

British High-Tech
and VC Industry
Digest



(4th Quarter, 2013)



Editorial

In the venture capital market, the quarter has seen a renewed effort by the government to attract venture investment into the UK, and in particular target the funding gap for early-stage companies that has been identified by, among others, BVCA and Nesta. With the new Budget announced in November, the Department for Business, Innovation, and Skills and the Treasury had good news for early-stage companies and investors alike. In both cases, the coalition government is building on policies begun under their predecessors (the Enterprise Capital Funds and EIS both predate the current Cabinet). This government has been quite successful in relaxing the framework for VC investment in the UK and it would now appear that the country is becoming an increasingly attractive destination for American as well as local funds – as evidenced by the participation of major US investors (Accel Partners, Union Square Ventures, and others) in the major fundraising deals of the quarter. This is good news for small UK-based businesses that have been struggling to secure funding through banking loans, as lending remains sluggish.

Other news from the quarter include the launch of several new high-profile funds, including Atomico, KPMG Capital, and Cambridge Innovation Capital. As a general trend, we expect to see the launch of several new major funds in the next quarter as many are approaching their closing dates and better-than-expected economic growth leads to a more optimistic outlook for investors.

The ICT sector remains highly focused on social networks. While Facebook, alongside other tech giants, came under fire for tax evasion, Tech City entrepreneurs continue to look for new revenue models that appeal to users whose privacy concerns continue to grow in the aftermath of NSA revelations. It remains to be seen whether non-advertising based revenue can be sustainable in the long term, but it certainly can serve as an important differentiator in a saturated market. The continuing development of Tech City, where Cisco has now joined Google, IBM, and Microsoft, provides a useful platform.

A number software development companies held successful IPOs, including Arria NLG and Servelec Group, while early-stage venture investment picked up in the Tech City, with seed and early stage investments of at least £7 million in November alone. A particularly heartening sign is the growth of interest in UK start-ups from Silicon Valley investors.

The British bio- and medical technology sector has seen a number of spectacular advances blending life sciences and enabling technologies like ICT and engineering. Characteristically, many of these were achieved through partnerships between universities and the private sector, underlining the UK's ability to translate research findings into practical applications. Government funding (both EU and

local) continues to play an important role in specific, high-impact areas like cancer and Parkinson's research, and is likely to increase in importance as the government's Life Sciences Strategy unfolds.

On the funding front, the biggest item was the successful American IPO held by Oxford Immunotec Global, which raised over \$64 million. British pharmaceuticals also remained active, with a \$440 million buyout of Spirogen by AstraZeneca's captive venture fund the highlight of M&A. On the venture capital front, a number of pharmaceutical companies based in the Golden Triangle area secured Series funding with average investments of around £18 million.

In chemical technology, large acquisitions of specialist UK companies by multinational corporations affirm the country's place in global knowledge-intensive value chains. Given the low costs of outsourcing low-technology production processes, British firms have chosen to specialise on specialty chemicals, particularly those used in the production of electronic devices. In this way, the country has been able to build on its industrial legacy by providing highly specialised products to global markets.

It is worth noting that many of the success stories in chemical technology this quarter came from the North East of England, where a number of specialised venture funds continue to support traditional industrial occupations with a high-tech twist. The £25.5 million investment into Fine Technologies from NorthEdge Limited is a good example of this trend.

Engineers from Cambridge University have demonstrated the flexible nature of engineering technology, coming up with multi-purpose products. Both Ubisense's tracking technology and audio recognition from Dr Turner were originally developed for different purposes (tracking people within a building and smart hearing aids), but can also be successfully used in other settings (aerospace manufacture and video software), with funding for the latter supporting development of the former use cases. Similarly, the lightweight batteries developed for automotive production are likely to find uses far beyond that, with important implications in, for example, aerospace manufacturing and clean technology. The intersection of engineering and ICT has been particularly productive.

For much of the quarter, media tracked the hostile takeover bid made by Oxford Instruments for Andor Technology. The story came to a conclusion in December, when Andor agreed to a £176 million deal. Venture funding, however, remains difficult to secure in engineering and aerospace, with many funding opportunities coming from corporations interested in developing a technology for their own use. The recently launched Advanced Propulsion Centre £75 million competition funded jointly by government and industry is a case in point.

The UK remains at the forefront of **advanced materials** development and demonstrates a remarkable versatility in its approach to this sector. Although the country is best known for the discovery of graphene at Manchester University, where works continues on a variety of practical applications, the presence of high-value manufacturing industries (such as automotive production) encourages the development of new materials and composites, as well as innovative approaches to cutting the costs of using more traditional materials like titanium.

The high expectations of the market for graphene were underlined by the very successful IPO of Applied Graphene Materials, which developed a technology for the production of graphene from ethanol and raise £11 mln. With more and more funding coming in this area from a variety of sources, including the Bill and Melinda Gates Foundation, we can expect to hear a lot more in this area in the coming year.

Similarly, in **energy efficiency** UK entrepreneurs and researchers are pursuing a variety of approaches. Some of the major problems in the energy sector are the high costs of fossil fuels and the underdeveloped infrastructure for their alternatives, both of which are being addressed. The willingness of the Technology Strategy Board to work with early-stage companies in the development of next-gen nuclear technology is particularly heartening, as the UK government starts to recognise the importance of SMEs for effective innovations.

The cleantech sector remains an attractive proposition for venture investors, thanks to its potential for high growth and significant social impact. Cleantech start-ups have raised at least £1.5 million in this quarter, and this number is likely to continue to grow as new technologies come out from the lab.

The UK government is looking to turn British universities into innovation hubs, providing significant funding for a number of schemes such as University Enterprise Zones. While the British higher education system is recognised globally as producing excellent research results, the links between academia and industry are not always strong (and often focused on a handful of leading universities). This quarter's developments demonstrate the willingness of the government and industry to engage with universities in biotechnology, engineering, and other areas. While many of the countries leading clusters have grown organically around the universities, a more concerted effort in this direction is going to benefit all participants in the innovation ecosystem, and in particular SMEs, where barriers to access university research are likely to decrease as a result. On the other, hand the recent announcement by Prime Minister David Cameron that he will seek to cap the number of EU migrants in the UK has raised fears that access to talented European workers may be constricted in the future.

Overall, the innovation sector of the UK economy has seen significant growth in Q4, as the improving economic climate attracts investors and government venture capital schemes make it easier for start-ups to raise funds. As expected, the pharmaceutical industry remains strong as they seek to outsource much of new drug development and testing and increasingly adopt VC models of funding for smaller contractors. Similarly, the ICT sector continues to grow, with a lot of attention going to the rapidly developing Tech City cluster in East London. It is interesting to note that as Silicon Valley investors increasingly look to enter the UK market, much of the focus has shifted to consumer-grade and SaaS software, as opposed to traditional UK strengths in enterprise-grade big data analytics and cyber security. Finally, the advanced materials industry and especially cleantech seem poised for significant growth in 2014, as scientific discoveries of the past few years gradually find their way into the real world. Overall, the market is rather optimistic about 2014; it remains to be seen whether this optimism will prove to be justified.

Venture capital market

Secretary of State for Business, Innovation, and Skills Vince Cable announced that a £25 million boost will be given to 'small but innovative' UK businesses¹.

Episode 1² is a £37.5 million fund and the 14th Enterprise Capital Fund entering the government's scheme to support fund managers who invest in small, high growth businesses. The Enterprise Capital Fund is a joint public-private venture. Since 2006, £197 million has been invested in over 160 companies.

Episode 1 will be led by Dr Simon Murdoch, an investor who has successfully invested in some of the most significant UK tech companies of the last 10 years including LoveFilm, Zoopla and Shazam. The fund has attracted £12.5 million of private investment, alongside the £25 million from the government, and will invest between £250,000 and £2 million into 20 to 30 early-stage technology companies. Vince Cable announced to be determined to give entrepreneurs the financial support they need to grow. This new £37.5 million Enterprise Capital Fund will target a serious gap in the equity market for high growth small firms.

The money had been raised from other entrepreneurs, supplemented by the finance matching from the UK government which enables the fund to invest and help more high growth UK businesses with global-market aspirations. The intentions of the government are to support the growth according to the objectives

¹ <https://www.gov.uk/government/news/business-secretary-announces-25-million-boost-for-innovative-small-businesses>

² <http://www.episode1.com/news/episode-1-enterprise-capital-fund-launches-to-support-uk-tech-entrepreneurs>

set in the Plan for Growth published at Budget 2011, such as 'to create the most competitive tax system in the G20, to make the UK the best place in Europe to start, finance and grow a business, to encourage investment and exports as a route to a more balanced economy and to create a more educated workforce that is the most flexible in Europe'.

IP Group plc (www.ipgroupplc.com), developer of intellectual property based businesses, **informed that portfolio company Oxford Nanopore Technologies Limited** ("Oxford Nanopore"), an Oxford spin-out company that specialises in nanopore-based electronic molecular analysis systems, **has raised £40 million in new funding via a private placement of ordinary shares**³.

The investment was received from new and existing investors in the US, UK and mainland Europe. New investors include Odey Asset Management. Funds will be used to further develop Oxford Nanopore's commercial and manufacturing infrastructure, continue innovative research and development in nanopore sensing, and for various corporate objectives including the building and defence of its broad intellectual property portfolio.

UK Peer-To-Peer Lending Platform Funding Circle Raises \$37M, Targets U.S. SMBs In Merger With Endurance Lending Network⁴.

Funding Circle, a UK-based peer-to-peer lending platform that lets individuals and institutions loan money to small businesses, picked up a \$37 million round of funding. It announced plans to take its business to the U.S., its second market, in a merger with San Francisco-based Endurance Lending Network. Its ambition, in the words of co-founder and CEO Samir Desai, is to become the "NYSE for small business lending."

Going into the U.S. will also bring Funding Circle a fresh wave of competition. There are already several platforms for crowdfunding initiatives, like Kickstarter and Indiegogo. New, more relaxed crowdfunding rules being proposed by the SEC could see the number of companies increase.

Funding Circle's Series C round was led by new investor Accel Partners, along with participation from Ribbit Capital (another new investor) and Union Square Ventures (also a Kickstarter investor) and Index Ventures. The latter two also clubbed together in a \$16 million Series B round in April 2012. It brings the total raised by Funding Circle to \$58 million.

Since 2009, Funding Circle says that it has facilitated over \$250 million in loans in the UK, the only market where it has operated up to now.

³ <http://www.ipgroupplc.com/media-centre/ip-group-news/2013/2013-10-09>

⁴ <http://techcrunch.com/2013/10/23/funding-circle/>

The UK Chancellor George Osborne's Autumn Statement outlined more favourable tax relief for the Enterprise Investment Scheme. The investors committing to EIS funds may receive immediate tax relief. The improved tax scheme comes as the BVCA launches a new framework to promote co-operation between angel investors and venture capital firms in deals using the EIS. The initiative gives angels the ability to invest alongside institutional funds in order to boost the deployment of the tax relief scheme. The framework provides a standard 'term sheet' for investors in venture deals that use the EIS. The reforms made to the EIS last year mean that individuals can claim 30% of the cost of each investment against their income tax bill. The reforms lifted many of the restrictions on the types of businesses that can be invested in (originally the scheme was aimed at start-ups and young companies). Target companies can be based almost entirely overseas and the amount of cash that can be raised by a business each year has increased to £5m.

Jason Hollands, managing director of London-based financial adviser Bestinvest (<http://www.bestinvest.co.uk/>), recently said that venture capital trusts are the 'ultimate play' on a recovering UK economy⁵. Small businesses look to expand and seek finance, and with corporate bank lending squeezed, many turn to venture capitalists for funding. Possible risks are offset by considerable tax breaks. Investing in a new share offer from an existing trust (the main way managers now raise money) or in a new trust altogether, any of such investments attracts upfront relief of 30 per cent.

The tax break – available on sums invested up to £200,000 in the current tax year – means that for every £10,000 invested one gets back an income tax rebate worth £3,000. In case of failure to hold the shares for a minimum five years, the rebate is to be handed back.

Some brokers, such as Bestinvest, Chelsea Financial Services, Clubfinance and Hargreaves Lansdown, allow investors to buy trusts online. They will also discount initial charges which range from 3.25 per cent to 5.5 per cent. Some discounts can reduce this initial charge to as little as one per cent. Minimum investment is typically between £3,000 and £5,000.

Information and communication technologies

Facebook paid no corporation tax in the UK last year despite them taking an estimated £223M share of the digital advertising market in the UK, the Guardian reports.

⁵ <http://www.thisismoney.co.uk/money/diyinvesting/article-2516084/Its-high-risk-long-term-investment-What-venture-capital-trusts-invest-them.html>

Over the last two years it's estimated that Facebook's British revenues have risen from £181 in 2011 to £223m in 2012. The vast majority of Facebook's advertising revenue from its 33 million British users is siphoned through their Irish subsidiary. Along with Facebook, Google and Apple have also taken advantage of Ireland's lower tax rates. Margaret Hodge, chairwoman of the Public Accounts Committee criticised Facebook's actions, but Facebook gave no substantial response saying only: "Facebook pays all taxes required by UK law and we comply with tax laws in all countries where we operate and have employees and offices. We take our tax obligations seriously, and work closely with national tax authorities around the world to ensure compliance with local law'.

The Google-backed genetic sequencing company 23andMe (www.23andme.com/) has been forced to stop the sales of its popular saliva-collecting testing kits by the US Food and Drug Administration. The government agency demanded that the company stop selling its at-home testing kits "immediately" because they required regulatory clearance and were supposedly being sold in violation of the US Food, Drug, and Cosmetics Act.

At this stage, the company has stopped marketing its products and has stressed that their relationship with the FDA is "extremely important". The sales of testing kits have not been stopped yet and the kits can still be purchased on the company's website.

23andMe said in September that its database had reached 400,000 people. The market for at-home genetic testing kits has grown in the past decade and the US Department of Health and Human Services has echoed the FDA's concerns, cautioning the at-home tests "have significant risks and limitations". The FDA said some of the intended uses of the PGS were "particularly concerning" because false positives or negatives may lead consumers to make important decisions about their health based on inaccurate information. FDA is also concerned about the possible inaccuracy of the test results and about the possibility that customers might be misguided by the data or simply frightened at an apparent high risk of a disease, leading them to make rash decisions.

Unii, A Student-Only Social Network, Signed Up 100,000+ Users In Six Months In The U.K.⁶

In recent years less overarching social network services have been able to come in and attract users to more tailored and intimate products, whether it's photo-sharing (Instagram), mobile messaging (Line, WeChat) or more targeted social networking services.

⁶ <http://techcrunch.com/2013/11/01/unii/>

U.K.-based startup Unii is focused exclusively on students. Unlike Facebook it's planning to stick with students and build out a business based on providing services to that specific user-base.

A tagline on the Unii website reads 'what happens at unii, stays at Unii' — a not-so-veiled dig at Facebook as a vast information repository that allows potential employers to pass judgement on job applicants based on the content of their Facebook profile. Unii is purposefully locking down its user-base to make students more comfortable that they are sharing stuff only with each other, not with their parents and/or future employers.

Unii.com launched in May, at a sub-section of U.K. universities and colleges (it's now live in over 185 out of a total pool of around 300). In those six months it's managed to gain a decent bit of traction among its 18-24 user-base, announcing today that it has pushed past 100,000 users.

The social network is free for students and won't be monetised by ads. Rather the plan is to launch a series of sub-businesses that sit on the platform and cater to students' needs — from the likes of finding accommodation (Unii Living), to buying and selling books, to finding a job (Unii Jobs). Some of these are already live on the platform (although it's not yet taking in any revenue, focusing first on building out its users), with many more planned: 10 will launch over the next three to 12 months, according to Nardone. Each of these sub-businesses will then have different revenue generating models. Unii is currently live on the web, with Android and iOS apps to appear soon.

Prime Minister David Cameron opened Cisco's innovation centre in east London on the third anniversary of Tech City.

Networking company Cisco set up IDEALondon with publisher DC Thompson and UCL in the Tech City area of London. The centre aims to nurture and grow early-stage and existing startup companies in London. Cisco chose its startups through its British Innovation Gateway awards (BIG), while UCL's Advances programme will select the best entrepreneurs from the university's digital programme. The start-ups will have access to all the opportunities working with a world-leading university can provide – advanced lab facilities, computer scientists and a closed community market research programme.

DC Thompson will focus on supporting startups working in digital content creative, advertising, e-commerce and educational technologies.

Biotechnology and medical technology

Researchers have estimated total expenditure for cancer in the EU at €126bn. According to Dr Ramon Luengo-Fernandez from the University of Oxford, this is the first ever comprehensive EU-wide study which allows to not only estimate the total cost of cancer in the EU, but also to make comparisons between countries⁷ His team collated data obtained from the WHO and EUROSTAT, as well as national ministries of health and statistical institutes to estimate the total cost of cancer across the EU in 2009, the most recent year for which comprehensive data were available. The overall calculation included the cost of health care for cancer, the cost of productivity, and the cost of informal care from friends and relatives and estimated the overall cost to be €126bn.

The results were published in *The Lancet Oncology*, and they reveal substantial disparities between different countries in the EU in spending on health care and drugs for cancer, with Luxembourg and Germany spending the most on health care for cancer per person, and Bulgaria spending the least. Overall, expenditure on drugs for cancer accounted for around a quarter of the total cost (€14bn). Spending on cancer medications as a percentage of health care costs was lowest in Lithuania, and highest in Cyprus.

The researchers also examined the different contribution of the four cancers which in the EU contribute to around half of all new cancer diagnoses and deaths – breast, colorectal, lung, and prostate cancer. They found that lung cancer had the highest overall cost, at €18.8bn, and was responsible for the biggest loss of productivity. Health care costs were highest for breast cancer (€6.7bn, 13% of total cancer-related health care costs), largely due to high rates of spending on drugs.

Researchers from the University of Leicester and GlaxoSmithKline (www.gsk.com) found a universal drug that may protect brain cells from neurodegeneration⁸.

A research team headed by Giovanna Malucci from the MRC Toxicology Unit in Leicester reports that a twice-daily dose of GSK2606414 (50 mg/kg) prevented mice models with prion disease from neurodegeneration by blocking the highly selective eIF2a kinase PERK-P. The enzyme, whose levels are elevated in patients with Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis and prion disease, jumpstarts a natural defence mechanism called unfolded protein response or UPR. UPR switches off the production of new proteins by blocking the initiation of protein synthesis.

⁷ <http://www.european-biotechnology-news.com/news/news/2013-04/cost-of-cancer-at-eur126bn-in-the-eu.html>

⁸ <http://www.european-biotechnology-news.com/news/news/2013-04/universal-drug-vs-neurodegeneration.html>

Oral treatment with the specific inhibitor of PERK-P (protein kinase RNA-like endoplasmic reticulum kinase) prevented UPR-mediated translational repression and abrogated development of clinical prion disease in mice, with neuroprotection observed throughout the mouse brain (Science Translat. Medicine).

Parkinson's disease may be diagnosed much sooner with the development of sensory pen technology⁹ that can identify the often subtle signs of the condition.

The system combining sensor and computing technology and developed by a venture led by Newcastle-based MANUS Neurodynamica, requires the patient to perform a set of writing tasks, drawing activities or a combination of both. The system records all movements of the pen as well as other parameters such as drawing pressure, plus acceleration and deceleration of movement to identify patterns that are indicative of specific kinds of neuromotor disorders. Dr Rutger Zietsma, director of MANUS explained that there are parts of the UK where there is a one year waiting list to see a consultant neurologist and that the current 'gold standard' - DaTScan radiological imaging - is expensive and requires specialist training to use.

The sensory pen can be used by non-specialists with minimal training and large numbers of people would be able to be screened, especially those deemed at risk.

The recordings enable the operator to assess akinesia/bradykinesia, tremor, rigidity and other subtle signs of motor deterioration that cannot be clinically detected by any other means.

The software takes inputs from a variety of sensors (accelerometers and gyroscopes) in the pen and converts them, using proprietary algorithms, into outcome percentages that represent the likelihood of the presence of PD or other neuromotor disorders. Founded in 2008, Manus has attracted funding that includes a grant from the EC Research Executive Agency under the Research 4 the benefit of SME scheme (R4SME), which is funding R&D until December 2013. The sensory pen, assisted also by a £178,000 late-stage industrial grant from the Technology Strategy Board, will now be put through final stage testing at North Tyneside Hospital.

AIM-listed Sareum, a specialist cancer drug discovery and development business, has signed a co-development agreement with HMUBEC to advance its Aurora+FLT3 cancer programme¹⁰.

⁹ <http://www.theengineer.co.uk/medical-and-healthcare/news/sensory-pen-can-detect-early-symptoms-of-parkinsons-disease/1017372.article>

HMUBEC has been granted exclusive rights to carry out pre-clinical and clinical studies within Greater China (the People's Republic of China, Hong Kong, Macau and Taiwan) to obtain approval for sales in that territory. Sareum will receive a significant milestone payment once a product receives authorisation for marketing and up to 15 per cent of operating profit from sales generated in Greater China. HMUBEC is an independent research centre operating within Hebei Medical University Science & Technology General Company, which has developed more than 85 therapeutic products and medical devices for the Chinese market since its formation in 1992.

The UK's first mind-controlled robotic arm was implanted in a soldier who lost his limb in Afghanistan¹¹. The technology relies on a medical technique that rewires a patient's nervous system so that nerves from the shoulder that would have controlled the hand, are wired into the chest muscle instead. Previous robotic prostheses have picked up individual signals created by muscle movement, which controlled separate arm functions such as lifting or turning. The new arm simultaneously gathers up to six signals directly from the nerves, enabling it to replicate much more lifelike motion from the user's thoughts. Ken Hurst, who manages the UK training academy for the company behind the robotic arm, Otto Bock, said that once patients had learnt how to use the arm they could operate it with more intuitive, sub-conscious movements rather than conscious effort.

The arm, which was implanted in Corporal Andrew Garthwaite at the Medical University of Vienna, relies on a six-hour surgical procedure known as targeted muscle reinnervation (TMR).

Once this is complete, the arms collects signals from six electrodes in the chest, digitises and amplifies them before transmitting them to a central processing unit (CPU) that converts them into physical movement in the arm.

Garthwaite had to undergo 18 months of therapy to learn how to use the device. Hurst said the challenge had been developing the software and hardware to manage the different signals and integrate the movement of the different elements of the prosthesis.

He added that smaller, more specified electrodes and more advanced motorised and electronic systems would create even more capable prostheses but that a different breakthrough would needed to make the technology easier to use.

¹⁰ <http://www.businessweekly.co.uk/biomedtech-/16224-cambridge-china-cancer-programme-advanced>

¹¹ <http://www.theengineer.co.uk/medical-and-healthcare/news/soldier-receives-uks-first-mind-controlled-robotic-arm/1017683.article>

Chemical technology

Albemarle (www.albemarle.com) has acquired Cambridge Chemical Company, a UK-based producer of high purity metal organic chemicals used in the laser market¹². Albemarle plans to continue producing specialty chemicals at Cambridge Chemical's existing facilities in the country.

Cambridge Chemical said its unique technological capabilities, products, distribution channels and expertise will further strengthen Albemarle's offerings in the electronic materials market, including light emitting diodes (LED), semiconductor, organic light emitting diodes (OLEDs) and laser segments.

Albemarle's Electronic Materials business global business manager Jenny Hebert said by adding Cambridge Chemical's DEOX technology to its existing PureGrowth portfolio, the company will be able to provide an even broader array of solutions to customers in the fast growing electronics market.

Merck is buying hi-tech materials firm AZ Electronic Materials for £1.6bn (US\$2.5bn), as it looks to extend its reach into specialty chemicals¹³.

The UK-based AZ is the world's largest producer of liquid crystals used in TVs and smartphone screens, and supplies Apple with the chemicals used in its iPad tablet. Merck's bid has been endorsed by the company's board and the deal will be funded using cash.

Merck chair Karl-Ludwig Kley says that the acquisition will allow it to add to its existing array of high-margin specialty chemicals businesses. The combination will enable Merck to access additional growth areas in the electronics industry to benefit even better from the increasing demand for electronic devices beyond displays.

Last year AZ made US\$262m profit on revenues of almost US\$800m. Some 70% of this came from the company's materials division, which produces process chemicals for integrated circuits in computers, smart phones, mp3 players and games consoles. Its optronics division, which produces light-sensitive materials for flat panel screens, accounted for around 30%.

¹² <http://www.chemicals-technology.com/news/news-albemarle-acquires-uk-cambridge-chemical-company/>

¹³ <http://www.tcetoday.com/latest%20news/2013/december/merck-bids-az-electronic-materials.aspx#.Uqo5nvRdU3k>

Engineering and aerospace

Tracking technology developed by Cambridge company Ubisense is helping make modern assembly lines up to ten per cent more efficient, by tracking hundreds of components in three dimensions and in real time¹⁴.

The technology is aimed at improving the accuracy and reliability of manufacturing lines, while reducing assembly times by up to ten per cent, by determining the exact coordinates of an item within a given space.

The Ubisense, spun-out from the University's Computer Laboratory in 2002, went public in 2011, and has developed a real-time tracking system, which decreases losses and increases efficiency in the manufacturing sector. The company's products are used by more than 500 companies in 50 countries worldwide, including BMW and Airbus. Ubisense's technology can improve accuracy while reducing assembly time by as much as ten per cent, automatically adjusting tool settings so that the correct settings are always used on the correct car.

Ubisense's Chief Technology Officer Dr Andy Ward originally devised a system to track individuals as they moved around the lab in mid-1990s when most people had no mobile phones. After leaving the University, Ward co-founded Ubisense and set out to develop a more accurate version of his tracking system, which could not only determine which room an individual or piece of equipment was in, but also exactly where they were located in that room, what equipment was nearby and what that equipment was doing.

The radio-based system consists of transmitters embedded in small tags, roughly two centimetres square, and base stations installed around a building. As a tagged item moves through a space, the base stations will identify its precise coordinates in real time.

Google is part-funding Cambridge UK audio technology that will produce a revolutionary smart hearing aid that eliminates background noise and could be adapted to clean up YouTube videos, compromised musical tracks and interference on mobile phones¹⁵.

The Cambridge University engineer behind the research, Dr Richard Turner, says future devices in the machine hearing revolution could include several different modes in which they can operate.

¹⁴ <http://www.enterprise.cam.ac.uk/news/2013/10/streamlining-manufacturing/>

¹⁵ <http://www.businessweekly.co.uk/academia-a-research/16000-google-bankrolls-cambridge-audio-technology>

These might include a mode for travelling in a car or on a train, a mode for environments like a party or noisy restaurant, one for windy outdoor environments and so on.

The device might intelligently select an appropriate mode based on the characteristics of the incoming sound or the user could override this and choose a processing mode based on what kinds of noise they want to wipe out.

With 100 hours of video now being uploaded to YouTube every minute, Google has recognised the potential for systems that can recognise audio content and is funding part of Dr Turner's research.

As an example, a YouTube video containing a conversation that takes place by a busy roadside on a windy day could be automatically categorised based on the speech, traffic and wind noises present in the soundtrack, allowing users to search videos for these categories.

Volvo Car Group developed a concept for lightweight structural energy storage components aimed at improving the energy usage of future electrified vehicles¹⁶.

The material, consisting of carbon fibre, nanostructured batteries and super capacitors, is claimed to offer a lighter energy storage solution that requires less space in the car whilst providing cost effective structural options.

The 3.5 year effort, funded as part of a European Union research project, included Imperial College London as the academic lead partner along with eight other participants.

The project team identified a feasible solution to the heavy weight, large size and high costs associated with the batteries in current hybrids and electric cars, whilst maintaining the efficient capacity of power and performance. Car panels developed by the project have now been incorporated into a Volvo S80 experimental car.

The reinforced carbon fibres sandwich the new battery and are moulded and formed to fit around BRUDERER UK, with the management team keen to build on annual sales of £3m in 2013.

¹⁶ <http://www.theengineer.co.uk/volvos-structural-battery-saves-space-and-weight-in-electric-car/1017398.article#ixzz2nZpHnzoV>

Advanced materials

Researchers at Manchester University have demonstrated that membranes can be directly 'written' on to a graphene surface using Lipid Dip-Pen Nanolithography (L-DPN)¹⁷.

The researchers at Manchester University led by Dr Aravind Vijayaraghavan, and Dr Michael Hirtz at the Karlsruhe Institute of Technology (KIT), described their work in Nature Communications. The human body contains 100 trillion cells, each of which is enveloped in a cell membrane that have a plethora of proteins, ion channels and other molecules embedded in them, each performing vital functions.

Understanding these systems will enable their application in areas such as bio-sensing, bio-catalysis and drug-delivery. Considering that it is difficult to accomplish this by studying live cells inside the human body, scientists have developed model cell membranes on surfaces outside the body, to study the systems and processes under more convenient and accessible conditions.

The graphene turned out to be a suitable new surface on which to assemble these model membranes, and is claimed to bring many advantages compared to existing surfaces. Graphene has unique electronic properties; it is a semi-metal with tuneable conductivity. When the lipids contain binding sites such as biotin, it actively binds with a protein called streptavidin. Also, when charged lipids are used, there is charge transfer from the lipids into graphene which changes the doping level in graphene. All of these together can be exploited to produce new types of graphene/lipids based bio-sensors.

UK researchers hope to replace potentially dangerous chemicals in cooling systems with materials that change temperature when electricity is applied¹⁸.

A team at the National Physical Laboratory (NPL) is trying to develop the first practical 'electrocaloric' cooler, providing much greater efficiencies than conventional gas-based refrigeration systems and without the high costs of using large magnets to generate low temperatures. The engineers hope to take advantage of a breakthrough made in 2006 when scientists showed the electrocaloric effect, which causes materials to change temperature under an applied electric field, was much larger in thin film substances than in bulk solids and big enough for its use in cooling applications.

¹⁷ <http://www.theengineer.co.uk/medical-and-healthcare/news/graphene-has-potential-as-cell-membrane-modelling-surface/1017291.article#ixzz2mgzbPWN2>

¹⁸ <http://www.theengineer.co.uk/channels/design-engineering/news/electrocaloric-material-could-lead-to-more-efficient-refrigerators/1017688.article>

Typical domestic fridges use a continuous cycle of vapour compression and expansion of chemicals such as Freon that condense into liquid and absorb heat from the surroundings. These chemicals can be harmful to the environment and such systems have low efficiencies of around 30 per cent.

Other cooling systems apply magnetic fields to provoke a cooling effect in materials but these require large, expensive equipment.

Theoretical predictions put the efficiency of electrocaloric at 60 to 70 per cent – comparable with magnetic cooling but potentially achievable with much smaller and cheaper equipment.

UK researchers claim to have produced the world's first 3D-printed titanium car parts, demonstrating how the metal could become cheap enough for commercial production¹⁹.

Titanium is usually considered too expensive for use in automotive manufacturing but a novel process for producing titanium powder from sand has opened the way for 3D printing parts cheaply enough for low-to-medium volume production, according to engineers from Sheffield University.

The process, created by Rotherham-based company Metalysis (originally a spin-out of Cambridge University), creates titanium powder at much lower cost than the conventional method of atomising blocks of metal, said Prof Iain Todd, director of the university's Mercury Centre in the department of materials. This means automotive parts can be made more economically using additive manufacturing rather than traditional subtractive techniques that waste large amounts of the expensive metal and use costly die set tools, he told The Engineer.

Todd's team has used the material to 3D print parts including impellers and turbochargers, as well as aerofoils, using a Renishaw laser additive manufacturing machine and standard operating procedures based on the material's thermal characteristics.

The research doesn't yet take titanium automotive printing to the point where the material or the technique could be commonly used for mass production.

¹⁹ <http://www.theengineer.co.uk/channels/design-engineering/news/team-prints-worlds-first-3d-titanium-car-components/1017653.article>

Energy efficiency

London, Luton, Leicester and Leeds were linked for electric vehicles (EV) after green energy company Ecotricity and EV market pioneer Nissan installed new fast-chargers all along the M1 motorway²⁰.

Powered with 100 per cent renewable energy from the wind and the sun, the Electric Highway fast-chargers allow EVs (such as Nissan's all-electric LEAF) to re-fuel in 20 to 30mins or about the time it takes to have a cup of coffee – matching the so-called 'dwell-time' that motorists tend to spend at motorway services, according to industry research. There are now nine fast-chargers at five Welcome Break service stations along the M1 corridor beginning at London Gateway in Edgware and including motorway services at Milton Keynes, Leicester, Derby and Sheffield plus the option of South Mimms on the M25.

The expanding Electric Highway now has 26 fast-chargers at motorway service stops – linking London to Birmingham, Manchester, Bristol, Cardiff and now Leeds. The company said the three perceived barriers to the growth of electric vehicles are price, travel range and re-charging times, and they are being rapidly overcome. The pricing matter is being resolved by motor industry competition, which has forced down new car prices by as much as 35 per cent over the past two years. The second and third barriers are to be overcome by installing fast-charging infrastructure in the right locations. An average car journey in Britain is less than 30 miles, and charging takes place mostly at home overnight, so charging is really needed on the longer journeys only. In addition, with petrol prices remaining permanently high, motorists driving a typical 8,500 miles per year would save around £1,000 in fuel costs at today's prices – and save around 2,000kg in CO2 emissions.

In the near future, solar panels will not only be more efficient but also more affordable²¹, claim researchers at Nanyang Technological University. This next generation solar cell, made from organic-inorganic hybrid perovskite materials, is about five times cheaper than current thin-film solar cells, due to a simpler solution-based manufacturing process.

Perovskite is known to be a remarkable solar cell material as it can convert up to 15 per cent of sunlight to electricity, close to the efficiency of the current solar cells, but scientists did not know why or how until now.

²⁰ <http://www.businessweekly.co.uk/travel-and-transport/15980-electric-highway-links-luton-to-leeds>

²¹ <http://www.theengineer.co.uk/energy-and-environment/news/insights-into-perovskite-could-lead-to-improved-solar-cells/1017334.article>

In a paper published in Science, NTU's interdisciplinary research team was the first to explain this phenomenon.

The team of eight researchers led by Assistant Professor Sum Tze Chien and Dr Nripan Mathews worked with NTU Visiting Professor Michael Grätzel, who currently holds the record for perovskite solar cell efficiency of 15 per cent, and is a co-author of the paper.

The high sunlight-to-electricity efficiency of perovskite solar cells places it in direct competition with thin film solar cells which are already in the market and have efficiencies close to 20 per cent.

The new knowledge on how these solar cells work is now being applied by the Energy Research Institute @ NTU (ERI@N), which is developing a commercial prototype of the perovskite solar cell in collaboration with Australian clean-tech firm Dyesol.

British engineering firms are being called on to propose ideas for innovative technology that could help grow the UK's nuclear power supply chain²².

The Technology Strategy Board (TSB) is offering up to £13m to help UK firms develop innovations for the nuclear energy sector, a move intended to help British industry reap more of the economic rewards from the creation of the next generation of power stations.

The main manufacturing contracts for the first of these plants – Hinkley Point C in Somerset – have gone to French firms, partly as a result of the disappearance of the UK's capabilities in nuclear technology.

The TSB is appealing for firms from across the economy – not just those from the energy sector – to put forward ideas that could make a difference in the construction, manufacturing, operation, maintenance and decommissioning of nuclear power stations.

This is the third competition of this kind the TSB has run for nuclear technology in the last few years. Last year's scheme saw £18m was invested in 35 projects, such as the development of OC Robotics "snake" arm for remote handling in decommissioning.

²² <http://www.theengineer.co.uk/energy-and-environment/news/firms-offered-13m-for-nuclear-power-innovations/1017659.article>

There are two strands to the new competition: early-stage ideas can receive up to £150,000 for a one-year feasibility study; more developed innovations can receive up to £3m for three-year projects.

UK universities and regulatory environment

Education and training received a boost from the Chancellor George Osborne who announced measures to increase university places and fund higher apprenticeships²³.

Osborne said an extra £40m will be provided to increase the number of people starting higher apprenticeships by 20,000, and that the cap on university places would be removed, allowing an estimated 60,000 more young people to go to university every year. A further £50m will be made available to fund the teaching of STEM subjects per academic year.

The funding for apprenticeships is aimed at delivering higher apprenticeships that start in the 2013-14 and 2014-15. The government will develop a model which uses HMRC systems to route apprenticeship funding direct to employers.

A new £15 million scheme will allow universities to drive local growth plans and support entrepreneurship and innovation²⁴. As part of the government's long-term economic plan, a new £15 million scheme will allow universities to drive local growth plans and support entrepreneurship and innovation.

University Enterprise Zones will provide funding to locations across England. The zones will allow business spaces to be built that can host a range of new high-tech companies in the early stages of their development. These innovative small businesses will then be able to share the expert knowledge at the university, helping them to grow and prosper. A competition will be held in the New Year to select 3 to 4 pilot zones.

Universities will play a leading role in the new zones. They will work with Local Authorities and the existing Local Enterprise Partnerships (LEPs) to be engines of new business growth in the area.

²³ <http://www.theengineer.co.uk/news/osborne-pledges-further-funding-for-skills-and-education/1017635.article>

²⁴ <https://www.gov.uk/government/news/15-million-boost-for-local-business-growth-at-universities>

University College London's (www.ucl.ac.uk) biochemical engineering department has won a 2012/2014 Queen's Anniversary Prize for higher and further education²⁵.

The awards are given out every two years by Queen Elizabeth and her husband Prince Philip, to recognise world class excellence in the work of UK universities and colleges.

Biochemical engineering at UCL was set up to convert new biological discoveries into commercial products, including vaccines, regenerative medicines and therapeutic drugs, and its main focus is improving global health and well-being.

The department works with other university departments and charities and end users including major pharmaceutical companies and NHS doctors. The department recently collaborated with London's Moorfields Eye Hospital to develop stem cell treatments for blindness, and with the Health Protection Agency to increase the UK's anthrax vaccine production capacity. The department also worked with Merck to develop the manufacturing process for Gardasil, the world's first cervical cancer vaccine.

In the past, UCL's biochemical engineering department also developed the world's first production process for semi-synthetic penicillin and carried out groundbreaking research into anti-viral flu medicine and the use of proteins as catalysts.

Huawei (www.huawei.com) pledged £10m to UK universities²⁶ to fund research projects in telecommunications technology. The money will come from the £1.2bn investment the Huawei announced in September 2012 in a bid to bolster its presence in the UK, which has already gone towards building new research and development facilities, as well as a UK headquarters for the company in Reading.

The £10m will be split between six universities, including the University of Cambridge and the University of Southampton. It will be used on projects including advanced multimedia, IT and optical technology, green radio, 5G technologies, optical technology, wireless communications and product engineering. Huawei hopes the findings will enable it to improve on its own products, used by large telecom companies in the UK such as BT and EE.

²⁵ <http://www.ucl.ac.uk/news/news-articles/1113/221113-Queens-Anniversary-Prize-awarded-to-UCL-Biochemical-Engineering>

²⁶ <http://www.computerweekly.com/news/2240210311/Huawei-invests-10m-in-UK-university-research>

The investment has gained the support of the UK government. MP David Willetts, minister for universities and science – and the man appointed by Prime Minister David Cameron as Huawei’s key government contact – praised the move.

The UK’s universities and science minister David Willetts has unveiled a £93.2m (\$141.6m) package designed to boost the country’s life sciences sector²⁷. The funding includes £29.3m to be directly invested into innovative life sciences firms, including university spin-outs.

Other parts of the package include £25.9m which forms Round 3 of the UK’s Biomedical Catalyst initiative, which supports 29 firms and five universities, and a further £38m to support the construction of the National Biologics Manufacturing Centre.

David Willetts said: “By investing in new technologies now we are maintaining the UK’s position as a world leader for innovation. The biomedical industry is a fast moving, high growth sector and the Catalyst has proven to be extremely successful in supporting new business ideas. This investment further drives forward our life sciences strategy.”

The Higher Education Funding Council for England (HEFCE) is launching a programme to strengthen social entrepreneurship and social enterprises across England’s universities²⁸.

Funded by £2m (\$3.28m) and outsourced to social enterprise support network UnLtd, the project will seek to encourage universities to act as hubs in support of social entrepreneurs from staff, faculty, and from surrounding communities.

The project will aim to unite universities with surrounding institutions, local authorities, and private sector companies to create ‘ecosystems’ that support social entrepreneurship.

²⁷ <http://www.globaluniversityventuring.com/article.php/2854/uk-biotechs-93m-boost>

²⁸ <http://www.globaluniversityventuring.com/article.php/3181/uks-2m-for-social-ventures>