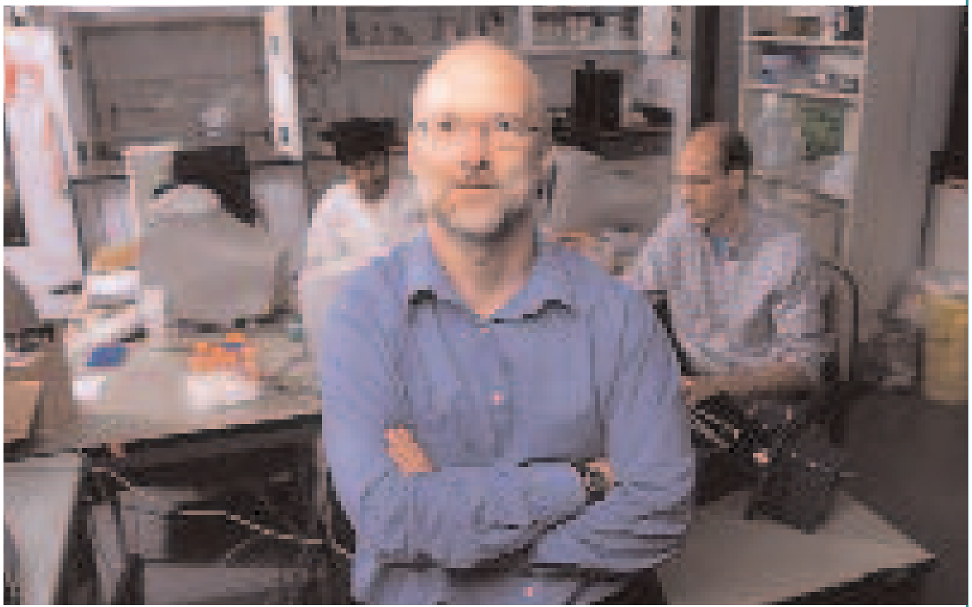
Electrical & Computer ENGINEERING

Tiny Technology Huge Implications

by Jim Sellers



Dr. Chris Backhouse is an electrical engineer, a scientist, and a humanist. But above all, he is an optimist. From micro to macro points of view—from individual cells to the overall public health care system—he sees a future of better health through nanotechnology.

Backhouse is a professor in the Department of Electrical and Computer Engineering, with interests in the study of nanotechnology, specifically in the areas of biomedical engineering, microfabrication, and space. Working with his team of researchers and students in the applied miniaturisation laboratory, Backhouse is finding ways to make health technologies more accessible through miniaturisation and integration.

Like most people, Backhouse is deeply concerned about keeping public health care affordable and accessible in an era of continually rising costs. Backhouse focuses his efforts on making improvements in the area of testing.

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The fourth largest cause of death in the U.S. (and presumably a major concern elsewhere) is inaccurate treatment. Over 100,000 patients die in the U.S. each year because they are being improperly treated for their diseases. An effective treatment for one individual may not work on another. Backhouse's team is working on the technology to provide individualized treatments based on better, more accurate diagnoses.

Improved diagnostic tools may be particularly vital during public health crises, says Backhouse.

"If you look at how poorly things worked with the SARS outbreak (in Toronto), if that had been something else, like Ebola, we would have been in very big trouble."

The Applied Miniaturisation Laboratory has produced several small devices that can move and analyse individual cells and molecules to accurately test for viruses, cancers, and other anomalies.

According to Backhouse, "We need to be able to do these things quickly, cheaply, and reliably. In terms of speed, we can now get a genetic analysis in much the same time you can hold your breath—a far cry from some forensics that can take months for an answer.

"We are being outnumbered or outgunned by viruses because they have the ability to mutate far faster than our ability to create a vaccine. With this kind of technology, we could break even. It's conceivable that, in 10 years time, you could identify the virus at the airport and have the vaccine the next day."

The technology is very small, but the implications and potential applications are huge. Individual diagnoses currently require expensive and slow testing to identify a patient's condition. Even then, in many cases a true diagnosis can be missed because the tests simply aren't precise enough.

Explains Backhouse, "We are not looking at individual cells but looking at a million cells and hoping the average answer is going to be relevant—but it's not. We need to be able to

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Huge Implications (continued from page 1)

identify the anomalous cell and analyse it. With this technology, that's what we can do: work with single cells and single molecules."

Backhouse doesn't think we will have to wait long to see widespread use of nanotechnology in health care testing.

"That thing that excites me most is knowing that the type of protocol that we are using to save lives through research will, in the near future, be commercially available to everyone through the health care system without breaking the bank."

Like many new medical technologies, nanotechnology raises huge ethical concerns. With the potential to screen otherwise healthy people for potential long-term health concerns, the system could be open for abuse.

If we can screen people for certain health problems or predispositions to these problems, can the health care system remain universal? What about health insurance? Do some people get left out or have to pay more because they may be susceptible to certain problems? Can fear affect further research into this type of health care technology?

"I want to see Canada, or another enlightened country, adopt this technology in an ethical manner," says Backhouse.

"The legal, social, and ethical components often catch up with a technology later. What I would like to see is a nice set of rules, regulations, and ethical guidelines so we do have a better quality of life. It's going to take a lot more informed discussion."

Backhouse sees promise and benefits for everyone.

"Right now, we have mapped the genome of one guy, but in the context of pharmacologenomics, we are all different. There is a lot be learned on an individual basis. Some say that in five or ten years, we can get a human genome for $100, instead of spending what it took to get a man on the moon. That's astounding. At that point we can ask any number of detailed questions."

Can we look forward to a cost-efficient and effective universal health care system?

"We are only starting on that journey," concedes Backhouse.

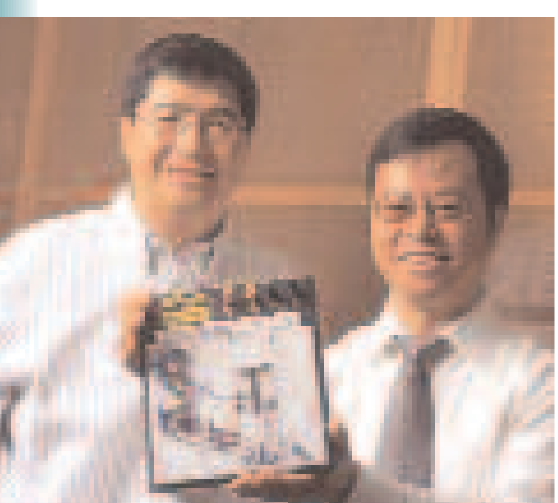
Plug and Play *the Oil Game*

Heat bitumen-rich oil sands with electricity and remove the oil from it. This idea mesmerized Bruce McGee (Electrical '80, MEng Electrical '84, PhD Electrical '98) from the moment his professor Dr. Fred Vermeulen (Electrical '60, PhD Electrical '66) gave a presentation on his research in 1980. McGee took Vermeulen's approach and made it one of the most successful technology transfers to happen at the U of A. Learn more about McGee's patented process on page 21 of the fall issue of the *U of A Engineer* alumni magazine.

The Tooth, the Whole Tooth…

by Jim Sellers

Broke a tooth playing hockey or that fateful fall off the ladder? Soon you won't need to face crowns, implants, and painful surgery. This tiny device will grow that missing tooth back naturally, using ultrasound.



The low-intensity pulsed ultrasound (LIPUS) device is the creation of Dr. Jie Chen of the Department of Electrical and Computer Engineering, along with Dr. Tarak El-Bialy and Dr. Ying Tsui.

El-Bialy was researching the use of ultrasound to repair jawbones and found that it was effective in regrowing broken teeth. The only difficulty was the unit's prohibitive size. He brought the problem to Chen and Tsui who immediately set to finding a more fitting (literally) solution.

The challenge was to create the unit small enough to work inside the patient's mouth while resisting the corrosive effects of saliva. The team created a durable, tiny device that operates on internal power and communicates with the outside world wirelessly. The team is now in the process of seeking a patent on the technology, the first device ever to regrow teeth.

"It's very exciting because we have shown the results and actually have something you can touch and feel that will impact the health of people in Canada and throughout the world," Chen explains.

Work on the device does not end with the successful regeneration of broken teeth. It can also restore roots damaged by disease and orthodontic braces. Doctors hope to eventually use this device to help regenerate broken bones elsewhere in the body. Soon millions of people may benefit from this new technology.

Dr. Tsui and Dr. Chen hold the components that will eventually be smaller than a fingernail and fit comfortably in your mouth.

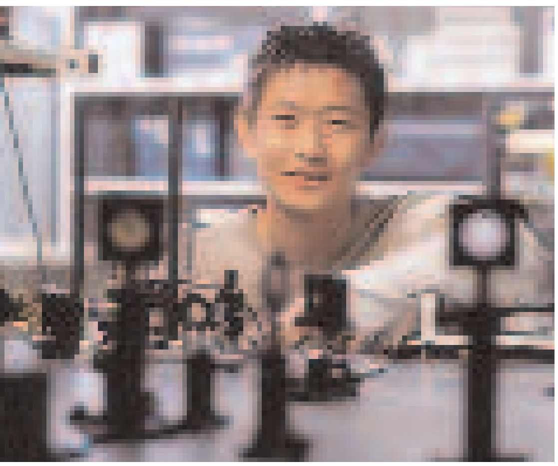
Student CENTRAL

A Light Look at Radiation

by Jim Sellers

Don't take anything for granted, including what you know about light. Sure, it can brighten a room. But did you know it could travel through metal?

According to Kenneth Chau, the answer is a resounding yes—provided it's the right kind of light. Working at the Ultrafast Photonics



and Nano-optics Laboratory in Electrical and Computer Engineering, the 24-year-old doctoral student discovered that terahertz (THz) light—invisible light whose frequency lies between that of far infrared and microwave radiation—can be transmitted through metals. Working with Dr. Abdulhakem Elezzabi, Chau is redefining the understanding and applications for this form of radiation.

THz light is a form of radiation that is being researched as an alternate to X-rays for medical uses. With only a fraction of the energy of x-rays, THz rays can still pass through tissues but without damaging cells. Chau's experiments looked at how samples of solids affected a single wave of THz radiation as it was shone through them. His initial work was with sapphires, but then, in a truly experimental approach, he turned the ray onto a sample of chromium powder. To his astonishment the wave appeared to pass through the metal. This seemingly impossible feat led to further investigation.

With more research, Chau determined that the light wave didn't actually travel directly through the chromium. Instead, it energized surface electrons on the metal, which in turn generated a wave of energy through the sample, passing the signal through to the other side.

Chau's discoveries in the nature of low frequency light and plasmonic phenomena have been published in the highly respected international physics journal, *Physical Review Letters*. He has also received the André Hamer Postgraduate Prize from the Natural Sciences and Engineering Research Council (NSERC) in Ottawa, one of two awards given to the top post-graduate students in the country.

"It was pure curiosity. Professor Elezzabi encouraged me to investigate," recalls Chau of his Masters research.

With this level of success and recognition early in his career, Chau is looking ahead to the future for further results from his work.

Did you know that, as an ECE alumni, you have a website and ECE email address for life? The accounts are maintained under current U of A website regulations but, unlike other U of A accounts, this site is yours for as long as you use it. If you have questions or wish to re-establish your account with us, send an email to: support@ece.ualberta.ca

His enthusiasm for the research is infectious and the potential for the future is enormous. It is easy to see that he has only just begun to unlock the potential of this technology.

"I love the research," Chau says.

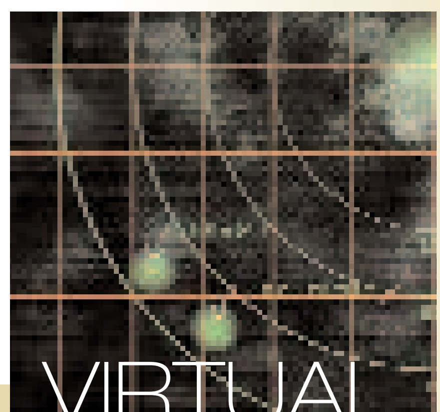
"I'm an experimentalist at heart, and at the same time I want to see my research applied somewhere."

"Somewhere" could mean almost anywhere the sun shines. True to Chau's intrepid nature, he is working on another project that challenges our imaginations: a new way of transforming THz radiation from sunlight directly into electricity.

Based on his work so far, Chau's ideas are not to be taken lightly.

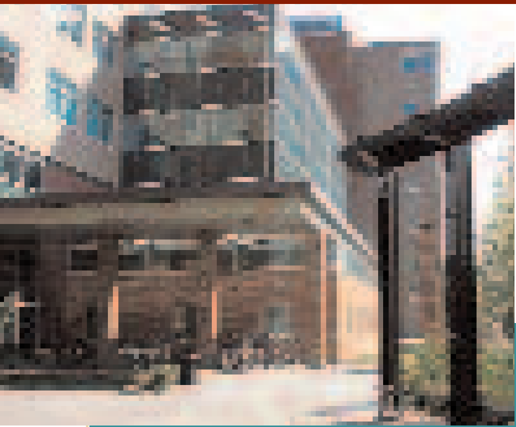
Invested with **Success**

When asked about memorable moments in their lives, few people would cite the time the mystery of electromagnetic theory was unravelled for them. But Jimmy Hsu (Electrical '75) is no ordinary person. Born in Singapore, Hsu came to the U of A in the early 1970s on a Canadian government scholarship and is now one of Asia's most knowledgeable private equity investors. Read more about Hsu's investment success on page 14 of the fall issue of the *U of A Engineer* alumni magazine.



VIRTUAL Engineer

Meet Ross Ulan (Electrical '84), doing voice communications with NAV CANADA in Greely, Ontario on page 24 of the fall issue of the *U of A Engineer* alumni magazine.



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The ECERF building was unveiled in 2001, focusing the spotlight on this dynamic group of educators and researchers. Now the fields of Electrical and Computer Engineering at the U of A have the facilities, the visibility, and the opportunity to open new doors. More than ever before, we can lead the way in engineering education and research in all areas of power, communications, health care technology, and nanotechnology.

Alumni will play a key role in maintaining this momentum. The ECERF building has many laboratories and learning spaces available for dedication. We encourage you to consider leaving a legacy through your support of one of these spaces. In doing this, you are able to invest in the leaders of tomorrow and make a public statement of your belief in the work being done in these exciting areas of research and education.

For more information, please call

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