



# Variable focus developments

*Optician* recently hosted a debate in liaison with Adlens with a variety of practitioners and experts to discuss the latest innovations in variable lenses

**V**ariable focus lenses have existed in different forms since the 19th century, but British manufacturer Adlens has brought the technology back to the fore with a range of products set to hit the UK optics market this year.

Ahead of the launch, *Optician* hosted a round table event late last year to showcase the products to a selection of optical professionals and practitioners. Chairing the event was *Optician* clinical editor **Bill Harvey**. Panel members included optometrist and Adlens director of industry affairs **Dr Graeme MacKenzie**. MacKenzie qualified as an optometrist in South Africa where he lectured and read for a DPhil before moving to the University of Oxford as part of a research team developing variable focus lenses.

Also present were Aston University lecturer and academic support officer **Dr Colin Fowler** who once supervised a PhD in variable focus lenses, contact lens optician and former lens technician **James Hall**, dispensing optician **Daniel Bleetman**, and optometrist, former director of professional services at Boots and member of the GOC standards committee **David Cartwright**.

All expressed at the outset an interest in the new product, both in terms of its clinical performance and its viability from a commercial viewpoint.

## Historical context

Proceedings began with getting to grips with Adlens' Hemisphere variable focus spectacles with fluid injection adjustable lenses, and where they and the wider variable focus technology sit in the UK optical market.

Referring to a review Fowler had published over 20 years ago, Harvey first asked about the various ways lenses could be designed to offer a variable refractive power. Fowler stated that, alongside fluid-filled lenses, there were lenses that could



**Has the technology of variable lenses the potential to be a game changer? Discuss**

change power with a simple electrical signal. Others, which he described as lateral displacement lenses, such as the Alvarez design, relied on two lenses passing next to each other to provide a composite power which changed with relative position, and axial displacement systems, which relied on variable separation of two lenses to produce different refractions.

MacKenzie then added more detail about the history of these designs. After many previous versions, Dr Alvarez produced a patent in 1967 for his translating lenses which improved greatly on previous efforts by minimising peripheral distortion. The surfaces were quite exotic and difficult to produce – at that time over \$1,000 per lens. They did find use in phoropters manufactured by American Optical in 1976. 'A brilliant system', confirmed MacKenzie who had experience working with the

instrument in South Africa. It was not until 2003, that a commercially viable product incorporating translating lenses was produced by Professor Rob van der Heijde of VU University, Amsterdam.

Fluid-filled lenses with variable focus were originally developed in 1879 by Dr Cusco, a Parisian physician, and used in his 'dynamoptometre', an early ophthalmometer first described in a paper in *La Nature* in 1880. Fluid between two thin plates of glass held before the eye was controlled by means of a pump.

This method has remained largely unchanged for many years, but Fowler stated that Professor Josh Silver 'had really pushed things along. Although the technology behind fluid-filled lenses looks simple, actually getting it to work without leaks is a different matter'. MacKenzie added that, in 1985, Professor Silver was dared to make a variable focus mirror, and then extended the idea to lenses.

In 2005, Professor Silver met James Chen, a Hong Kong-based philanthropist, who had been involved in various literacy projects in China. Chen immediately saw the potential for use in developing

## THE PANEL

- Dr Graeme MacKenzie, Adlens director of industry affairs
- Dr Colin Fowler, Aston University
- James Hall, contact lens optician
- Daniel Bleetman, dispensing optician
- David Cartwright, optometrist



## Looking at lenses

countries. The pair later formed a research group and the commercial arm of that group went on to become Adlens, which purchased a licence for the design in 2005 and have been working on the project ever since. Adlens was the only company that had succeeded in mass-producing variable focus lenses, MacKenzie told the group.

MacKenzie also pointed out how, in 2005, PixelOptics had produced an electronic lens which could switch from one power of reading addition to another very quickly. This was based on a liquid crystal lens and, as MacKenzie pointed out, 'once the manufacturing capability becomes available, this approach is going to change ophthalmic optics overnight but it's a long way off'.

At present, the technology is restricted to small area add adjustment, but the future may well allow electronic precise control of lens powers. As Fowler pointed out, the challenge was to allow this power control over a wider area. Also, early patents were particularly temperature sensitive, UV damaged them and curved cells were required. MacKenzie added that the majority view currently recommended a combined technology, with a liquid crystal lens incorporated onto a Fresnel type lens. At the moment, the hurdles were huge and a finished product some years off.

In 2006, SuperFocus produced a fluid-filled lens which was a round prescription lens with a fluid-filled variable area adjacent. It cost around \$800 in the US. Focus on Vision makes an Alvarez type lens and another group in Oxford makes the Eyejuster on similar principles, but without the benefit of being ISO certified.

### Hemisphere/John Lennon collection

Fluid-filled lens designs allow many ways of mass manufacture. MacKenzie focused on the Hemisphere/Lennon product with a rigid polycarbonate front lens and similar back lens with fluid-filled deformable membrane in between. This meant there was a cavity between the back lens and the membrane and the membrane and the front lens. One cavity was filled with air, the other could be filled with fluid from an external reservoir – this was the detachable adjustment barrel on the side of the spectacles. Moving fluid in increased the positive power, sucking fluid out increased the negative power.



David Cartwright tries on the Hemisphere spectacles. Also pictured are two frames from the new John Lennon collection

The fluid injection principle at present was limited to a circular lens as in this way the membrane was in contact evenly around the whole lens. However, if designs were to move towards being non-round, the membrane would only be in contact with the frame at certain points. If the membrane was pinned down to this style of frame, it would distort vision, producing poor optical quality. MacKenzie added that a new idea from Adlens was to 'move the frame to the membrane', and this would allow the correction of higher powers, spherocylinder powers and progressive powers. This had just been done.

David Cartwright asked whether the correction of cylinder would require an individually designed frame, to which the response from MacKenzie was: 'Yes, but one way around this is to use a prescription lens in combination with the fluid-filled component.' MacKenzie's point here was that, although the current models had limitations, it was likely that in a few years all the design challenges would have been met.

### Markets

Harvey wanted clarification as to what the current market was for variable focus lenses. MacKenzie stated that there was a programme in Rwanda that offered them as a correction. In Japan, Indonesia and the US, they were being offered as a second pair or incremental pair. They might be offered as a prescription-only spare or back-up pair. Bleetman clarified this by confirming that this meant they had to be adjusted on the

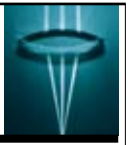
premises by the practitioner and not at home by the patient. Harvey asked how this differed from keeping a store of ready-made spectacles in store. MacKenzie thought that the benefit would be 'that glasses can be set to the exact prescription'. In Japan, he added that sales of related goods increased after the variable focus lens became available.

Cartwright wanted to know how much the spectacles retailed for in the US. 'Between \$80 and a \$100,' MacKenzie confirmed. Fowler said: 'One of the challenges in trials has been the price per unit.' MacKenzie said the main cost was the fluid – the Alvarez type product (Adlens produce one called the Emergence) were better suited to aid projects. The product had sold well in Japan in the wake of the 2011 tsunami and now found a place in the earthquake preparedness kits.

Cartwright said registered practitioners would be on 'difficult ground' if they dispensed the Hemisphere with the adjustment barrels in place, an act which would go against ABDO and College of Optometrists' guidance on dispensing glasses which were correct and to British standards.

The entire panel agreed that the Hemisphere spectacles could be dispensed to patients who required simple vision correction in a hurry, as legislation covered practitioners acting professionally and dispensing for the right reasons. As long as the patient was made aware that it was a temporary measure.

Harvey also saw some advantage



in clinical situations where one might expect a changing refraction over a short period, perhaps postoperatively or during a period where systemic disease was being controlled. However, these would be unusual cases and in the commercial market all agreed that the refraction would need to be set at the point of supply.

Cartwright felt that they might offer an alternative to a lab, though with a limited range of powers available. Harvey pointed out that the US had similar tolerances to centration of lenses, refractive correction and so on, so a set centre along with a range of sphere-only lenses would present a problem.

James Hall noted how some Chinese research had shown that people had been successful setting their own correction as compared to a clinician.

Doubt was expressed when the panel were asked whether they would be happy about dispensing the spectacles as a second pair which only corrected mean sphere.

'I think you'd be on decidedly dodgy ground,' said Cartwright. But Fowler believed you wouldn't know the outcome of such a sale until someone tested the Opticians Act.

MacKenzie countered. 'We have looked extensively at this in a number of countries and there are no firm legal opinions on this, because this sort of product has never been anticipated before. In the US and Indonesia, they are positioned as an incremental second purchase for when the patient needs something in a hurry. They are sold accordingly by practitioners according to FDA rules.'

He added that the product was also sold in Japan, which did not have a regulated optical market and as such,

the products could be sold by a variety of outlets over the counter.

MacKenzie pointed out that products were verified according to established standards, but the product that left the practice with the patient was the one that the professional had verified was fit for purpose.

## Adaptation

Harvey next wanted to explore the adaptability of the human system. 'Many people could adapt to a wide range of corrections if given the chance.'

His point was, if variable lenses were to be offered as a mean sphere in a set centration, would it really matter? Did the panel believe asthenopia existed? Did a correction need to be spot on?

Fowler pointed out that people probably would correct themselves fairly well but there needed to be a large scale study to verify effects before one could be certain of this. The analogy of an emergency back-up pair for contact lenses was acceptable, but, as Harvey pointed out, still an emergency back-up.

Cartwright felt that there was variation between optometrist results and this was to be expected in smaller errors due to the subjective nature of testing. Bleetman pointed out that the room for error would decrease with higher corrections.

Still thinking about asthenopia, MacKenzie explained how the centration distance might not have such a major impact as one might think. He presented the group with Figure 1 (below) showing the impact of a range of optical centration distance errors ranging from -10mm to +10mm (shown on the y-axis) and a range of refractive error ranging from

-10.00DS to +6.00DS. The central white area represented no reported issues whereas the extremities, colour coded from blue for mild discomfort up to red for more significant discomfort, showed clearly how, with no accommodative demand and a 33 per cent fusional reserve, the scope for comfortable vision within a range of centred sphere lenses appeared large. MacKenzie suggested that most of the lenses would fall into the white area.

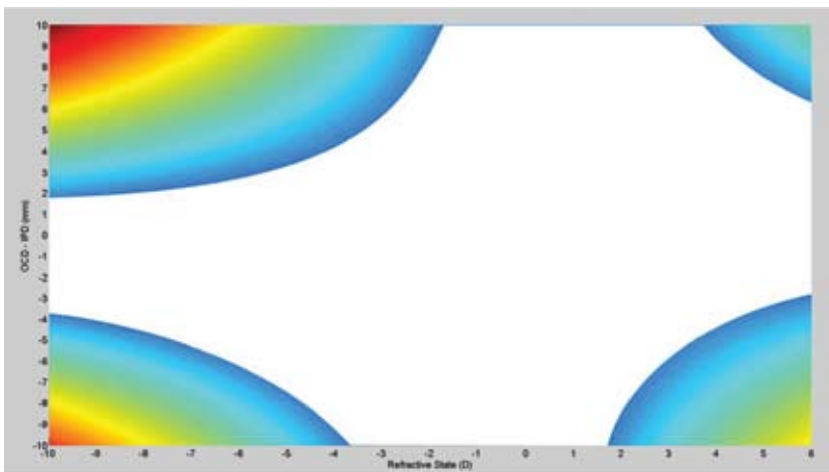
Cartwright added that in the UK, registered practitioners would be bound to supply accurate prescriptions or would risk falling foul of GOC regulation. Harvey asked, would the sale of prescription spectacles that people could set themselves from a magazine catalogue be illegal. The group confirmed a resounding yes. For an unregistered sale there would need to be a signed Rx, centration accuracy and lenses of equal powers for the correction of presbyopia – it fell down on several counts pointed out Cartwright.

Harvey asked the panel if Hemisphere, or a similar product, was something they would stock.

'I'd happily stock them for emergency type situations where I can be pretty sure that I will be able to stand up at a later date and say supplying them as emergency back-up was better than nothing. I would also be happy where I wanted to offer a sphere correction immediately,' said Cartwright. Hall and Bleetman agreed.

Bleetman believed that once the adjustment barrels were detached, the glasses could have limited appeal to patients as they would lose their 'unique selling point,' especially when he said he could make up a pair of spectacles which could correct cyl in as little as 20 minutes. MacKenzie's view was that there was still a strong reaction to buy. For the patient, not only was fluid-filled an interesting new concept, created to give sight to the developing world, but the John Lennon collection had appeal as a fashion brand. Moreover, those who bought the glasses could also help to make a difference through Adlens' buy-one-give-one programme.

'With the right regulation and control in place this has the potential to be a game changer and a serious asset to our dispensing armoury,' Hall said. 'Will it replace conventional glasses? Probably not, but we need to embrace this change as a profession and work with it. This will prevent the public misinterpreting our reluctance to be involved as protectionism.' ●



**Figure 1** White area represents no reported issues. Extremities are colour coded from blue for mild discomfort up to red for more significant discomfort