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Bill Hollins

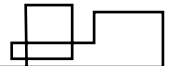
Westminster Business School

This is an electronic version of an article published in the *Engineering Designer*, 34 (3). pp. 19-22, May/June 2008.

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Mayor of London
Ken Livingstone
with his
Toyota Prius



Have

alternative fuel cars reached a 'tipping point' or are they just a fad?

Part one of a paper exploring the reasons for the recent wider adoption of the hybrid car.

In 2000 Malcolm Gladwell wrote a book entitled *The Tipping Point How Little Things Can Make a Big Difference*, in which he indicated that certain circumstances occurred that resulted in various products becoming more widely adopted. In this article we will explore the prospect that the time is now right for hybrid cars or cars with alternative methods of propulsion, other than petrol, to become more widely adopted.

In short, the 'tipping point' has been reached for hybrid cars. Our question is asked against the background of ever faster developments around the concerns of climate change and sustainability and a need for alternative modes of transportation to petrol fuelled cars. Events like the December 2007 United Nations Climate Change Conference in Bali bring to the fore the importance of and need for alternative, sustainable technologies. Therefore, this paper sheds important light, not only on the potential value of hybrid cars as part of sustainable development, but also highlights the context of adoption of hybrid cars as a viable solution for the immediate future of transportation.

It might be thought that hybrid cars are a relatively recent development, they have, in fact, been around since the mid 1970s. Hybrid cars come in various forms but, most commonly, they incorporate an internal combustion engine and an electric motor, which can also be independently powered by either nickel-metal hydride or lead acid batteries. The car will operate using the batteries but, at a point where the battery power is insufficient, the internal combustion engine will 'kick

in' to recharge the batteries. The engine also provides sufficient range to drive distances that cannot practically be achieved by a battery only car. Quite often the internal combustion engine operates over a fairly narrow power range, resulting in very efficient use and, therefore, very low fuel consumption. Other advances, such as regenerative braking and converting kinetic energy into electrical energy, can improve the efficiency of the vehicle. More recently, in the UK and Australia, hybrid cars have become increasingly more popular, especially for use in cities, indicating growing customer interest in this technology as an alternative to petrol driven personal transportation.

In this article we explore the reasons for the recent wider adoption of the hybrid car. We will concentrate on five potential major influences that could spur the 'tipping point' of hybrid cars. These are: fuel prices, technology, legislation, availability and consumption.



Fuel prices

The original interest in hybrid cars came about because of the fuel crisis of the '70s. The high rise in fuel costs and the lack of fuel availability meant that, for a time, car companies looked for alternative methods of propulsion. Of course, battery powered cars were considered but, in spite of several promising breakthroughs in forms of battery, none lived up to their initial promise. Either they were very expensive, did not operate well at room temperature or were not easily recharged. This meant that the main option then, as now, for electric cars was the familiar lead acid battery.

As a method of propulsion they remain inadequate as they are large, heavy, have limited power output and are slow to recharge. Another problem, not immediately considered in the efficiency of battery cars, is the high cost of replacing battery packs. Constantly recharging lead acid batteries can mean that the entire battery pack will need to be changed after about three years. This can cost over £1000. It is not apparent that electric car or hybrid car users fully appreciate this deficiency in the technology.

In spite of these factors, quite a few companies have attempted to introduce lead acid battery powered cars and most of these have been unsuccessful. Less effort appears to have been put into hybrid cars and they have been left on the 'back burner' by most vehicle manufacturers.

Over the years, fuel prices have gone up and down and there is always the fear that oil will run out, but the rise in projected fuel costs for the average motorist in the next few years is likely to make this one of the main tipping points for hybrid cars. Therefore, it is not going to be the car industry itself that will lead the way in innovation and development of hybrid cars to counter the rising fuel costs. Rather it will be the consumers' responsibility to generate the initial demand in order for the industry to respond.

Technology

The main difference in the technology available since the '70s that would make hybrid cars more effective is the phenomenal improvement in electronics. Moore's Law has been, and continues to be, relevant in the development of electronics and, as such, electronics can be widely called upon to control many of the aspects of the hybrid car. These include switching between drives, maintaining constant economic power use and aspects of the regenerative braking. Such electronics can be provided at a low cost, are compact and their availability significantly improves the driver feel of the car.

Over the same period, internal combustion engines have become more efficient, essentially, through wider use of electronics and static design improvements around existing concepts. This has had the effect, especially in the US, that customers no longer buy as many 'gas guzzlers' and, generally throughout the world, drivers own cars with smaller engines than they used to.

As the IC engine is not generally required for acceleration, the motor can be used at its optimum speed, ensuring that it always operates near to its peak performance in terms of fuel efficiency. Although, one 'benefit' of the hybrid system is that the electric motor can be used to supplement the internal combustion engine for greater acceleration, as in the Lexus (which is not a very green practice).



In the '80s and '90s, car companies experimented with lean burn engines or with more friendly diesel engines. The continuing high cost of diesel fuel in the UK resulted in a much lower acceptance of the more efficient diesel engines than was the case in Europe where diesel fuel costs are lower. In the case of lean burn petrol engines, the choice to go with catalytic converters tended to end this initiative, which we consider to be a shame, as these may have resulted in more efficient engines and performance that could rival that of a hybrid.

Another fuel saving aspect is the method of stopping the car engine when the vehicle is at a standstill and then it starts again when the clutch is depressed. It should not be forgotten that the Mini, with its new stop/start diesel model is more fuel efficient than the Toyota Prius, as is the Citroën stop/start models C2 or C3. The Citroën models have seen CO₂ reduction varying between 8% and 15% in urban cycle.

Certainly, these advances in technology have improved hybrid cars but, on their own, it is unlikely that such improvements would have caused the 'tipping point'. Rather they could have contributed to it through offering car manufacturers alternative markets to boost their growth and competitive advantage. Where the changes in fuel prices alone would not motivate the car industry to invest in the development of hybrid cars, the advancements in technology could potentially offer new markets for the manufacturing businesses, allowing the industry itself to drive the trend.



Legislation

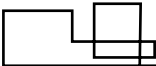
There are several pieces of legislation that have occurred within the last 30 years that could have swayed producers and customers to look towards hybrid cars. The main three are legislation against pollution, the Congestion Charge in London, and the greenhouse emission targets of the Kyoto Agreement. Most of the anti pollution legislation was initiated in California, but then spread throughout the US and, subsequently, the world. In an attempt to reduce pollution coming from car exhausts, catalytic converters were made a requirement, which in themselves are expensive and reduce the efficiency of the car.

The original Californian legislation required that 10% of cars would have to produce no emissions. This resulted in an increase in the use of electric cars and spurred other ideas, such as induction rails set into the road to drive electric vehicles, as tried in Zurich. The main problem with the legislation was that individual Californians did not wish to be one of the 10% to be forced to drive an underpowered, slow to charge, electric vehicle. This ended up with most of the 10% of vehicles being leased by the Californian authorities, whereas most ordinary citizens continued to buy conventional cars.

The congestion charge in London currently amounts to £8 each day and is imposed on people driving their cars into a specified area of London. The congestion charge is not payable on motorbikes, electric cars and hybrid cars. Therefore, there is an incentive for somebody who lives in London or who drives into this area each day to purchase an electric or hybrid car. Certainly, the introduction of the congestion charge has seen a significant increase in electric and hybrid cars.

Looking at the Prius hybrid car, which is the most popular of the hybrid cars around London, the difference in price between the hybrid and the conventional model of a similar sized car means that the driver would need to drive into London's congestion charge area many times to break even.





There are additional disadvantages that make this less of a good idea. The car purchase payment must be made up-front (or the additional cost of a higher-purchase agreement must be paid), whereas the congestion charge need only be paid on the days that the drivers go into the area. Even somebody in a full-time occupation is unlikely to go to their place of work more than 46 weeks a year and five days a week.

Furthermore, there is the cost of the battery pack, as mentioned above, and when part of the car is full of batteries, there is less room for passengers or luggage. For these reasons, the hybrid car does not appear to be a good purchase decision as first viewed when compared with a conventional car.

There are plans within the EU to pass stricter legislation that would curb the pollution emissions of current petrol fuelled cars by 20% by 2012. These plans are embedded in the larger commitment to meet the greenhouse gas emission targets of the Kyoto Agreement. Therefore, from a car industry point of view, further investment in hybrid cars aligns rather well with potential tighter emission measures. However, new legislation generally takes almost ten years from the initial idea until it is actually implemented. At this time there are proposals to introduce the congestion charge in other British cities, but these have yet to be confirmed. There is no other legislation currently being considered that would further enhance the prospects for a hybrid car. Within the current economic and political climate, we do not believe that legislation on its own could instigate the 'tipping point' for hybrid cars.

This paper will be concluded in the July/August issue of *Engineering Designer*.

This paper was written by:

Dr Noemi Sadowska BFA, BD, MA, PhD
– Regents Business School, London
Eur Ing Dr Bill Hollins BSc(Hons), PhD,
DMS, CEng, R Eng Des, FIED, MCMI, ILTM.
– Direction Consultants, London
Paul Wellington BSc.(Hons), Adelaide;
Dip.Ed. (tertiary), Monash; MEd. Monash
– Monash University, Victoria, Australia.

