

Strength in depth

Alistair Welch looks at Warwick Manufacturing Group's extensive activities in low carbon mobility

As one of the UK's leading research facilities applying academic rigour in an industrial context it is no surprise that WMG, a department of the University of Warwick, hosts several projects of relevance to the low carbon mobility sector.

WMG is home to a High Value Manufacturing (HVM) arm of Catapult (the UK's network of technology and innovation centres dedicated to transforming ideas into economically beneficial products) which in turn focuses in particular on lightweight technologies and, in the form of the Energy Innovation Centre (EIC), energy storage technologies and battery chemistry. Furthermore, it was announced in July that Warwick is to host the hub of the Advanced Propulsion Centre (APC), a national organisation concerned with the advancement of propulsion systems and the associated supply chain.

Paul Blackmore is project manager of the EIC, a facility that incorporates a £13 million battery materials scale-up pilot line for the development

of new battery chemistries. The pilot line enables the creation of full-size prototype battery cells with novel chemistries. The facility includes a climate-controlled dry room necessary for battery research because even low humidity is detrimental to the electrolytes.

One increasingly significant application of batteries is in hybrid and electric vehicles and the EIC is focussed on identifying and demonstrating battery chemistries that deliver sufficient energy density and safety levels to meet the requirements of the automotive industry. "The Automotive Council looked at where there may be gaps in terms of the future of energy storage research in the UK and felt that we were lacking in the area of bringing technologies from academia through into industry," explains Blackmore. "We lobbied hard for this facility to be based at WMG to allow us to leverage the technology we are working on in a similar way to the Fraunhofer Institutes in Germany."

In addition to developing battery prototypes the EIC is also equipped

to analyse battery performance and how it varies according to certain conditions (age, temperature, vibration and so forth). Blackmore explains that the testing his team carries out is more than aggressive testing and constitutes what he terms 'battery abuse'. "We push the battery beyond the realm of standard use," he says. "We'll over charge it and put nails through it all in an attempt try to understand the reaction of different chemistries and how flammable they might be and so on."

Such rugged testing exists not merely to indulge the destructive tendencies of the engineers but can offer vehicle manufacturers information about battery behaviour that goes beyond the data sheet. "Vehicle manufacturers are becoming smart users of the battery technologies that are out there," adds Blackmore. "We are doing specific stress tests on the battery to fit the applications for automotive makers."

He continues: "We are looking at it from a systems viewpoint – the triumvirate of the battery being the performance, safety, and cost. Ultimately there are UK manufacturers who could apply their technology to this potentially huge market for batteries off the back of automotive."

Addressing the future of battery technology for the low carbon mobility sector Blackmore suggests that certain figures such as a five-fold increase in energy density are unrealistic and that improvement will be incremental. Nevertheless, he is hopeful that the work of the EIC at



Paul Blackmore



Richard Dashwood

WMG will support the growth of a UK value chain in next generation battery chemistries.

Blackmore's WMG colleague Professor Richard Dashwood is an academic director and chief technical officer of the WMG High Value Manufacturing Catapult. As such he is responsible for coordinating the research of the HVM Catapult and in particular the activities of the Lightweight Technologies Centre of Excellence.

The centre aims to design and manufacture the next generation of lightweighting solutions in response to the significant challenges facing the UK and global transportation industry as a result of the low carbon agenda. The focus of research is split across design, manufacture, and product performance. Whilst the primary application of the centre's work is on the automotive sector, the activities are also relevant to the rail, aerospace and defence industries.

"Achieving low carbon mobility has two strands: one is working on

the propulsion side (engines and hybridization), the other is making the whole structure lighter so we are carrying less mass around and that of course means less fuel," says Dashwood. "We are going against nearly 50 years of increasing vehicle weight and trying to reverse that."

The Lightweight Technologies Centre enjoys a £20 million portfolio of funding (from Horizon 2020, European funding, industry, and the Engineering and Physical Sciences Research Council) that facilitates research across a range of materials and technologies. Indeed, Dashwood asserts that the Centre is "material agnostic". "We don't work with a particular material – our focus could be steel, aluminium, magnesium, or polymer composites. We have projects across those material classes to develop manufacturing solutions to exploit in high volume applications," he says.

Aluminium and composites have traditionally been the reserve of the aerospace industry - low volume and

high cycle time. The goal of WMG's work in lightweighting is to transfer those technologies into a high volume sector, namely the automotive industry. "If something costs more than £5 to save a kg of weight off a vehicle it is unlikely to be adopted," comments Dashwood. "If you compare that to civil aviation it may be £50 per kg or space where you might be prepared to spend £10,000s you can see that automotive requires cheaper options."

WMG's outstanding existing capability in research and development for the low carbon mobility sector has been further recognised following the opening of the Advanced Propulsion Centre (APC) hub on the Warwick campus. The APC, which is to draw £1 billion of funding from industry and government over ten years, exists to develop the propulsion elements of the low carbon agenda, namely engines, electric motors and power electronics, and energy storage. The APC, formed on the recommendation

Dave Greenwood



of the Automotive Council as part of the Government's industrial strategy, has chosen to locate its hub at Warwick following a selection process that concluded in August 2014.

Dave Greenwood, professor of advanced propulsion systems at WMG, was responsible for coordinating the Group's bid to host the APC hub. "The APC's remit is to pull through to production technologies that will help low carbon propulsion," he says. "Our support to the hub is more than just bricks and mortar, it involves putting together academic support to allow the APC to access the latest technologies."

WMG will provide the APC with back office services and support but the APC will operate as its own organisation with its own governance as the hub of a nationwide hub-and-spoke network. The location of the spoke sites will be announced later in 2014 following a selection process which is ongoing at the time of writing.

Greenwood joined WMG (taking up the new post in March 2014) following senior roles in advanced technology at engineering consultancy Ricardo. His role at WMG involves building on the Group's existing strengths (in lightweighting, energy

storage, and battery chemistries for example) as well as broadening capability in other areas of the propulsion system, such as electric motors, power electronics, and integration with control systems.

The University will provide the seed funding to allow WMG to build capability in these areas whilst the Group seeks project funds through the various bodies and mechanisms. Greenwood is confident that he can build on his industrial experience at Ricardo to extend WMG's already formidable links with industrial collaborators.

He believes that the UK is better positioned to conduct research into the low carbon powertrain than ever before. "We've got the best coordinated industry network we've had in my career and the best support from Government in the form of institutions like the APC," he says. "Through the Automotive Council, there is a single forum working to common roadmaps and an agreed agenda – that's making a real difference to the ability to get things done."

Greenwood continues: "We've got a well-recognised technology



roadmap that is bought into by both the research community and the product community. We can now focus our efforts around the technologies we know will have relevance over the next 20 years."

Considering the question of whether vehicle or infrastructure development needs to come first if electric vehicles are to be adopted by the mass market Greenwood says it is "difficult to break away from a chicken and egg situation". However, he argues that infrastructure is perhaps less important than we might believe. "It's only at the point where you get to plug-in hybrid or pure EV that you have any reliance on the external infrastructure," he says. "The existing infrastructure can support mild- and full-hybrids and the plug-in infrastructure is growing to a point where it is not a major constraint for the adoption of vehicles. The main issue now is developing vehicles that have the range that users need at a price that they can afford."

Greenwood argues that whilst the UK is strong in OEMs (automotive manufacturers and vehicle assemblers) and in SMEs, there are fewer large

supply chain companies based in the UK. Part of his role at WMG is to attract Tier Ones to work with the UK or help to grow medium-sized UK companies to the scale where they can pick up technologies emerging from universities or small companies and industrialize them on a meaningful scale.

As such, WMG not only focuses on research into product and technologies but also addresses research around manufacturing techniques. "We are interested not just in creating the new technologies but in understanding how you manufacture them in high volume

at sensible prices," comments Greenwood. "We work in the design of production line equipment and the design of supply chains to make products feasible at full-scale market."

Hosting the APC hub confirms WMG's position as the UK's leading research institution for low carbon mobility. Over the coming years the Group's research activities and industry collaborations will accelerate to market many technologies likely to improve penetration of low carbon vehicles.

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