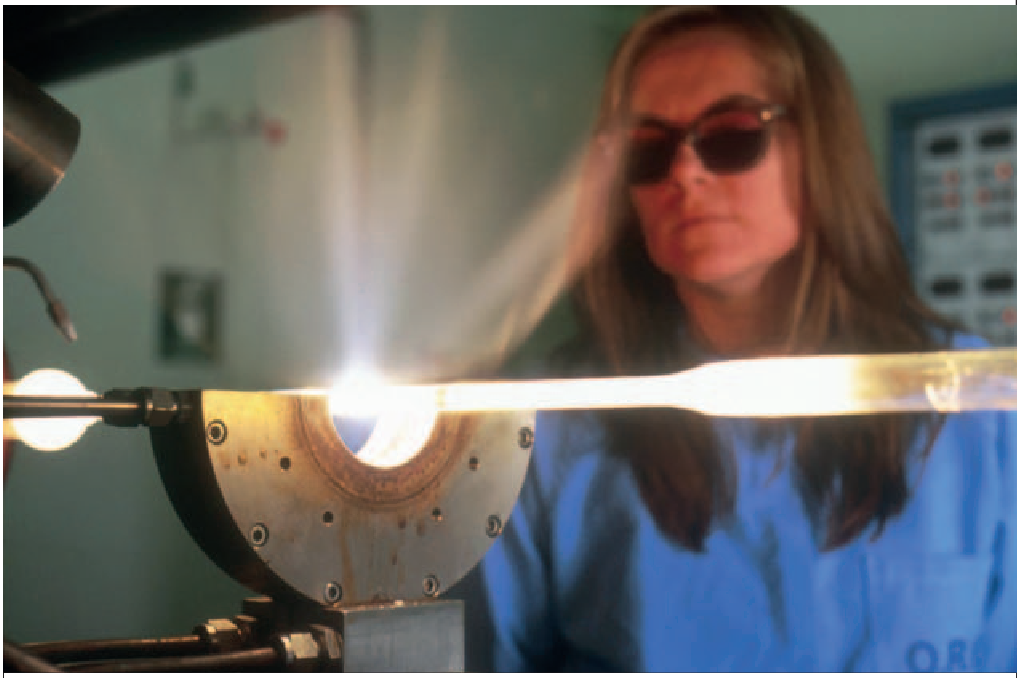
A GOLDEN TOUCH

PROFESSOR DAVID PAYNE CBE FREng FRS

Without abundant and inexpensive communications, there would be no globally available internet, no Google, MySpace, eBay or Amazon. Professor David Payne's work on optical fibres that can amplify passing traffic did much to facilitate that network revolution. Michael Kenward went to Southampton to find out how the much-honoured David Payne's groundbreaking optical research very nearly didn't happen.



A technician fabricating an amplifier fibre at the Optoelectronics Research Centre © ORC

The young David Payne had a problem when finishing his time as a student at Southampton University. He was all set to go off into the world of industry with his degree in power engineering, but his wife-to-be needed another year to complete her own degree. So Payne took a stop-gap research post at the university, working on an MSc, fully expecting to go out into industry.

Forty years on, Professor Payne is still anchored at Southampton, where he heads the Optoelectronics Research Centre. The ORC, one of the world's leading laboratories for research in optoelectronics, has helped to change the shape of modern telecommunications.

POWERING LASERS

The temporary research position not only turned Payne into an academic, it began his transition towards optical engineering. At the request of one the academics, Payne drew on his electrical engineering degree to build a power supply for a laser. Back then, in the late 1960s, a laser was an exotic piece of equipment. Even the best catalogues of

Professor David Payne CBE FREng FRS

scientific equipment lacked a section on 'lasers' – researchers had to make their own.

The next request to land on Payne's lab bench was for a way to make optical fibres for telecommunications, another newfangled device that had yet to find commercial use. Professor Alec Gambling, a pioneer of optical fibres, asked him to stay on and investigate if thin hairsbreadth glass fibres could carry light over long distances.

Payne ended up as part of a team at Southampton working on the science that was to revolutionise telecommunications. "What incredible luck to have got into this field that has changed the world," he reflects now.

IN AT THE BEGINNING

The Optoelectronics Research Centre itself came into being in 1989 because the Science and Engineering Research Council, as it was then, wanted to encourage different disciplines to work together. It was preceded by the Optical Fibre Group where Payne worked on his doctorate, spending seven years gaining his PhD and developing the ways and means to make the world's lowest loss fibre.

Since then, the ORC has launched a further 750 PhD researchers into the world and has played a part in creating what Payne describes as a "mini cluster" of photonics companies around Southampton.

Payne himself has been head of the ORC for the past 14 years. Ever since its beginnings, the plan was for the Research Centre to be somewhere that industry and other customers for research could tap into academic excellence. To this day, Payne's group mixes physics and engineering. The ORC is a joint venture between the university's School of Physics and Astronomy and the School of Electronics and Computer Science.

FISH NOR FOWL

This raises a question: is Payne an engineer or a scientist? He laughs at this one. "I seriously avoid answering that question," he adds. "To scientists I am an engineer. To engineers, I am a scientist. I bounce between the two fields easily."

Maybe it is the interest in applying research that marks Payne out as firmly in the engineering camp. And, for Payne, technology

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transfer isn't just a case of shepherding ideas into the hands of a company. He has had a hand in the creation of a number of new businesses to exploit his research.

In the 1970s and 1980s, the traditional pattern for turning academic knowledge into technology and products was to take the ideas to a big business. If the company felt like it, its own researchers might investigate the notion. Too often, though, says Payne, nothing much happened "I got tired of seeing our ideas turning up in US start-ups." The solution, he found, was to become a serial spinner out of ideas. "If you can't do knowledge transfer with big companies, you have got to do it yourself."

MADE TO MEASURE

Payne started his first business in 1980. The ORC academics needed to measure what was happening in their optical fibres. "Nobody had the instrumentation to measure what they had made," says Payne. "We had to create it in the lab."

British Telecom, as it then was, began sending their own fibres in for examination and the ORC started charging for the service. But running a full-blown test facility doesn't really appeal to most academics. They prefer more challenging problems.

They looked for someone to take over their technology. "We couldn't get any interest, so we decided to start our own company," says Payne. This gave him his first lesson in spinning out research. "We put in so much technology that the company couldn't handle it. So the business exploded into a multiplicity of new companies" says Payne.

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Payne clearly likes spinning out: he is now up into double figures for the number of new firms where he has an input. Three of those went on to be acquired by major companies, a classic exit route for investors in a start-up. One Southampton company, SPI Lasers, was floated on the AIM Stock Exchange before TRUMPF, a high-tech company focusing on production and medical technology, acquired the business in 2008.

SPI was another lesson in spinning out for Payne. The technology for this business came out of many experiments over the years, putting rare-earth elements into optical materials, an initiative that gave the Southampton team its greatest success. Incredibly, says Payne, the same fibres that amplify tiny optical data signals on the internet can also generate kilowatts of power, sufficient to cut through inch-thick steel or perhaps even shoot down missiles.

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The first generations of optical links contained electronic repeaters at regular intervals. These extracted the light from the fibre, turned it into an electrical signal, amplified this, turned it back into light, and then fed this into the next link in the fibre chain.

Why not, Payne and his colleagues reasoned, miss out electronic amplification and boost the signal optically? If lasers can amplify light, why not incorporate them into the fibre at intervals? Thus was born the fibre-optic amplifier.

Payne's group deployed its ability – developed in the early days of high-power solid-state lasers – to incorporate exotic materials into optical materials. They added rare-earth elements to fibres and created the first fibre lasers. "The key to that invention," says Payne, "was that after decades spent getting impurities out of lasers we knew how to put stuff back in without killing the quality of the fibre."

A GRAND SUCCESS

Around the mid 1980s, the Southampton team made the world's first erbium doped fibre amplifier (EDFA). At the time, Payne's group was working with large companies that did realise the value of the science on offer. There was no need to create companies to commercialise the EDFA. "The rest is history," says Payne. There was a massive boom in deployment of fibre amplifiers in the mid 1990s. Within a few years the EDFA had replaced electronic amplifiers in long distance links and had changed the face of telecommunications. Has spinning out companies like SPI Lasers made Payne rich? More laughter. "No. Not faintly. I have never focused on making money." In any case, says Payne, setting out just to make money could be a disaster. "You really will have conflicts of interest if you just want to be rich."

Payne didn't even feel the urge to run the companies that grew out of his research. Always be wary of an academic who fancies taking on that role, although some can do it, says Payne. "They never cease to gain my admiration." But putting together a

Lord Broers FREng FRS presented Professor Payne with the Marconi Society Prize and Fellowship in September 2008. Payne was selected for his pioneering work in the field of fibre optoelectronics and fibre telecommunications

disciplined team that can operate a business isn't the same as running a research group. "It is the opposite of what you are trained to be as an academic when you are supposed to be divergent."

RETURN TO THE FRAY

Payne feels a new field of research coming on; the environmental side of telecoms. "Do you realise that information and communications technologies (ICT) now accounts for 5% of the world's energy consumption, and that this is rising? This is a pretty terrifying number if it scales with bandwidth. If you believe the simple forecasts, ICT could eventually take up half the power we use. Obviously we wouldn't want that to happen, but what is the solution?" It will come as no surprise that he sees optical processing as the way out. "We have to do more in the optical domain."

Like a phoenix, the Southampton labs are rising out of the remnants of the ones destroyed by a fire in 2005. The impressive new building will house one of the world's most advanced facilities for research in optoelectronics. "It is a wonderful facility. It is going to be unique in Europe."

Optical electronics will be one area of research in the brand new building that the ORC is in the process of occupying. Like a phoenix, the Southampton labs are rising out of the remnants of the ones destroyed by a fire in 2005. The impressive new building will house one of the world's most advanced facilities for research in optoelectronics. "It is a wonderful facility. It is going to be unique in Europe."

Payne is already thinking about the businesses that could build on what the ORC originates in the new labs. He may be as keen as ever to get the centre's research back to normal, but the conversation keeps coming back to the business of turning research into products and profits.

THE BOTTOM LINE

Even in his academic research, Payne likes to see something useful at the end of the tunnel. When researchers want to head off in new directions, he explains, "One of my first questions is, what is the application, where is it leading?" This doesn't mean that he favours short-term, problem solving research of the type favoured by companies, product development as he calls it. "I don't mind if the application is for 20 years time. But I need to know, what is it for?"

Even in these financially strained times, there is still money out there to develop good ideas, says Payne. And today's generation of spinners out don't have to make it up as they go along. Payne and his fellow pioneers are happy to pass on their knowledge. Indeed, when he does finally think about retiring he would not mind spending more time passing on the tricks of the trade. "I give talks, even in America, on start-ups. Quite extraordinary," he says.

Payne's CV is quite extraordinary too. Currently running at 85 pages, most of these are taken up with the papers he has helped create but there is also a considerable number of awards that recognise his unique contribution to optoelectronics.

MILLENNIUM TECHNOLOGY PRIZE

One of the most recent was the Millennium Technology Prize panel that made him a laureate in 2008. Awarded by the Technology Academy of Finland, this biennial prize rewards and gives recognition to those whose work has helped provide answers to the challenges of the modern world – the winner, Professor Langer, was awarded €800,000 for developing biomaterials for controlled drug release.

Payne was put forward with others for his work with the amplifiers that transformed the telecommunications industry; a vital part of the global optical fibre network that acts as a backbone to the internet. He said at the time that he was proud and humbled by the way his amplifiers had helped the global roll-out of the internet.

The magnitude of this discovery was such that it sometimes comes up when people start to speculate on Nobel prizes but Payne insists "I am not holding my breath. I think that I'm all prized out!"

BIOGRAPHY – Michael Kenward OBE
Michael Kenward has been a freelance writer since 1990 and is a member of the *Ingenia* Editorial board. He is Editor-at-Large of *Science|Business*.

ACHIEVEMENTS AND DISTINCTIONS

Academic Enterprise Award for establishing York Technology, **1982**. Queens Award for Industry (York Technology), **1986**. IEEE/OSA John Tyndall Award (USA), **1991**. Rank Prize for Optics (UK), **1991**. Elected Fellow of the Royal Society, **1992**. Computers and Communications Award (Japan), **1993**. NASTS (USA) Real Advances in Materials Award, **1994**. Elected Fellow of the Optical Society of America, **1996**. Benjamin Franklin Medal in Engineering - Franklin Institute USA, **1998**. ISI Certificate for one of the world's most cited authors, **2000**. Basic Research Award of the Eduard Rhein Foundation (Germany), **2001**. Ernst and Young Entrepreneur of the Year finalist, **2001**. Appointed Commander of the British Empire (CBE), **2004**. Elected to the Norwegian Academy of Sciences, **2004**. Kelvin Medal of the 8 major UK engineering institutions, **2004**. Elected Fellow of the IEE, **2005**. Elected Fellow of the Royal Academy of Engineering, **2005**. Royal Academy of Engineering MacRobert Award finalist (SPI Lasers), **2005**. IEEE Photonics Award for outstanding achievements in photonics, **2006**. Elected to the Russian Academy of Sciences, **2007**. Marconi Prize and Fellowship, **2007**. Millennium Prize Laureate, **2008**.