feature

21ST CENTURY SURVIVORS

With their brand new hearts and bionic limbs, the future belongs to a generation sustained by advanced bio-engineering. Meet Generation B: the biotech boomers.

Judy Skatssoon

In the cult 1970s TV series *The Six Million Dollar Man*, scientists use advanced technology to rebuild crippled astronaut Colonel Steve Austin and turn him into the world's first bionic man. This principle underlies a bold and futuristic-sounding research initiative at the University of Sydney, known as Bio^3.

Mobility restoration such as that enjoyed by the fictional Steve Austin uses implanted electrodes to restore movement to people paralysed by spinal cord injury, brain trauma or nerve damage. In TV-land, the post-operative Steve Austin was "better, stronger, faster" than ever before. But in reality, gains in mobility restoration – at least initially – are expected to be more modest.

"The goal behind the project is to restore some basic mobility to people who are paraplegics," says Professor Tony Weiss, of the University of Sydney's School of Molecular and Microbial Biosciences.

"The way to do that is to put electrical stimuli directly into paralysed muscles through implanted electrodes [and] an intelligent wire delivery system.

"It's saying if there's a breakdown in circuitry, why not just rewire the circuitry?"

It may be a bit like the bionic man, "but of course it wouldn't be quite a case of running at a million miles an hour – it's pretty basic functions in the first instance."

The implanted electrodes would be connected to a chip that bypasses the brain and stimulates muscles directly using a distributed network that is interconnected via a local wireless network. Much of the required sequence of electrical stimulating signals will be generated autonomously, once the trigger for a specific type of movement, such as a step forward, is initiated.

Bio^3 is a multi-diciplinary project led by a University of Sydney biophysicist and bioengineer, Professor Hans Coster. According to Professor Coster, much of the science behind the project is well established; what is needed now is a process which brings it all together. The technology is being developed by researchers from the University of Sydney together with groups in Britain and the US, and Professor Coster says the interdisciplinary nature of the research, which involves quadriplegia experts, biophysicists, physiotherapists and biomedical engineers, makes it ideally suited to the Bio^3 vision.

Welcome to the brave new world of biotechnology. One day in the not too distant future, it may be possible to replace a worn-out heart with a brand-new one built or grown in a lab. Implantable gadgets will give movement to people incapacitated by age, illness or disability, and armies of tiny stealth bombers will seek and destroy cancer cells in our bodies.

Although relatively slow to jump on the biotech bandwagon, the University of Sydney is establishing a Bio^3 research and teaching facility that its architects hope will give the university pole position in the revolution. The centre will develop and commercialise replacement body parts, electronic health surveillance systems and new forms of drug delivery. It's scheduled to begin operating some time this year and will have initial funding of about $1.5 million a year.

The ambitious project is the joint brainchild of Professors Richmond Jeremy, associate dean, infrastructure and finance, in the faculty of medicine, Hans Coster and Tony Weiss.

The plan had its origins at a cafeteria lunch, when a discussion about research synergies led to speculation about the future of medicine. The group greed that as the population aged and fewer babies were born, medical research would need to find ways to keep people healthy and productive for longer.

"Looking at what the needs would be 20 years or more in the future is the ability to have artificial organs and artificial bits and pieces that you can either grow or make and implant," Jeremy says.

Bio^3 will foster a unique interaction between the physical and life sciences, says the dean of medicine, Professor Andrew Coats. "You can invest heavily in biotechnology as a discipline, but [Bio^3 is about] taking advances in physics, chemistry and engineering and applying them to medicine … very few universities in the world are doing that," he says.

Whether by designing artificial eyes and blood vessels, coming up with new materials for joint replacements or improving robotic surgery, Coats says Bio^3 will be a big step forward in treating diseases of the 21st century.

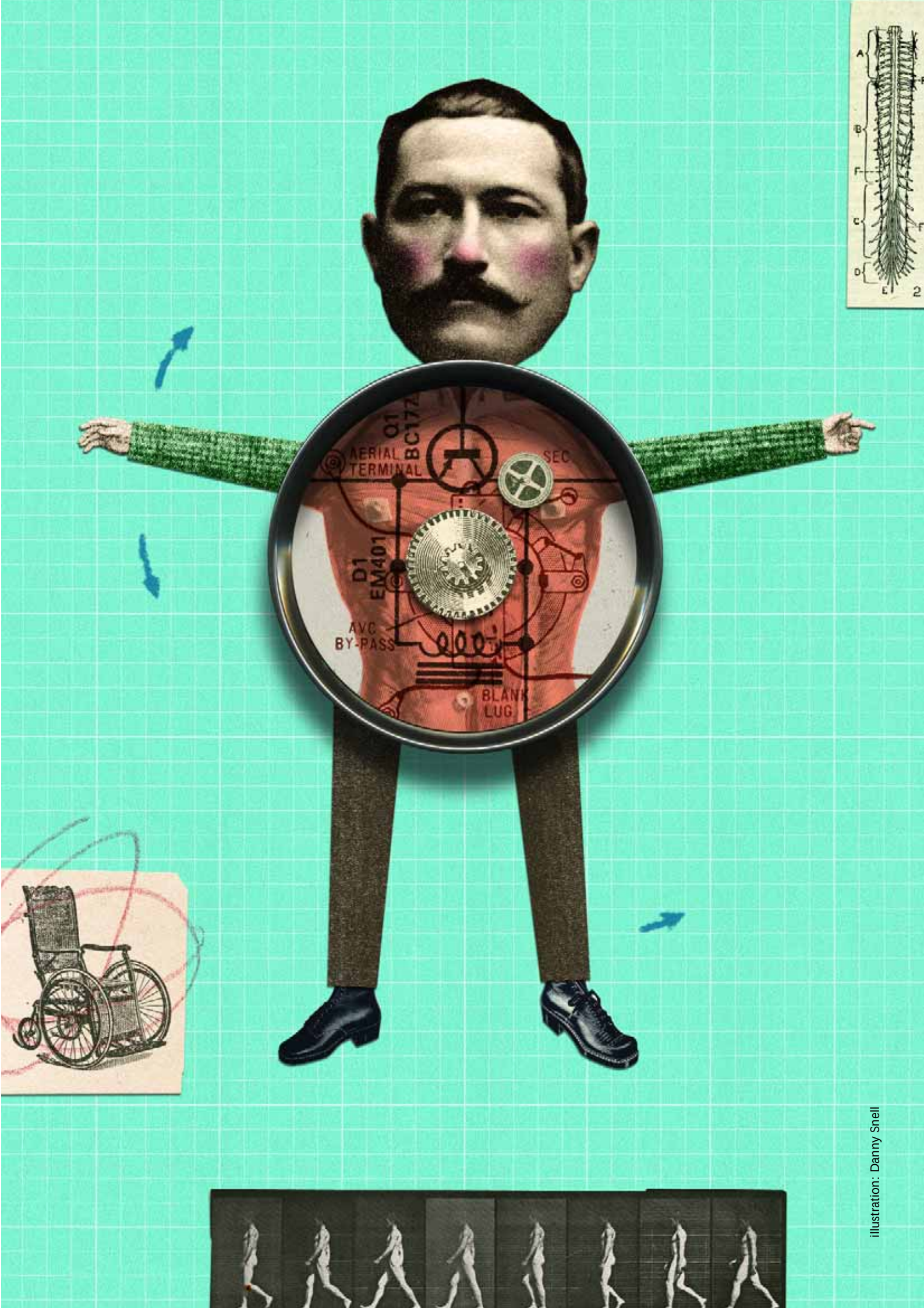

illustration: Danny Snell

Richmond Jeremy and Tony Weiss ... if there's a breakdown in circuitry, why not re-wire it? photo: Karl Schwerdtfeger

The Bio^3 network

Bio^3 is envisaged as a "research motel": a place where biological researchers, clinicians, scientists, chemists, engineers and mathematicians can come together to exchange ideas and research in shared labs.

Some activities will begin early this year, including creating a network of Bio^3 labs around the university. The committee is identifying a long-term home for the centre and has two potential sites, one on the Darlington campus and the other in the Blackburn precinct. Building is hoped to take two to three years.

Bio^3 will employ extra staff to help kick the venture off and will also be recruiting talent locally and overseas.

The project, which will initially be paid for by existing research funds, hopes to win international funding through the US National Institutes of Health and US military bodies.

Jeremy says the NSW Government is enthusiastic about the venture but has not yet made a financial commitment, and the Federal Government is yet to be approached. Nevertheless, Bio^3 will have a strong commercial focus and it's hoped the initiative will reap significant financial returns. He says Bio^3 will function as a brains-for-hire for governments and the private sector and will seek commercial partnerships.

The biotech revolution is changing the way universities operate, says the editor of *Australian Biotechnology News*, Iain Scott.

"It's had a fairly big impact on the way academia regards the private sector and commercialisation isn't such a dirty word any more," he says.

But the formerly foreign concept of patenting information rather than automatically publishing has caused substantial debate. "[In the past] patenting just wasn't an option and the idea of providing information to all your peers equally was definitely the main game in academia," he says.

"There was never an idea of putting a fence around your research."

Jeremy says a more commercial approach does not represent a major philosophical shift for the university.

"Many faculties within the College of Sciences and Technology perform consultancies for industry and for government in engineering, chemistry … all we would be doing is another form of consultancy or contract," he says.

By the time Bio^3 is fully established and operational, which will be around 2015 to 2020, it will require an annual budget of about $20 million to $30 million. It's hoped the venture will return at least that amount in revenue.

Jeremy admits that the University of Sydney is a late starter in the biotech field, but says this could work to its advantage. He says some universities plunged in at the beginning of the biotech revolution, when people were primarily "manipulating yeast in Petri dishes" and "growing molecular things in tanks". He doesn't diminish the importance of this kind of work, but says Bio^3 will have a broader perspective.

"What we've done is been able to stand back from that and look at a much bigger picture which has, I think, greater potential and reward for the University than the more traditional established things that a lot of universities have poured a lot of dosh into.

"In a sense, by having waited a bit and looked over the horizon, we're making an investment which will take us over the horizon. We're starting something which is the next generation."

Iain Scott says Bio3 will probably have a lengthy gestation period and may look "fairly nascent" against other established centres, but he says the venture is the way forward for biotechnology.

"I think people will be looking to universities and this kind of creative model much more in the future to make biotech work," he says.

Andrew Coates ... describes Bio3 as a unique interaction.

Principal Biotech Research Areas

Bio-engineering

Pacemakers, hip replacements and the cochlear implant are all examples of basic bioengineering, which according to Professor Richmond Jeremy is based on the principle that "human beings are extraordinarily adaptable to having bits of hardware inside them". Bio3 plans to take the concept further by creating artificial organs and replacement parts, such as hands, organs, limbs, eyes and joint replacements.

Tissue engineering

This is an emerging technology where the aim is to grow a new organ or body part from human cells, sidestepping the problem of organ donor shortages. One way of doing this involves encouraging stem cells to grow around carbon microfibre structures, replicating the architecture of an organ and the network of blood vessels that feed it.

Bio-sensing

Bio-sensing is a way of remotely monitoring a patient's health status and transmitting data back to a doctor. For example, an implanted device could detect whether cancer cells are returning after a course of treatment. Bio-sensing may also have applications for vets and farmers. A device that monitors proteins in blood, for example, or worm loading, could tell farmers that it's time to treat stock.

Biological nanotechnology

Nanotechnology could create tiny "machines" to deliver drugs to a specific site. For example, high doses of drugs could be cased in miniature "submarines" and sent like guided missiles to cancer cells. The same principle could be used to deliver a poison pill directly to worms or larvae in parasitic infections.