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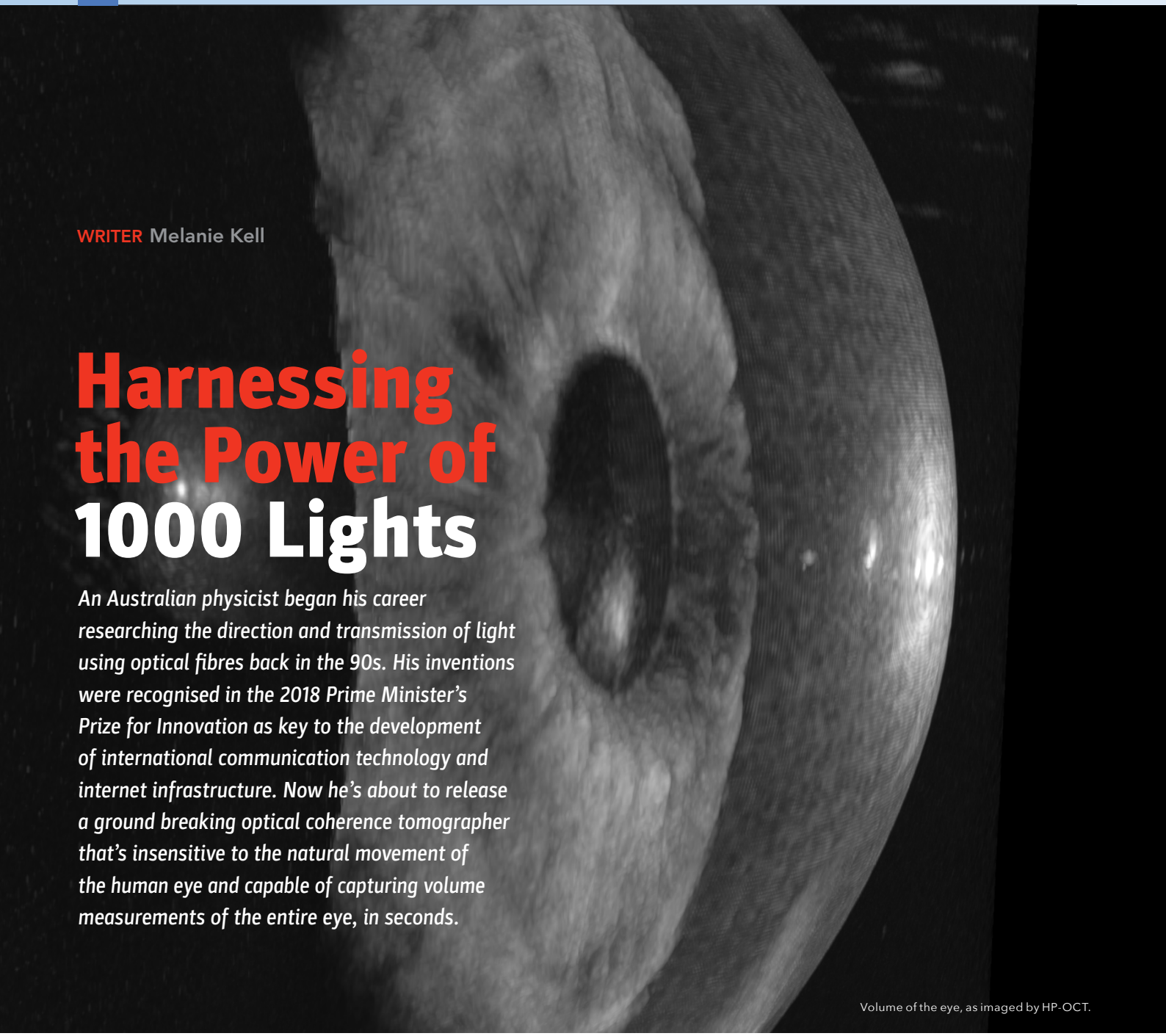

WRITER Melanie Kell

Harnessing the Power of 1000 Lights

An Australian physicist began his career researching the direction and transmission of light using optical fibres back in the 90s. His inventions were recognised in the 2018 Prime Minister's Prize for Innovation as key to the development of international communication technology and internet infrastructure. Now he's about to release a ground breaking optical coherence tomographer that's insensitive to the natural movement of the human eye and capable of capturing volume measurements of the entire eye, in seconds.

Volume of the eye, as imaged by HP-OCT.

It all started with a phone call one Sunday night back in 2012.

"My brother called me and we were talking about optical coherence tomography. It was something I'd previously been exploring through my research and development work with the US telecommunications company Finisar. I was interested in its relevance for the medical profession and Grant had a pretty good understanding of how it was being used and what its limitations were, for eye health in particular," said Dr Steve Frisken, CEO and co-founder of Cylite.

"Grant said OCT had great potential for optometry and ophthalmology, but the biggest problem was the eye moves too much to enable the acquisition of scans that are true enough to get accurate eye measurements. He set me the challenge to come up with a solution."

OCT uses light waves to scan across the surface of an object then create a three-dimensional image. To do this, a regular OCT must perform multiple scans using a single beam. When scanning an eye, its constant movement makes it impossible to capture an absolutely accurate image.

Steve Frisken's interest in directing and transmitting light was sparked soon after completing his PhD in nuclear magnetic ordering.

"I wanted to do something more practical, and more commercially relevant than nuclear magnetic ordering and so I found a position in the R&D department of the Overseas Telecommunication Corporation

– OTC, which was the predecessor to Telecom Australia. We were looking at optical communications which was just starting to take off and I was involved in exploring the use of optical fibres to transmit data instead of electrical communication."

As it turned out, Dr Frisken's work was to remain relevant for the next 30 years as the world turned its attention to increasingly sophisticated solutions for communication, which ultimately provided the backbone for the telephone network and became the infrastructure for the internet.

Dr Frisken's work with OTC exploring the manipulation of lasers and optics took him around the world and provided insights into the development and commercialisation of new products. Additionally, it provided the inspiration he needed when some time later, OTC closed-down its research and development department, leaving him out of a job.

"It made sense to take some of the product ideas we'd been exploring and bring them to the market in some way, so I got together with a colleague, and we did a typical start-up – we set up with a bunch of equipment in his garage and began our journey, looking to create a new business based on ideas and inventions. Soon after, we migrated to a shopping centre office, and before we knew it we were applying for patents associated with different products in the fibre optics business. We ended up creating two products that could direct laser light in different ways to send different signals to specific locations along optical fibres – it was in effect the backbone for the telephone network."

The business was called Photonic Technologies and it was eventually acquired in whole, by the Canadian telco, Nortel.

"That was a rollercoaster of a time. In the late 90s there was huge interest in optical / internet technology and companies involved were booming on the stock market. In the rush to develop the infrastructure for the internet, we expanded our operations by a factor of four from 70 people to almost 280 in 15 months.

> "I wanted to do something more practical, and more commercially relevant than nuclear magnetic ordering ..."

"We were thriving in the .com boom but in 2001 we had the .com bust and and all the money that had been invested into the internet development dried up. Fear took over and the .com bust became a telecom crash. Global companies liked our parent – Nortel – slipped in value until they disappeared.

"We were one of the early casualties of that period and in late 2001, our operation

Trevor Anderson, Armin Segref, and brothers Steve and Grant Frisken presenting the HP-OCT to ARVO researchers.

of several hundred people in Botany was closed down in quick time."

Dr Frisken bounced back again, this time forming Engana with his business partner Simon Poole.

"We took the time to think about what life was going to be like after all the doom and gloom associated with the .com bust and we started developing new network configuration products."

Engana proved to be successful and was acquired several times, while Dr Frisken and Dr Poole continued to work there, however as had been the case with OTC, the research and development budget to explore non-core projects dried up.

"Forming a new group and working with external partners, I'd begun exploring new opportunities in different areas, one of which was the application of fibre optics technology to optical coherence tomography (OCT). That got me thinking about different market places and technologies, but as part of a large company we found the long term research and development budget was constantly being compromised and after 18 months the OCT group was shut down and disbanded," he explained.

THE GERM OF AN IDEA

"By that point, the potential for OCT had whetted my appetite so when my brother Grant spoke to me about it one Sunday evening, I couldn't help but allow my imagination to run."

Over the course of the next year, the Frisken brothers had regular conversations, mostly over the phone on Sunday nights.

Dr Steve Frisken finding inspiration from an urban art installation in downtown Dallas.

"Forming a new group and working with external partners, I'd begun exploring new opportunities in different areas, one of which was the application of fibre optics technology to optical coherence tomography"

"We'd catch up on the kids and life in general then eventually circle around to the thoughts we'd had about OCT, exchanging ideas and diagrams about how you could develop the technology. For much of that time, the conversation was very much hypothetical but eventually we started getting serious about it.

"After about six months I came up with a proposal – it was a completely different approach to OCT that was more relevant to measuring the surfaces and layers of the eye. We agreed the proposal had merit and so I went away, drew up some diagrams, and developed some patent applications."

At this point you might wonder what an Australian researcher, working from his home office on a Sunday night, was thinking. Wasn't he about to go up against some of the world's biggest medical technology companies?

"There's a fine line between arrogance and confidence – the confidence I had in developing the idea came from having worked with R&D companies before. I'd come to realise that in all different industries, and in all different sized companies, the R&D teams are just a bunch of researchers like me, trying to find solutions to problems… however unlike me, they were being hampered in their development by thousand pound gorillas who were able to block their way. I was working for myself and I was free to follow my own ideas.

"I'd also been through the whole process enough times to realise that if you have an

idea for a product, and you think there is a potential market, there are always ways to bring that product to market. The trick is to decide whether the idea you have really is a market opportunity – or whether you're just deluded."

The Frisken brothers set up a new company – Cylite – and allowed themselves a year to refine their ideas and product ambition before taking the OCT development further.

In 2013, they took on a mathematical analyst, Trevor Anderson who understood the data processing side of things and Armin Segref – a German backpacker with a background in optics – to do some initial experimental work.

That's when things started moving quickly.

"One of the things about innovating is that you come up with a lot of ideas and you have to be prepared to throw many of them away. It takes a lot of confidence to do this, but it's really exciting when you recognise you're on to something and you get to see where it can go. For us, this was the moment. Our German backpacker validated our technology – we'd come up with an alternative technology for anterior segment imaging, and without even trying, we'd also found the way to image the retina."

From there, Steve and Grant Frisken presented their work at numerous science conferences, including Photonics West, BIOS in San Francisco, and later at the Association for Research in Vision and Ophthalmology (ARVO) and Laser World of Photonics in Munich.

"These conferences are invaluable because they provide an opportunity to present directly to researchers and ophthalmologists who can give you an idea of the technology's potential impact in research and in the clinic. They're also a great way to get an idea of what other people are doing in the area – whether there's someone else quietly working away on a similar concept.

"We got a lot of interest from industry players coming through the booth, and in fact at one of the conferences, our major competitor sent almost every staff member over to have detailed conversations with us to find out what we were doing. They seemed quite interested – even worried – and at that moment we knew we had a product that could really succeed in the market. They provided the impetus we needed to develop our technology properly."

While it could have been tempting to rush things, Dr Frisken said taking time to do this was essential.

"There are a lot of barriers to a start-up, particularly in the medical industry which is very much constrained by regulation. You have to cross all the 't's and dot the 'i's. That can be frustratingly slow when you've found a window of opportunity – if you don't get to market fast enough with a solution to a problem, someone else will. Even if their solution isn't as elegant as yours, it's always harder to enter the market after."

> "One of the things about innovating is that you come up with a lot of ideas and you have to be prepared to throw many of them away"

WHAT IS THE DIFFERENCE?

Dr Frisken says it's all in the beams.

"To develop the Hyperparallel OCT, we broke up the single beam used by other OCTs into 1,000 beamlets. Each of those beamlets takes simultaneous measurements at a scan rate of over 300,000 A-Scans/second. This enables accurate, motion-artefact-free measurements of all ocular surfaces, even in the presence of eye movement. As a result, we can capture an accurate

Toasting the award of an Accelerating Commercialisation Grant in 2016 – Unused porcine eye sample holders were appropriately repurposed as the company moved towards in-vivo testing. Left to right: Trevor Anderson, Grant Frisken, Dr Steve Frisken, Herman, Dirk Lorenser and Armin Segref.

360° image of the entire eye in just four seconds."

Cylite's 4th Generation OCT provides:

- Accurate anterior and posterior corneal topography (sclera to sclera),
- Optical biometry (axial length, pachymetry, lens thickness and curvature),
- Full anterior chamber OCT volumetric imaging (cornea to posterior lens),
- High speed retinal OCT volumetric imaging, and
- High resolution corneal imaging.

MANUFACTURING IN AUSTRALIA

Having kicked off in 2013 with a part time backpacker from Germany, Cylite is now a research group of more than 30 people with a manufacturing facility in Melbourne, and several of its 4th Generation Hyperparallel OCTs in use in laboratories in Europe, the United States, Asia and Australia.

The company is eagerly awaiting regulatory approvals from Europe and of course Therapeutics Goods Administration, at which point it is ready to launch and has customers waiting to buy.

"It's a tricky time for all companies and start-ups are not immune to this," says Dr Frisken. "We had planned to launch on 1 July 2020, however with the challenges brought about by COVID-19 we have had to review this timeline." It's a scenario that is uncannily familiar to both Dr Frisken and his VP of Business Development, Dr Simon Poole, "We faced very similar economic challenges in the early stages of our venture Engana – but looking forward to what customers will need at the end of this down-turn will provide the opportunity to differentiate," he said.

Cylite has set up a modular, scalable clean room for the manufacture of its OCTs opposite Monash University in Victoria with the support of an Advanced Manufacturing Growth Fund Grant. The company sources as many sub-assembled components as possible, ready for final assembly, alignment, calibration and testing within its own facility where engineering support is on hand.

"The manufacture of ophthalmology technology is lower volume but more complex than the manufacture of telecom technology but the principles are all the same. I'm comfortable that Australia is a good location for this now and into the near future. As we grow and scale up, we'll find new ways to ensure we're able to manufacture in the most economic and sensible way," said Dr Frisken.

POSITIVE FEEDBACK

"The feedback we've had from optometrists and ophthalmologists has been very positive – mostly they're surprised by the quality and volume of imaging that we've been able to achieve. They've been quick to point out the need for us to work on a better clinical interface and this is something that we have prioritised for the first clinical release – we will, for example, provide access to some IOL formulas.

"Industry experts have also provided us with plenty of ideas for other applications – like virtual gonioscopy with a 360° view – which gives us great confidence in our roadmap forward."

Steve (right)with his Telecom colleagues at the PM's Science awards - Dr Simon Poole (back) is now VP of Business Development for Cylite.

> "The feedback we've had from optometrists and ophthalmologists has been very positive – mostly they're surprised by the quality and volume of imaging"

PERSONAL SATISFACTION

As he prepares to launch the Hyperparallel OCT, Dr Frisken says he's excited to have been able to draw on his expertise in optics to develop a product that will make a difference to the lives of people around the world.

"Personally, I'm a bit of a natural geek – I love the whole optics technology side of things and I love that in ophthalmology, not only are we using optics to measure something, but we're also dealing with one of the human body's primary sensory organs capturing light.

"Ophthalmologists and optometrists are some of the most creative and innovative potential customers I could ever have imagined working with. The vast majority reflect an honest desire to really do something constructive and good in the world, with a lot of entrepreneurial spirit and a desire to achieve profitability at the same time.

"I'm really excited at the prospect of working with them."

AND WHAT OF THE BACKPACKER?

"Armin had come to Australia with his girlfriend for a holiday and six months of work. Finding him was great as he wanted work and we needed someone with his expertise – but neither of us wanted to commit to an arrangement for longer than six months.

"As it happens, Armin is now employee number one – an integral member of our R&D team. He's married and he lives with his wife and children in Melbourne."

A fortunate stroke of serendipity. mi