**Institution:** University of Exeter

**Unit of Assessment:** Physics

**Title of case study:** Inspiring successful sales strategy of a global healthcare company

**1. Summary of the impact** (indicative maximum 100 words)

Natural photonics research by Professor Pete Vukusic at the University of Exeter was responsible for shaping the successful global communications strategy of Bausch & Lomb, a world-leading supplier of eye health products. Drawing on Vukusic's studies into bio-inspiration, Bausch & Lomb built its core brand messaging for a major new lens product around the ability of nature to inspire technological breakthroughs. Outreach campaigns targeting media and optometry professionals took Vukusic's research to an international audience, raising wider public awareness of the concept of bio-inspiration. Bausch & Lomb attributed their subsequent rapid sales growth to Vukusic's work.

**2. Underpinning research** (indicative maximum 500 words)

Bio-inspiration – the application of processes observed in the natural world to the design of new technologies – is an increasingly important stimulus for innovation. Bio-inspired products have become a popular marketing strategy for manufacturers to attract 'conscientious consumers': those who may be attracted to a particular product due to the perception that naturally inspired designs are efficient, effective and 'natural'.

Research led by Pete Vukusic, Professor in BioPhotonics (joined Exeter 1998) at the University of Exeter's School of Physics and Astronomy seeks to understand the photonic properties of nanostructures in living systems [3.1, 3.2], drawing on techniques from across the physical and biological sciences. The aim is to discover and characterise photonic system designs that exist in the natural world, which may inspire breakthrough technological applications [3.3, 3.4, 3.5].

Vukusic's research group at Exeter has advanced a wider understanding of photonics in biological systems. As an example, the study by Vukusic *et al.* (2007) of a small Southeast Asian beetle revealed how its brilliant whiteness is created by a material only five microns thick [3.3]. This material is a highly disordered, filament-based photonic solid that, through optimised spatial arrangement of its scattering centres, has a quality of whiteness equivalent to commercial paper products upward of 50 times its thickness. The group is now collaborating with the paper development division of French multinational Imerys Plc to design paper formulations with less mineral coating making it lighter with consequently lower product transport costs.

A 2004 paper by Vukusic analysed the nature of the black and unreflective surfaces of arthropod wings [3.4]. It described the discovery and characterisation of a significant structural component to the blackness of some natural surfaces. These 'black' structures are aperiodic, in complete contrast to the structural periodicity causing vivid iridescent colour that he identified and published in *Nature* a year earlier [3.1]. The aperiodicity strongly incoherently scatters light, increasing the light's path-length through the absorbing pigmentation and thereby enhancing the overall absorption cross-section of the system.

An investigation of several *Papilio* butterflies [3.5, 3.6] led to the discovery that the bright wing colouration of this group results from cooperation between highly fluorescent pigment, a 2D photonic crystal and a highly tuned distributed Bragg reflector. (Previously, fluorescently coloured systems and structurally coloured systems were characterised separately in many different animal phyla; however, none had indicated an interaction between the nanostructure and emission from the pigment.) This work successfully demonstrated that the butterflies' wing colouration exploits high efficiency fluorescence [3.6] from a 2D photonic crystal of cuticle and air, the design of which prevents emission of light in two dimensions but assists its emission in the third dimension (namely the light is emitted upwards and out of the wing towards an observer). The Bragg reflector located

directly beneath the 2D photonic crystal ensures both the reflection of non-absorbed photons of the correct colour and upward-redirection of the downward-emitted fluorescence. High visibility blue/green light emission is achieved through the use of significantly less fluorescent pigmentation than would otherwise be necessary if this nanostructure arrangement did not exist. This is a well optimised and adapted optical system, the light extraction mechanism of which is analogous to that of the new range of ultra-high efficiency light emitting diodes.

The study of these natural designs provided Vukusic with an extensive understanding of how the power of bio-inspiration could be harnessed for technology transfer, prompting an approach from one of the world's largest suppliers of eye health products: Bausch & Lomb.

**3. References to the research** (indicative maximum of six references)

References in bold best indicate the quality of the underpinning research.


3.1. "Photonic structures in biology", P. Vukusic and J. R. Sambles, Nature **424**, 852-855 (2003).
3.2. "Structural Colour: Now you see it – Now you don't", P. Vukusic, J. R. Sambles, C. R. Lawrence, and R. J. Wootton, Nature **410**, 36 (2001).
**3.3. "Brilliant whiteness in ultrathin beetle scales", P. Vukusic, B. Hallam, and J. Noyes, Science 315, 348 (2007).**
3.4. "Structurally assisted blackness in butterfly scales", P. Vukusic, J. R. Sambles, and C. R. Lawrence. Proc. R. Soc. Lond. B **271**, S237-S239 (2004).
**3.5. "Mimicking the colourful wing scale structure of the Papilio blumei butterfly", M. Kolle, P. M. Salgard-Cunha, M. R. Scherer, F. Huang F, P. Vukusic, S. Mahajan, J. J. Baumberg, and U. Steiner, Nat. Nanotechnol. 5, 511-515 (2010).**
3.6. **"Biomaterials: Directionally controlled fluorescence emission in butterflies", P. Vukusic and I. R. Hooper, Science, 310, 1151 (2005).**


**4. Details of the impact** (indicative maximum 750 words)

Global eye healthcare company Bausch & Lomb drew on the principles of bio-inspiration to develop a new contact lens solution that mimics the natural fluids of the human eye. By studying how the eye keeps itself clean, hydrated and germ-free, it brought together three bio-inspired innovations to create a unique product: Biotrue™ (http://www.biotrue.co.uk). It uses a lubricant found naturally in the human eye, matches the pH of healthy tears and ensures beneficial tear proteins remain active. Based on a decade of research into bio-inspiration derived from natural photonics, from 2000 to 2010 [3.1 – 3.6] Vukusic acted as a consultant and advisor for Bausch & Lomb in the development of the brand positioning and core messaging of Biotrue. Vukusic helped shape the company's definition of bio-inspiration, which formed the backbone of the marketing and communications strategy for the product launch.

From May 2009 to September 2011 Bausch & Lomb's communications efforts about bio-inspiration were aimed at two key target audiences: eye care professionals (ophthalmologists, optometrists, and opticians) and consumers. Through the use and description of examples based on his research into optical bio-inspiration and photonics in nature, Bausch & Lomb were convinced of the value of using bio-inspiration as the platform on which to position the Biotrue brand. Bio-inspiration became an integral part of the company's core messaging, in its efforts to convey how the Biotrue product is designed in a completely new and different way – i.e. 'to work more like the eyes'. This resulted in the following brand promise:

*"Nature has always inspired new ideas. It's called bio-inspiration. And it's leading to some of today's biggest breakthroughs – including a lens care solution that looks for inspiration from the most natural place – the eye. Biotrue is formulated to work more like the eye."* [5.1]

Specifically to engage with eye care professionals, Bausch & Lomb drew on a research-based contribution from Vukusic that comprised 16 posters and 154 publications published in 17

countries. This core messaging on bio-inspiration was delivered to 40,000 eye-care professionals at 1,000 symposia and seminars in 40 countries [5.1]. Vukusic himself gave 35 presentations on bio-inspiration in the US, UK, Netherlands, France, Belgium, Russia, Korea, China, Japan and Brazil. Vukusic authored the introductory feature – An Introduction to Bio-inspired Design – to a 2010 issue of Contact Lens Spectrum [5.2] and an additional supplement [5.3], the leading magazine for optometrists, opticians and ophthalmologists. As part of this communication, Vukusic also featured in three issues of 'Visions' Magazine and one issue of 'Optician' [5.4, 5.5, 5.6 and 5.7].

To reach consumers, a media campaign was instigated following a press event and was held in New York in May 2010 at which attendees were introduced to a video created by Vukusic, from which Bausch & Lomb secured 285 million web impressions for Biotrue in the national print and broadcast media. This resulted in consumer familiarity with bio-inspiration and products 'inspired by the natural world', rising sharply over two periods in 2010, as measured by Directions Research Inc. In Europe, there were 115 articles published that mentioned bio-inspiration in relation to Bausch & Lomb's product, reaching 29.7 million users in 15 countries. Around 340,000 Asian consumers across eight countries were reached through Internet Forum Discussions, videos and two magazine advertorials. Articles about bio-inspiration featuring quotes and research from Vukusic reached 313,000 readers in Brazil and Argentina. A Bausch & Lomb video *The World of Bio-inspiration*, based on Vukusic's presentations, has been viewed over 29,000 times [5.1]. This led to a series of industry and professional communication events resulting 'in a unique impact that is unlike any other new product launch from Bausch & Lomb,' according to the Director of Medical Affairs Global Vision Care at Bausch & Lomb [5.1]. In June 2010, Vukusic was invited to a roundtable discussion [5.8], organised by Bausch & Lomb, at the annual meeting of the American Optometric Association where he gave a presentation on bio-inspiration based on his research findings. Illustrating the importance of the bio-inspiration message, one of the participants, Dr Bruce Anderson, a fellow of the American Academy of Optometry, observed: 'When patients learn a product is bio-inspired, I believe their confidence in the product increases. They realise there's research behind it that makes it more compatible with the eye, and they're more willing to try it and accept it.' The 'highlights' website quotes *'physicist Peter Vukusic, PhD, who has done extensive work to bring bio-inspired products to the market'* [5.8].

Summarising the contribution of Vukusic's research to the commercial success of Biotrue, the Director of Medical Affairs said:

*'The launch of Biotrue has been unprecedented in the lens care solution category. This is largely due to the excellent consulting support and insightful guidance by Vukusic in leading us during the development of the bio-inspiration positioning and our communications plan. Having been introduced to the United States in June 2010, Biotrue had launched in 35 countries in the Americas, Europe and Asia-Pacific regions by the end of 2011. In the US, Biotrue's market share growth after one year was five times faster than the previous best-in-class launch of a lens care solution. Unique bio-inspired positioning has contributed to highly incremental volume for Bausch & Lomb lens care products in total.'* [5.1]

**5. Sources to corroborate the impact** (indicative maximum of 10 references)


5.1. Letter of corroboration - Director, Medical Affairs Global Vision Care. Bausch & Lomb.

5.2. Contact Lens Spectrum 'Bioinspiration, Nature's Best Ideas: Is Eye Care Next?' Bausch & Lomb. September 2010. *References Vukusic p.8 and 15.* http://www.clspectrum.com/supplementtoc.aspx?sn=specialed10&tm=04/01/2010

5.3. Contact Lens Spectrum supplement 'Bringing New Inspiration to Contact Lens Care'. Bausch & Lomb. September 2010. *References Vukusic p.3 and 4.* http://solution.biotrue.com/ecp/Lifestyles.pdf

5.4. Visions 'Bringing visionary ideas to eye health' Bausch & Lomb. Spring 2010, issue 8. *References Vukusic p.18*. http://www.bausch.co.za/ecp/-/m/BL/South%20Africa/Files/Downloads/ECP/Clinical%20Resources/Visions-Magazine-8.pdf

5.5. Visions 'Bringing visionary ideas to eye health' Bausch & Lomb. Summer 2010, issue 9. *References Vukusic p.2.* http://www.bauschsurgical.co.uk/sites/default/files/visions_summer_2010_0.pdf
5.6. Visions 'Bringing visionary ideas to eye health' Bausch & Lomb. Autumn 2010, issue 10. *References Vukusic p.10.* http://www.bausch.co.za/ecp/-/m/BL/South%20Africa/Files/Downloads/ECP/Clinical%20Resources/Visions-Magazine-10.pdf
5.7. Optician Online: Nature of Inspiration 'Bio-inspired Design' 4th September 2010. *Cites Vukusic*. http://www.opticianonline.net/assets/getAsset.aspx?ItemID=4004
5.8. Highlights from Roundtable discussion 'Bringing new inspiration to contact lens care' Contact lens spectrum 1st September 2010. Quotes *'physicist Peter Vukusic, PhD, who has done extensive work to bring bio-inspired products to the market'* http://www.clspectrum.com/articleviewer.aspx?articleid=104638