

INTERVIEW: ADRIAN VINSOME

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in applied automotive research and development.

Buran: If you were to modify current HEV technologies, which component / system would you prioritise in adapting / changing first?

Adrian Vinsome: Commercially available HEVs represent the state-of-the-art in all of the associated technologies, so it is difficult to say which area needs changing first. However, the limiting technology at

Adrian Vinsome started his professional career in Jaguar Cars Ltd in 1983, working as an Electronic Engineer in the Instrumentation Department. In 1988 he joined the University of Warwick as a Research Fellow, working in the Advanced Technology Centre's Electronics Group on engine management, journey prediction and hybrid vehicle development in collaboration with Rover Group.

In 1997 he joined the University of Durham to help establish and then lead a significant commercial consultancy operation, which expanded over a 5 year period until it employed 20 full-time staff. In 2002 he became involved in battery research for traction applications, and he is currently engaged as Project Manager for Hybrid Vehicle Research and Development in the Premium Automotive Research and Development Programme at the University of Warwick. He is a Chartered European Engineer with 20 years of experience

the moment still seems to be the electrical energy storage system, particularly the batteries. Research is needed to improve the cycle life, especially when the batteries are being exercised over a wide range of state of charge. In terms of development, I think significant improvements could be achieved with better battery management and control.

Buran: Do you think that current HEV models are too expensive for prospective customers? Do you think that the price is too high regarding the technology that they possess?

AV: There are two different questions there! HEVs are probably too expensive for the majority of customers at the moment, but these vehicles represent a great deal of R&D and embedded technology and I would argue that they are not too expensive for the technology that they possess. Also, the technology is still

relatively new, and volumes are low, so I think that we can expect to see prices fall before they level out.

A lot of the on-cost in commercial hybrids is due to the batteries, typically Nickel Metal Hydride, and it is reported that both the battery manufacturers and automotive manufacturers are incurring a loss on these vehicles, but are accepting this because they see longer term gains as sales volumes increase. However, these battery chemistries will not fall in cost to rival lead-acid, and could even start to rise if demand outstrips supply. If the durability of lead-acid could be improved, the cost benefits of the technology would help to push down HEV prices and widen their acceptance, so this is one area of research that certainly warrants further investigation.

Buran: How effective is regenerative braking? Are there any specific areas which could be improved within this process?

AV: The big selling point of hybrids is that they are more efficient than a conventional powertrain, and this is largely because they can recover energy that would otherwise be lost as heat when braking. The braking power that a vehicle can achieve is several times higher than the power available for acceleration, and normal driving shows relatively high, but also short duration, braking power spikes.

The efficiency with which this energy is recovered is limited by the battery's charge acceptance, which is also a function of its state of charge. It may be possible to improve the energy recovery into the electrical system with a supercapacitor, either with or without a battery, but this will require careful management to gain the maximum benefit without damaging the components, and also adds further complexity. There is a lot of research needed to derive the best control strategy for a hybrid powertrain, and recovering the maximum amount of energy for reuse is a key consideration.

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Buran: With Rover going bankrupt recently, and Fiat owing a significant amount of money, do you think that in order to maintain a creditable market status it is important to put a considerable amount of resource into more alternative vehicle types; for example HEVs?

AV: The automotive industry is extremely cost sensitive, and competition is very strong. Manufacturers need to differentiate their products and HEVs are one mechanism to do this. However, it is difficult to produce a sensible business case for hybrids because the benefits are very dependent upon the driving cycle and style, and also on the cost of fuel, since the savings have to be weighed against the additional cost. I think that governments in particular need to take a close look at incentives and actions that will promote introduction and market penetration. Once the manufacturers are confident that a stable opportunity exists, I'm sure they will invest in the technology.

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Buran: To your knowledge are there many car manufacturers investing in hybrid technologies? If so, which ones?

AV: Toyota is clearly leading the way with the Prius and Lexus RX 400h. However, Honda, Ford, GM and PSA have all released models with some level of hybridisation, and almost every manufacturer has demonstrated the technology at some point in the last 10 years. I would be surprised if any manufacturer wasn't



seriously considering the technology at the moment. It isn't only car manufacturers that are interested. In many cases, the commercial vehicle and bus manufacturers are ahead of the field in hybrid technology.

Buran: Why do current HEVs have only permanent magnetic electric motors (synchronous alternating current), rather than any asynchronous types? What would you consider to be the significant advantages / disadvantages of each type?

AV: Asynchronous machines are still cheaper, will operate at higher temperatures, and have simpler control requirements that are still better understood by industry. Some buses use asynchronous machines, and I think the GM Silverado Hybrid does as well, so I wouldn't agree that current HEVs only have PM machines.

However, the main advantage of permanent magnet motors is that they offer high efficiency and high power density—packing a lot of power into a smaller electrical machine. They are more expensive than other electric machine types, but the cost is falling, so they are becoming more competitive on price. Packaging components is always an issue on modern vehicles, so the smaller size of the permanent magnet motors is likely to favour their use for new applications.

One significant disadvantage is that the magnetic materials cannot withstand high temperatures, and additional cooling will usually be required, especially for under-bonnet applications.

Buran: Biodiesel / Diesel vs. HEV, any comments on this matter? Do you take this matter into account when considering your research objectives; based on competitor's movements for example?

AV: Clearly, all research needs to be aware of what is happening in the market place, so it is important to track industry and market trends. Biodiesel offers a better carbon balance than

fossil fuels, and I believe we will see more and more being introduced as a blend with conventional diesel. Diesels in general offer better efficiency than gasoline, and they account for about 45% of the new sales in Europe at present. However, gasoline is better than diesel for noxious emissions, with lower NO_x and particulates, and improvements in combustion technology are narrowing the gap. Automotive consultants Ricardo claim it is now possible to achieve diesel efficiency with a high compression (HCCI) gasoline engine. This is one development we'll be watching closely, since an HCCI/HEV drivetrain will offer benefits all around. The other option, of course, is to investigate diesel hybrids to establish whether the benefits justify the additional cost and weight.

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Buran: The reduction in CO₂ emissions and reduced fuel consumption are two distinct advantages of HEV technology. However, the new Honda Accord i-CTDi engine offers results very close to that of current HEV performance. Which of these technology types do you think has the current advantage? Also, which technology has the greatest long term prospects?

AV: State-of-the-art diesels, like the Honda i-CTDi, currently have the advantage over HEVs in terms of cost and complexity, and in Europe high pressure direct injection diesels offer an option that is hard to beat. In gasoline based markets, such as the US, they are not popular because the public perception of diesels is very poor, and they are still associated with noisy, dirty trucks without adequate performance or refinement. Since diesel is not seen as a viable alternative to gasoline in these markets, the manufacturers are looking to hybrids to offer

the customer improved fuel consumption without having to persuade drivers to adopt a different engine technology.

The obvious extension is to develop a diesel hybrid, particularly for the European market, but this will add weight and cost to the drivetrain. Since a diesel block is already heavier and more expensive than a gasoline engine, manufacturers will look to gasoline hybrids first, which is why I believe the HCCI/HEV research is so exciting.

Buran: How important do you consider the needs of the market / collaborators when defining the objectives of an HEV project?

AV: In any project, whether research or development, it is essential that the requirements of the stakeholders are considered at the outset. However, in defining a collaborative project you also need to consider that particularly industrial partners may face short-term commercial pressures that can detract from longer term strategic goals.

Also, 'the market' isn't a static, fixed set of conditions over which we have no control, but it is dynamic and can be influenced. It is important that not only is the market considered, but also how it might alter as technology is introduced, cost structures vary and legislation is changed.

Buran: How important do you consider the business case of HEVs to be? Have you ever considered putting together a business case for both the potential sales and movements of HEVs?

AV: It's essential. As a Project Manager in applied research, I'm continually reviewing the project plan against the business case, since without this it would be impossible to assess whether the project outcomes continue to justify the cost. In a research environment, the business case is wider than simply anticipated sales and margin, since there is also credit for the quality of the research undertaken.

We are putting together a detailed business case for HEVs including all these considerations, and also a much wider «what-if» analysis based on anticipated and potential changes to the external environment, such as new technology introduction and government intervention. This will be published in due course.

Buran: Could you please give an overview of current and future work with HEV research within PARDP (Premium Automotive Research & Development Programme) at the University of Warwick?

AV: We are working on two HEV projects at the moment – one is looking at the technology necessary to realise a successful hybrid powertrain, and as I've implied in my previous answers we're also looking at building a better business case to encourage hybrid introduction, looking at the political and socio-economic aspects that exist alongside the technological developments.

The research is part-funded by the Regional Development Agency, and we are collaborating with a number of local companies to develop a model that will allow us to simulate how locally produced components will perform in a hybrid powertrain. We can also 'scale up' the results to build a picture of the wider benefits that can be achieved for a number of external scenarios, such as a range of fuel prices or bands of taxation on CO₂ emissions. There's a better overview of the ongoing research on the projects' website, at www.iarc.warwick.ac.uk/8-hybrid-overview.html!

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