vehicles for 2020*.

Carrying out the plan and engaging the policy, research and manufacturing communities has been greatly assisted

by the creation of the Foresight Vehicle LINK Programme. This LINK programme has had the anticipated effect of bringing together a wide network of interests to work towards Foresight Vehicle goals. It is a process through which Government financial support can be applied to research and technology development collaborations between industry and the science base. However, Foresight Vehicle LINK programme was not launched until autumn 1997 and there was work to be done in preparation.

Two years previously, the Department of Trade and Industry accepted the task identified in the Foresight Transport Panel's report and its Automotive Directorate has maintained its support and commitment ever since. The task was defined in the creation of a Foresight Vehicle programme that will *stimulate the UK automotive supplier base to develop product and systems which satisfy increasingly stringent environmental requirements while meeting mass market expectations for safety, cost and desirability*. I am pleased to record here that our successes to date are traceable to the DTI's sustained role of champion, supported by DETR.

The Foresight Transport Panel's report proposed the Thematic Group structure, presented on page 77 of their report [4] as a tree with the themes feeding technologies, products and systems into the Foresight vehicle, which is the output. These themes have evolved over time to become five active groups, namely:

- Hybrid, electric and alternatively Fuelled Vehicles
- Materials and structures
- Advanced electronics and sensors
- Telematic systems
- Powertrain

An interesting and important fact about the presentation of the technology and product tree is that the possibility, perhaps probability, of the hybrid and electric vehicle activity feeding a niche market, rather than the mass-market Foresight Vehicle proper, is recognised there.

So, where do I come in? I agreed at the outset to create the group, which I continue to chair and I now turn to its history, the time it stumbled and its present prospects for success.

#### 3.2. Thematic group on hybrid, electric and alternatively fuelled vehicles

In the opening weeks of 1996, I assembled a small group of people who worked for eighteen months to identify, articulate and represent the interests of the hybrid, electric and alternatively fuelled vehicle interests, mostly in the UK, within the Foresight Vehicle Programme. They also had the task of giving me a grounding in the subject.

The foundations for Foresight Vehicle Programme were the results of a major survey of informed opinion, called the Delphi survey after its methodology. Some of the outcomes of the survey relate to the work of the group, particularly where quality of life in the future was consid-

ered but, ominously, not so much when wealth creation opportunities were considered.

In terms of quality of life, the respondents to the major survey foresaw a future in which:

- there will be widespread use of zero emission vehicles for mass transport of passengers/goods in urban areas in place of conventional, heavy diesel-powered, vehicles.
- there will be widespread use of internal combustion-engined vehicles twice as efficient as today's catalyst equipped vehicles and with half the present exhaust emission of the regulated pollutants.
- travel by private vehicles in inner urban areas will be halved compared with today through public transport improvements and the introduction of electronic road pricing and access control
- there will be widespread use of vehicles for urban personal transport powered by electric or other negligible emission power sources, the former supported by re-charging facilities at termini and/or en route.
- there will be widespread use of large freight vehicles with NO<sub>x</sub> emission comparable to today's catalyst equipped petrol-engined cars and with very low particulates.
- 20% of urban journeys will be undertaken by dial-a-ride services using zero emission vehicles.

These statements, which describe a transport scenario, change their ranking when the respondents' opinions on their potential for wealth creation are factored in. Indeed, the last one disappears completely. When wealth creation alone is considered, all of the electric vehicle statements disappear.

The group that I assembled covered vehicle and electric component manufacturers, gas and electric supply, battery system integration, fuel cell system integration, transport system and local authorities. This industry-led group declared its objective to be: *To maximise UK exploitation of the developing European and global market for components and systems required by hybrid, electric and alternatively-fuelled vehicles.*

That is to say, we recognised the wealth creation reservations expressed by the Delphi survey but pointed out the measurable development and demonstration activities in America, Japan, elsewhere in Europe and, indeed, here in the UK, where vehicles and their supporting systems can be seen being taken forward from technology prototypes, through commercial prototypes towards market penetration.

In November 1997, the LINK programme was launched. By then I had opened up membership of the Thematic Group, in preparation for the first call for project proposals. The mailing list has since exceeded 80 entries and meeting attendance is typically 40. I made a bullish presentation of our interests and expectations at the launch and plenty of proposals went in from our group. None were selected for funding.

Under my leadership, we had focused on the barriers as we saw them, which are largely political, economic and social issues, whereas the funding mechanism was for technology development. Measured against technological criteria, none of the market and product definition proposals scored well enough.

There were other problems too: in our group, few of the organisations knew each other at that stage. But, mainly, the LINK programme tests for proposals, of academic peer review for technological research and of a clear exploitation path to market, were beyond us.

Now, a year later at the time of writing, the second call is open and full proposals are being prepared. Again, I have the expectation that there will be a good result for proposals coming from our group. We know each other better, we know the rules and, most importantly, the barriers to market uptake are being addressed, not just for electric vehicles but also for radically improved conventional vehicles, by a sub-group of the Foresight Vehicle Steering Group. So we have a separate path through which to consider the market problems and can use LINK to make appropriate progress with market-led technology development.

### 3.3. Beacons and barriers

The Foresight Vehicle Steering Group conducted a major strategy review following the selection of projects for funding from the first call, which has been successful in overall terms. A primary outcome of the review was to think of the overall objectives in terms of 'beacon' sub-markets, within which attractive vehicle products might be launched. All of these products would necessarily meet the primary Foresight Vehicle objective of meeting stringent environmental criteria and then would combine features to meet the perceived needs of the specified sub-market.

The following 'beacons' are currently presented:

- vehicle efficiency
- vehicle adaptability
- environmental responsibility
- efficient delivery
- 'no waiting' urban people transport
- efficient haulage
- inter-modal efficiency
- generic

Hybrid and electric vehicle technologies, components and system clearly have much to offer to several of those 'beacons'. Each of them has an expanded description.

For example, *Environmental responsibility* unfolds as: *socially acceptable; safe to occupants; other road users and pedestrians; low pollution; no servicing; secure and unstealable; addresses total environmental cost at point of impact and finally, has charisma. Efficient delivery* is expanded to be: *effective urban light goods delivery vehicles with low or zero pollution and a major improvement in fleet operating efficiency through telematics.*

In each case, the delivery point for an emerging technology development can be seen clearly. This will allow the proposals emerging for the group to concentrate on technology, as befits the available funding mechanism.

In the meantime, the steering group will develop the means of tackling the barriers that have been identified. In the strategy and action plan [6] it doesn't yet say how, but I shall make a few observations of my own in a later section.

This area of barriers is very much work in progress and I don't wish to anticipate the outcome. We are finding it challenging and demanding but we do expect to learn a lot from the process. I believe that it will bring proportionally greater insights to the hybrid and electric vehicle community and is therefore particularly worthwhile.

As an observation, when we ranked the barriers that came out of a traditional 'brain-storming' session and then grouped them according to type, all of the first priority items appeared under headings orientated to political, economic and social categories. Technological, skill and resource categories contained the second and lower priority barriers.

From this important observation came reinforcement of my experience with the first LINK programme call, namely that the further development of technologies is necessary to overcome the barriers to progress but it is not sufficient. There is a bigger picture that recognises the headline public policy objectives and the appropriate business pro-

cesses for arriving at competitive products, as well as technology and service developments outside of the vehicle.

I address some of these issues in the next section.

#### 4. The bigger picture

The question at the end of Section 2 was: *where is the perception of compelling need, without which there will be no change [to electric vehicles]?*

An answer is that it lies both in the headline public policy objective and in connecting the products on offer, via technologies and processes that we can develop, to that policy. Then we market the concept and sell the products.

Fig. 1 shows how some of the pieces fit together to meet one of the policy objectives.

The bottom row, the foundation, shows technology development of three classes of vehicles and their components, namely conventional, alternative and radical. Here is the delivery point for emerging vehicle technologies; the work areas of the thematic groups on hybrid, electric and alternatively fuelled vehicles, on powertrains and on the enabling area of advanced electronics and sensors and of structures and materials.

Increasingly, we are aware that how these vehicles are used has as much bearing, perhaps more, on air quality as

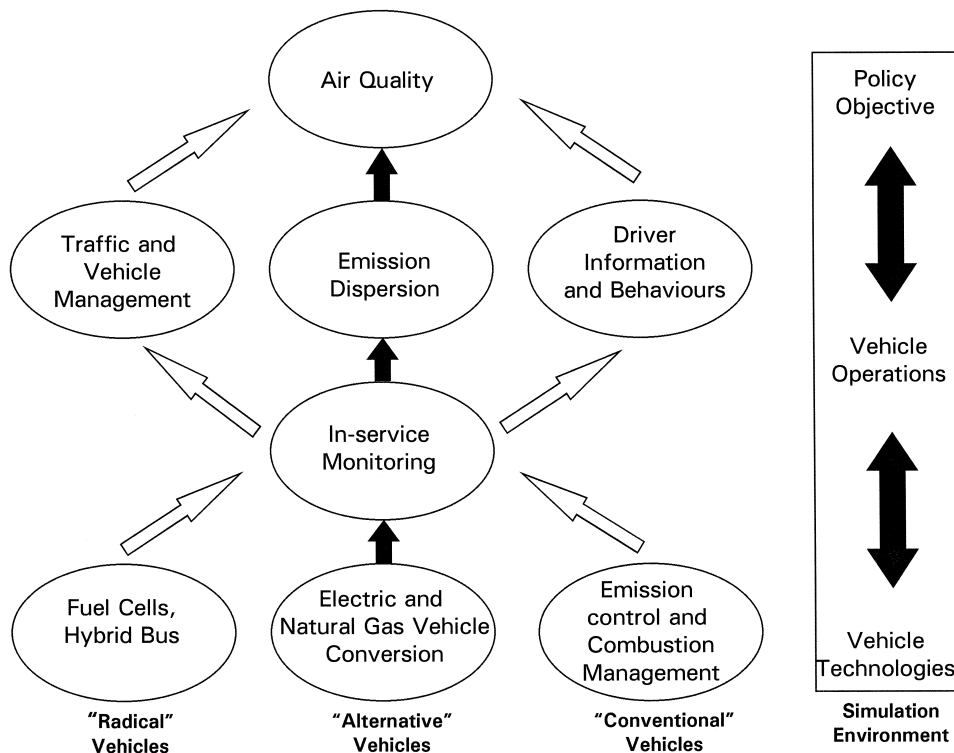


Fig. 1. Interactions between policy objectives, vehicle technologies and operations.

the intrinsic cleanliness of the vehicle and, indeed, the numbers of vehicles. Careless use can produce several times the emissions of careful use. Such ratios are not present between the intrinsic cleanliness of vehicles or estimates of their numbers in use.

Two factors affecting in-service emissions and one external factor are shown at the next level. The dispersion of emissions is a factor that needs attention: climatic factors have an effect and interact with traffic management decisions, a passing vehicle stirs up particulates, perhaps from a non-automotive source that had settled on the road. Here, telematics contribute to the intelligent management of vehicles and traffic and to the behaviour of better-informed drivers. Here also is the connection to congestion which itself has a public policy dimension, of infrastructure utilisation as well as an impact on individual drivers.

The public policy of air quality could be replaced in the figure by rational use of energy in transport.

At the right-hand side of the figure, the attention is drawn to the benefits of simulating the full system to evaluate the impact of combinations of technologies, products, policies and implementation processes.

Consideration of this figure, in the light of my group's objective of maintaining UK exploitation, makes us recognise the point made at the close of the preceding section, namely that technology development is one strategy by which a business may produce a commercial product. Another, the 'fast-follower strategy', is to harness existing components and technology into a novel product. No less risky at the product level, this development process does not easily fit the available Government support mechanisms, yet it may be the best way of creating a supply chain of world-class suppliers in the UK. The question of policy variety to deal with other risks than technology development is dealt with in detail in Ref. [7].

Turning back to the figure for a final observation, the three classes of vehicle, radical, alternative and conventional, could be seen to complement each other, blended as required for a vehicle that, well managed, delivers the air quality policy. They could also be rivals engaged in competition. A recent paper [8] presents the case that the success of electric vehicles is as a pace-setter for internal combustion-engined vehicles, which have so far managed to respond to the challenges set by EV performance. So if the internal combustion engine continues to keep up, there never will be a compelling need to change to electric vehicles.

## 5. Conclusions

A compelling need to change is proposed as an essential pre-requisite of change from present vehicles to future types of vehicle.

Such a need is seen to be established for conventional vehicles, though individuals appear to assume that Government will deal with it for them.

No compelling need is perceived for a change to electric vehicles. Individuals are much more concerned with congestion.

The Foresight Vehicle Programme is considered to be pivotal in the UK for the preparation of new generation vehicles and the supply chain for components and systems. Its funding mechanism, Foresight Vehicle LINK Programme, will successfully support technology development.

The barriers to adoption of new generation vehicles are now under active consideration by Foresight Vehicle. This is shown to be of major importance. The barriers appear to be mainly non-technical.

Attention is drawn to a need for a wider spectrum of policy actions to complement Government support for technology development, so that industry, Government, the science base and others can work together across a wider range of activities than at present.

It is suggested that a compelling need for zero emission vehicles might be found by considering the full range of actions and actors that connect vehicle technologies to the public policy objective of air quality.

## References

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