Building the **foundations**

With £18m of funding, an academic network is looking to address as many of the underpinning challenges in power electronics as possible. By **Graham Pitcher**.

There isn't a sector of the electronics industry that operates without the use of power. Whether it's a device which uses harvested energy or a large industrial drive, power electronics is the technology which makes it work.

So it's no surprise to find that the global market for power electronics devices is estimated to be worth $135billion a year. Perhaps more surprising to some is the fact that the UK has a reasonable share of this market, with power electronics acting as the enabling technology for products that contribute some £50bn to the UK's economy each year. We might not think so, but power electronics is a strategic national technology.

A review of the power electronics sector was published by the Department for Business, Innovation and Skills (BIS) in 2011. Essentially, the report concluded the sector 'could do better' and the aftermath saw PowerelectronicsUK created as a means of driving the industry forward.

While PowerelectronicsUK is, in general, looking at the applications for power electronics, a parallel initiative – the National Centre of Excellence for Power Electronics – is taking a look at the underlying technology, backed by £18million of investment from the Engineering and Physical Sciences Research Council (EPSRC).

The investment will be made as a series of grants, each of which involves multiple universities. These universities are arranged around a central coordinating hub, led by Professor Mark Johnson at the University of Nottingham, with research projects being undertaken at the universities of Manchester, Newcastle, Greenwich, Bristol, Warwick, Nottingham and Imperial College London.

But the initiative isn't fresh out of the blocks, as Prof Johnson noted. "About six years ago, there was a programme funded by the Innovative Electronics Manufacturing Research Council. This was all about power electronics, with industrial partners trying the raise the technology's profile. There was a bit of a failed attempt at getting it started, with another go in 2009. Since then, NMI has come on board to get things going and to make sure the message doesn't get lost."

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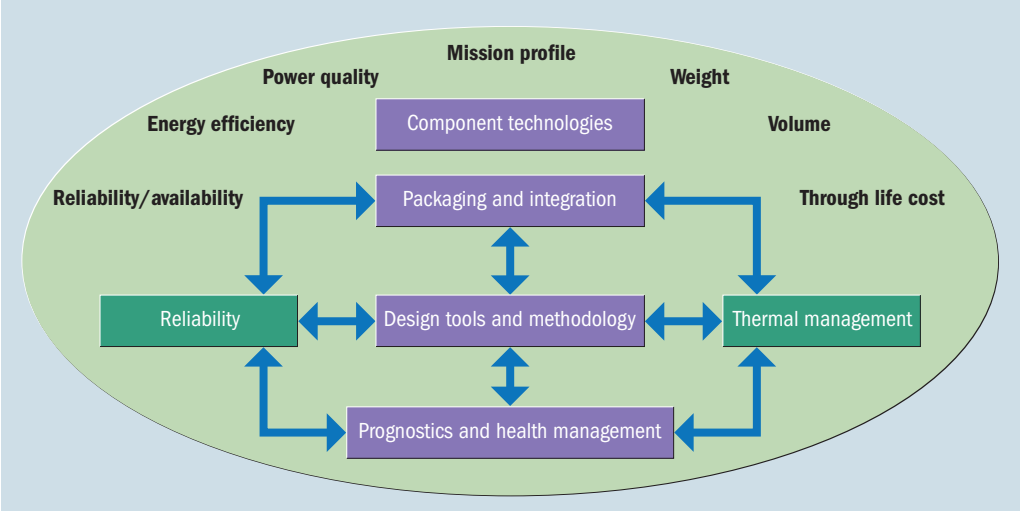
Prof Johnson indicated the scale of the problem. "When we met with EPSRC, BIS and so on, it was clear that many of them didn't know what power electronics was and what it did. Power electronics hides in the background until it doesn't work, at which point people complain."

According to Prof Johnson, the creation of what is officially known as National Centre of Excellence for Power Electronics is part of a long term vision to get the technology's profile raised. "There has been a lot of work behind scenes to get the BIS document in progress," he said. "The industrial community was involved in creating a strategic document and the result of that work enabled us to go back to EPSRC."

The money invested by EPSRC is intended to fund underpinning research at the various universities. And this, in Prof Johnson's opinion, is significant. "EPSRC is also funding applied research, but that's applying

Fig 1: Focus areas for power electronics research in the UK



what's known, rather than things that are more ambitious. We're trying to break away from that and have tried to cover as many of the underpinning challenges as we could, whilst aligning with what the UK is good at. But it doesn't cover everything."

The Centre has four main research themes and three cross cutting themes. The research themes are: semiconductors; integration; converters; and devices. Cross cutting themes are: design tools and modelling; structural and functional integration; and operational management and control. "The whole point," Prof Johnson explained, "is they are all supposed to be tied together, with the cross cutting themes acting as 'glue'."

Fragmented community

In identifying the research themes and exploring the sector, Prof Johnson found a number of similarities with earlier reports on other areas of the electronics industry. "The community was fragmented," he noted, "with a lot of companies working in isolation outside of the mainstream."

So the Centre is not only attempting to bring together expertise into focused projects, but also to undertake work that might not otherwise get done. "If you want to develop a new design tool," he said, "that might not necessarily get funded."

Even though EPSRC is investing £18m into power electronics research – as well as another £5m in capital equipment – Prof Johnson believes the UK's academic performance is already 'up there'. "We are competitive and world leading in a number of topics," he asserted. "A lot of European countries are looking with interest at what we're trying to do. EPSRC, meanwhile, sees this as an experiment; it hasn't done anything quite like this before."

Officially, the Centre has four key targets: to address key research challenges through a coordinated programme; to build critical mass in the area of power electronics; to develop a widely recognised, internationally leading research capability; and to develop a UK research strategy for power electronics. "But we won't get things done in five seconds flat," Prof Johnson pointed out.

Work in semiconductors research is described by Prof Johnson as 'interesting'. " We have a strand of work inside the centre and another strand outside. The work being done at Glasgow on gallium nitride on silicon forms one of the Centre's activities, but funding is complementary, because we don't want to duplicate the work."

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Amongst the projects being pursued is how to get the 'last drop' out of silicon. Prof Johnson said work is also being done on silicon carbide. "It's a wide band gap material with different, but equally attractive, application areas to those expected for GaN. NXP and International Rectifier are heavily involved in the GaN project.

"But we're not trying to compete with commercial companies; rather, we're working with them to solve particular problems. Even though these companies have launched commercial devices, they still have problems with the technology – stability, for example – and applying the devices isn't trivial; they're fast, but can cause more problems than they solve if not applied correctly. All of this means we need to know more."

Knowledge and technology transfer are other activities. "We're coordinating training," he continued, "and exposing people to what others are doing. It's not an 'academic only' activity. All the universities associated with the Centre have strong links with industry and our aim is to bring the academic and industrial worlds together."

Industrial liaison

One way in which that might happen is through a soon-to-be-filled industrial liaison post that links the Centre with the High Value Manufacturing Catapult. "Finding out how we can help small businesses is problematic," Prof Johnson admitted. "Having that person will marry industrial need to academic capability and help that union in a more coordinated way."

The Centre is also building what Prof Johnson calls a 'cohort' of students being trained in power electronics. "It's not just about pure research; while we need a supply of good ideas, we also need people who can translate these ideas."

While the Centre is not tied firmly to PowerelectronicsUK, the two organisations are trying to unify activity. "What we are trying to do," Prof Johnson concluded, "is to say 'this is where you come if you want to do power electronics."

Fig 2: The power electronics supply chain in the UK