Moving away from more conventional retro-reflective technology, two London-based teams of designers and researchers have prototyped an alternative which they claim is both fashionable and functional. The power for the jacket relies on rechargeable flexible thin-film batteries, which are already a commercial reality and are improving all the time in terms of reliability and power delivery. And electroluminescent inks.

Technology and fashion: a brighter future for cyclists



The prototype Illum cycling jacket.
Goose Design

Around 20,000 cyclists are killed or injured on the UK's roads every year, the vast majority as a result of accidents on urban streets. Seventy-five per cent of these accidents occur at or near road junctions and while statistics do not reveal how many of these are as a direct result of cyclists not being seen by other road users, this is clearly a major factor. But, to date, strategies for improving the visibility of cyclists have concentrated on small, directional lights and the addition of reflective material to bicycles and clothing. These techniques are not only limited in their effectiveness, they can present serious issues to those cyclists for whom fashion may hold sway over safety.

Research under way at PDD, a leading UK product innovation consultancy, and Goose Design, an independent and innovative apparel design consultancy, is set to change this. Working closely together as part of PDD's Futures programme and Goose's WHEN initiative, the two companies have just unveiled their concept for a new cycling jacket that successfully combines the potentially conflicting elements of safety, fashion and functionality.

Future perfect

PDD's Futures programme is an ongoing series of projects that encourage the company's researchers, engineers, technologists and designers to use their skills to predict how new and emerging technologies will be translated into the commercial and industrial products of the future. Having successfully completed a number of projects in the fashion and textile industries, PDD was keen to explore how it could move forward in this promising market sector.

Through a previous joint project exploring an innovative clothing manufacturing technique, Goose knew it could form a successful partnership with PDD as both consultancies hold valuable knowledge and expertise of their own industries and market.

Prior to the formation of Goose Design with business partner Phil Dickinson, Jenni Arksey worked on a major consumer project that involved the integration of wearable electronics into products designed for urban commuters, and was successfully developed in Korea and distributed and sold at retail throughout Europe. This led to an interest in creating innovation throughout the apparel industry and forming

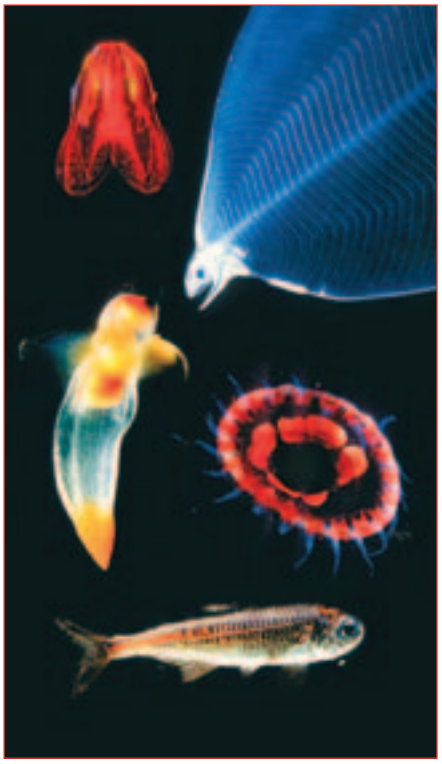
partnerships with credible and complementary partners such as PDD. Goose's WHEN initiative creates the vehicle to do this and is about delivering technology in apparel to the market that is relevant and achievable within a realistic timeframe. "It's important for us as designers to ensure that any technology we do incorporate into clothing does not adversely affect its overall impact as a fashion item," said Arksey.

Starting out

With a host of emerging technologies and any number of garments and fashion items to choose from, the first task for PDD and Goose was to narrow down the scope of the project. "We wanted to address a genuine consumer need rather than just being creative for the sake of it," explained Miles Hawley, head of industrial design at PDD. "We quickly identified urban cyclists as a suitable consumer group and looked at a number of issues that affect their lives. The group breaks up neatly into cycling enthusiasts, who take their performance clothing and accessories almost as seriously as their bikes; commuters, who cycle to work but need to be smart when they get there; and those who simply use their bicycles to get around and don't necessarily want to wear special clothing when they're doing it."

Having identified a target audience, the research team began to look at what was currently on offer in the marketplace and how the different categories of cyclists distilled this into their chosen apparel. Cycling enthusiasts tended to favour specialist clothing such as SPD shoes, fingerless gloves and lots and lots of Lycra; commuters went for what might be termed hybrid clothing - tracksuits and waterproof outerwear featured highly; and fashion-conscious casual cyclists did very little to modify their outfit when riding (typically even shunning the use of a helmet). These findings essentially underlined common perceptions about cyclewear but did serve to identify a single garment that would attract interest from each section of the market.

"We wanted to work on a concept that would appeal at all levels so we decided we would design a stylish jacket that the commuter could wear over work clothes but would not look out of place in the wardrobes of an enthusiast or a dedicated follower of fashion," added Hawley. "We then looked at a number of issues we could address with the jacket - we considered navigation, air filtering, medical diagnostics and communication, for example - but decided the most positive, interesting and broadly appealing project would be to see how we could use technology to create a jacket that would improve the safety of the cyclist wearing it."



Examples of bioluminescence in nature which the Illum jacket design team used as visual inspiration.

Goose Design

Safety first

In order to improve safety through the jacket, PDD naturally began looking for ways of increasing visibility. Eighty per cent of road accidents take place during daylight hours, but this is more a reflection of when most cycling takes place than the relative safety or danger of cycling during the day. A significant number of accidents take place at night and poor visibility is a factor. A look at the currently available technology helps to explain why. "Front and rear mounted bicycle lamps tend to shine straight ahead or straight behind," explained Simon Browning, senior manager, industrial design at PDD. "Reflective material is even worse, as it essentially only sends light from car headlights back at the driver. None of these measures improves the visibility of the cyclist to those road users who aren't equipped with headlights (pedestrians and other cyclists) or - more importantly given the danger around road junctions - drivers whose cars are not facing the cyclist head-on."

Having defined the scope of the project in terms of the style of garment and the overall goal of improving safety through visibility, PDD set about researching the new and emerging technologies that could be used to make it possible. Having decided against a solution based on reflection, the specific areas that needed addressing were illumination, power, conductivity and switching. "Although we were flexible about what we were going to end up with we were very clear about what we didn't want," explained Arksey. "We didn't want the kind of wearable technology that consists of gadgets that have blatantly been bolted on or sewn in to existing clothing. We wanted something that could be worn, washed, damaged, stitched up and ultimately thrown away just like any other jacket."

Light touch

The combined fruit of PDD's research and technical know-how and Goose's skill and experience in technical apparel design and the market it exists in, is the Illum cycling jacket which uses a combination of technologies to create a self-charging, powered external 'shell' made up of individual fabric panels with properties selected to minimise weight and ensure the wearer remains cool, dry, comfortable and - above all - safe. Safety comes in the form of a series of electroluminescent surface graphics that fit logically around the anatomy and provide all-round illumination. Illum is activated by a soft-switch set into the cuff and powered by an integrated thin film battery that provides the small charge needed to activate the lighting via a transparent, printable conductive layer. A further printable polymer forms a photovoltaic solar cell used to recharge the battery and ensure the jacket is self-sufficient. Using the facilities at Goose Design the garment was prototyped and the positioning for the printed technology was correctly placed on the jacket to maximise the safety options while the wearer was in a riding position.

A key feature of Illum is that the electroluminescent ink that gives the rider so much safety when the jacket is activated fades away to near invisibility - nothing more than a near-transparent pattern - when it is switched off. This is an important area where it is believed that electroluminescence wins over current visibility solutions based on reflection or conventional lighting.

After a fashion

By opting for a design based on printable technology, the Illum team automatically fulfilled its major objective of designing a 'normal', washable, lightweight, flexible garment. But, as

Browning explained, Illum is about more than just throwing together some cutting edge technology: "We wanted this to be a compelling, commercial proposition. If we'd wanted it to be simply a showcase for the new technology that's out there and our own consumer research we could have designed a simple - or outlandish - jacket ourselves. Only by working with Goose could we understand what goes into designing a functional garment that someone would want to buy in the current market and the challenges involved in integrating the technology into that process."

On some areas of the jacket the technology naturally dictated the choice of material composition: the thin-film lithium-ion battery was to be located in the chest panel so thinner material was chosen here to maintain the lightweight feel of the whole garment. In other areas, the function of the garment laid down the law about where the technical elements could be positioned. The back area, for instance, was kept largely clear, mostly on the assumption that the wearer would want to carry a backpack. This meant the photovoltaic solar cells were only to be printed on the back of the neck, the shoulders and around the small of the back - areas that should still receive maximum exposure during normal cycling. "The lightweight stretch fabric used throughout the garment allowed a better fit across the body and enabled the printed graphics to become more visible where they were needed most. Lighter weight fabrics were used in the central spine panel and chest pocket panels enabling moisture evaporation in 'hot spot' areas and means the garment can be worn in most climates," said Arksey.

Mind the gap

Detailed design too saw a number of compromises and design decisions that could only be made by combining expertise in clothing and technology: no ink or polymer could be printed across a seam, for instance, as this would present serious manufacturing issues. Areas where the electroluminescent ink was to be laid down needed to be designed in such a way that the inked zones would not stretch too much. This indicated a series of linear stripes that could safely move away from each other and be able to absorb a certain amount of stretching along their length: the cracking associated with solid areas on ink on fabric would compromise the overall functionality of the jacket.



Concept drawing showing how the electroluminescent surface graphics appear when switched off and on.

Goose Design

The road ahead

So how soon can we expect to see Illum in the shops? As with most of its Futures projects, Illum is based on truly cutting edge technology so there's no point going down to the local bicycle retailer to pick one up just yet. But there may not be too long to wait: electroluminescent inks are being actively - and successfully - researched throughout the world, notably at DuPont. The current state of the art for printing on fabric required screen-printing onto a 'sputtered' substrate, which creates the conductive layer needed to spread the electric charge. PDD and Goose have taken this to a natural conclusion by anticipating the development of a reliable method for printing the inks directly onto the fabric.

The power for the jacket relies on rechargeable flexible thin-film batteries, which are already a commercial reality and are improving all the time in terms of reliability and power delivery. The batteries are to be recharged by solar cells in printed photovoltaics (PVs) in the form of organic polymers, the third generation of research into PV technology. First created in 1986, PV films - produced by spraying or printing directly onto fabric - will be considered commercially viable when they reach five per cent efficiency. Researchers at Siemens reportedly exceeded this threshold in 2004.

Other technical components of the concept jacket, such as the clear conductive ink and the soft-switch that will be used to activate it, are already commercially available. The material proposed for the design is a combination of the latest lightweight, waterproof and breathable fabrics, durable enough for cycling and light enough for aerobic activity; printing techniques using these fabrics are becoming more available at certain key fabric manufacturers.

Glowing places

PDD and Goose firmly believe that in Illum they have a winning concept, a jacket that will appeal to both the fashion- and the safety-conscious, to the committed cyclist and the casual rider. And because the project has been approached from a commercial standpoint, they believe that with the right backing - and the clearing of the remaining technological hurdles - Illum could very soon be a common sight on High Streets everywhere.