Mars comes to Auckland

by Owen Hembry

An Auckland University professor, his students and a research scientist for Fisher and Paykel Healthcare are developing a piece of world-beating technology so far only available — if you can find it — on the surface of Mars.

Professor John Harvey and his students are working with Fisher and Paykel Healthcare in the field of biophotonics — a technological blend of optics and electronics applied to biology and medicine.

Their 10-year partnership is developing a portable laser-based hygrometer for measuring absolute humidity — the number of molecules of water within a given volume of air.

The reason some companies are prepared to commit to such long-term investment in this field is simple, Harvey says. Money.

"Fisher and Paykel Healthcare dominate the world market for respiratory humidifiers and it wants to maintain its lead, so what it sells has to be the best."

Fisher and Paykel Healthcare research scientist Dr Igor Shvarchuck said using photonic technology will make the new sub-second hygrometer at least 50 times faster than anything currently on the market — essential when measuring humidity changes in human breath.

"The reason you build an optical hygrometer in the first place is because it's fast. It's the only one of its kind for the medical field," Shvarchuck says.

As a laser is shone through a sample cell, the wavelength is adjusted and the absorption of light measured. The speed and controllability of the laser enables very precise measurement of humidity.

"If you're in the business of producing steel, you'd better know how to measure it. If you're in the business of producing humidifiers you'd better know how to measure humidity.

"With this technology we can create the best in the market — that's the goal."

Shvarchuck says the partnership with Auckland University is a huge advantage for such cutting edge projects. A similar hygrometer was developed by NASA for the ill-fated Mars Polar Lander — technology now lost on the surface of the red planet.

"That is the reason we are doing this — you can't buy one," Shvarchuck says.

PHOTOS: OWEN HEMBRY

CUTTING EDGE: Professor John Harvey at work in the laboratory.

The Photonics.com website defines photonics as the harnessing of light and radiant energy whose quantum unit is the photon. This light energy can then be used for a range of purposes including communication, information processing and detection.

Most of us are unaware of the growing impact photonics has on our lives — from supermarket checkout scanners, to the latest optical control systems used to fly planes. But, Harvey says, if we took it away tomorrow, life, as we know it, would stop.

"It's the mark of a really successful technology — that it's invisible. Nobody ever complains about it because it never breaks down."

Not so long ago photonics ruled the technological world. The blend of optics and electronics was key to the explosive growth of internet communication in the 1990s.

Millions of miles of optical cable were laid. Then in 2000 the dot-com bubble burst, leading to the collapse of hardware companies in what became known as the "tech wreck".

Companies folded overnight, billions of dollars were lost, and photonics engineers found themselves on the street. But research didn't stop, Harvey says. It diversified.

Following the "tech wreck" of 2000 photonics engineers took their talents into other fields.

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"So now we see a whole lot of new developments in display technology, lighting, and biophotonics.

"It's made people realise that you can use all this fancy technology for other things apart from making phone calls," Harvey says.

Current developments in LED lighting, which may soon appear in car headlights, are 10 times more efficient than current light bulbs.

Television screens, which can be rolled up and put away, sound like science fiction but may soon become science fact.

Harvey says since the terrorist attacks in the US on September 11, 2001, these everyday applications have been joined by another — homeland security.

"If you can make an optical device that detects explosives, or a system for screening high speed communications, then you can get people to throw money at you in America."

In New Zealand, optical gas sensor technology could determine readiness for harvest by measuring the concentration of certain molecules produced by an orchard of ripening fruit.

Using optical sensors to detect the presence of any harmful biological contaminants could also ensure safe drinking water in poorer countries.

The application of photonics is limited only by the imagination, Harvey says, but the real question is whether new proposals can be achieved at an economic cost.

However, the stock market crash of 2000 scared many venture capitalists away from investing in photonics projects.

Wildly inaccurate over-estimation of internet traffic doubling every 90 days fuelled massive investment. Eventually the truth came out, many companies collapsed and about 500,000 communications employees lost their jobs.

"Nobody wanted to rebut them [growth estimates] because they wanted them to be true," Harvey says.

Although previously over-estimated, internet growth is dramatic. More recent factual studies show that internet traffic doubles every year. But millions of miles of cable are still underused.

These are called "dark cable", and Harvey says nobody really knows how much capacity is out there.

"The first undersea cables could only support maybe a dozen phone lines simultaneously. It would be entirely possible these days to carry a million phone calls on one or two fibres."

In the communications field the holy grail of photonics is fibre to the home (FTTH). Harvey estimates that one optical fibre could carry every movie ever made, and restart showing each film every 15 minutes.

Ericsson marketing general manager Stephen Inglis says a successful trial in Lower Hutt last year showed FTTH is technically and financially viable in New Zealand.

"Typically, fibre operators can offer a triple play of telephony, broadband internet, and television services. For new property developments the costs of rolling out fibre are comparable to rolling out new copper cables," Inglis says.

Announcements in August from Telecom New Zealand of a five-year, $120 million dollar investment in fibre networks, and a $10 million FTTH trial in Manukau, bring the holy grail closer to hand.

However, the cost of replacing currently viable copper cable with optical fibre in existing homes means only "green field" new home developments are likely to receive the technology in the short term.

When FTTH does become a reality for the average household it is likely to trigger a new boom cycle within the communications field, and for those who supply the technology.

But with America investing to ensure a manufacturing lead for new technology, Harvey warns New Zealand runs the risk of being left behind.

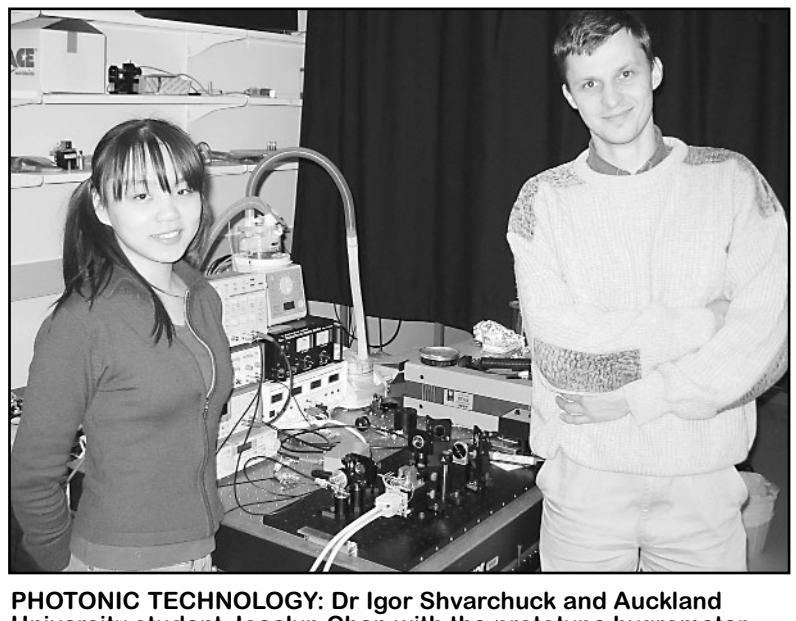
Large overseas companies tend to focus on, and dominate, areas that will give a big return on their investment. Harvey says there are, however, many niche areas where New Zealand can specialise.

"New Zealand's got a lot of smart people and our wage structure is not that high. I can envisage a lot of small companies selling five to 10 million dollars worth of gear a year — and that's not to be sneezed at."

Government support for his start-up company, Southern Photonics, selling specialised optical communication instruments, is an encouraging start, he says.

Harvey expects demand to grow as investment returns and the next generation of communication systems roll out around the world.

"That's what got to me. All of my graduates were going overseas and were not coming back. Many of them want to come back but there are no jobs. Before I retire I want to see if we can make an industry so these guys can come home."



PHOTONIC TECHNOLOGY: Dr Igor Shvarchuck and Auckland University student Jocelyn Chen with the prototype hygrometer.

A brief history of optical communications

1831: Joseph Henry sends electric current one mile to ring a bell using an electro-magnet.

1844: Samuel Morse sends electronic pulses along copper wire from Washington DC to Baltimore, creating markings on a strip of paper. The message, "What hath God wrought", is the first Morse code telegraph.

1880: Alexander Graham Bell's photophone delivers world's first wireless telephone message. A mirror is vibrated by sound. A beam of sunlight transmits the vibration 600 feet to a receiving point where it is rebuilt back into sound.

1930: Medical student Heinrich Lamm assembles the first optical fibre, transmitting the image of a light bulb.

1956: First transatlantic coaxial copper cable carries 36 telephone calls.

1960: Theodore H. "Ted" Maiman invents the world's first working laser.

1965: Satellite "Early Bird" carries 240 simultaneous telephone calls.

1988: First transatlantic optical cable carries 40,000 simultaneous calls.

2000: Southern Cross optical link connects New Zealand to the USA.

2003: Transatlantic optical cable, named Apollo, goes live. Capable of transmission equivalent to 200 million simultaneous telephone calls.