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Special report

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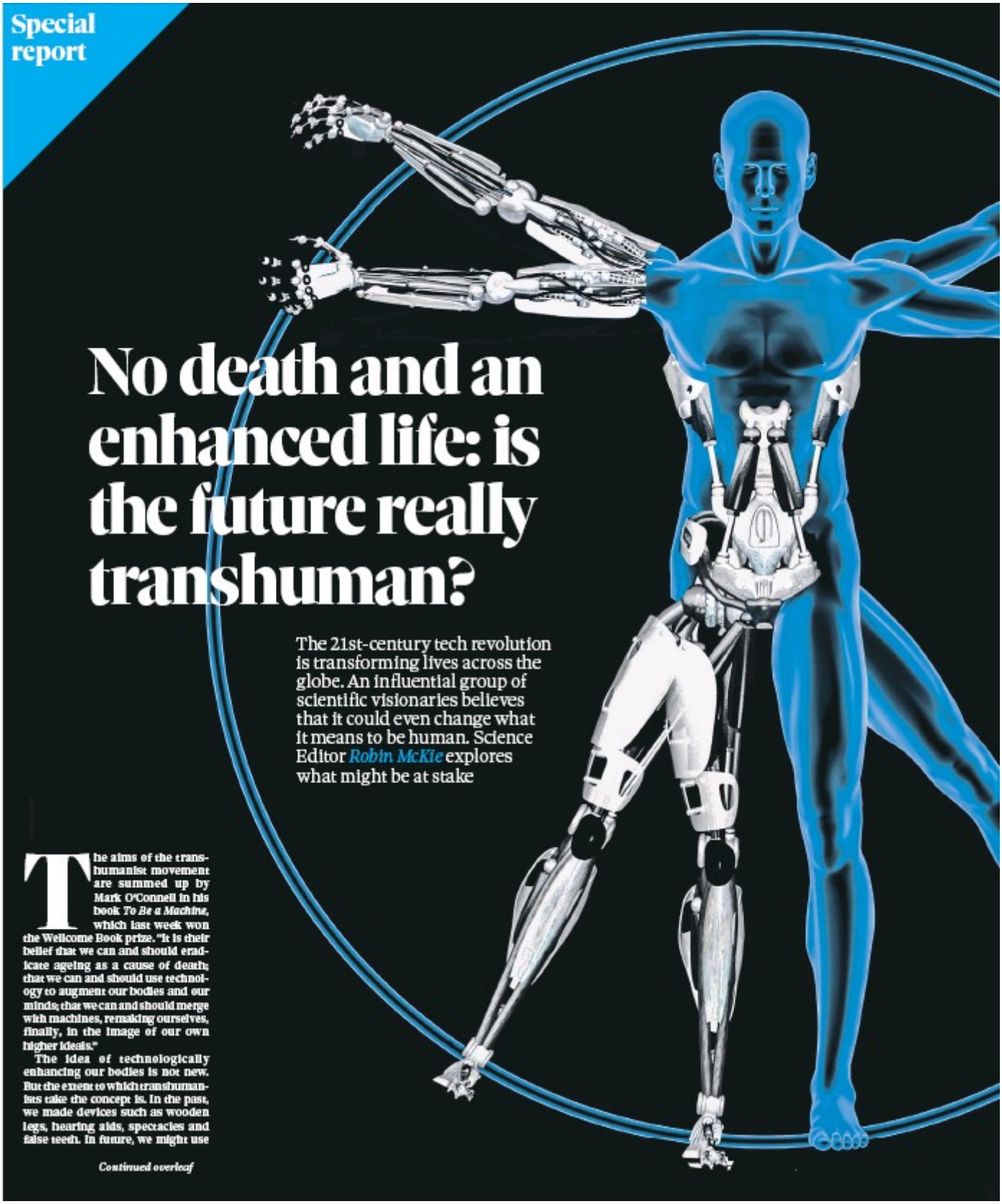

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implants to augment our senses so we can detect infrared or ultraviolet radiation directly or boost our cognitive processes by connecting ourselves to memory chips. Ultimately, by merging man and machine, science will produce humans who have vastly increased intelligence, strength, and lifespans; a near embodiment of gods.

Is that a desirable goal? Advocates of transhumanism believe there are spectacular rewards to be reaped from going beyond the natural barriers and limitations that constitute an ordinary human being. But to do so would raise a host of ethical problems and dilemmas. As O'Connell's book indicates, the ambitions of transhumanism are now rising up our intellectual agenda. But this is a debate that is only just beginning.

There is no doubt that human enhancement is becoming more and more sophisticated – as will be demonstrated at the exhibition The Future Starts Here which opens at the V&A museum in London this week. Items on display will include "powered clothing" made by the US company Seismic. Worn under regular clothes, these suits mimic the biomechanics of the human body and give users – typically older people – discrete strength when getting out of a chair or climbing stairs.

In many cases these technological or medical advances are made to help the injured, sick or elderly but are then adopted by the healthy or young to boost their lifestyle or performance. The drug erythropoietin (EPO) increases red blood cell production in patients with severe anaemia but has also been taken up as an illicit performance booster by some athletes to improve their bloodstream's ability to carry oxygen to their muscles.

And that is just the start, say experts. "We are now approaching the time when, for some kinds of track sports such as the 100-metre sprint, athletes who run on carbonfibre blades will be able outperform those who run on natural legs," says Blay Whitby, an artificial intelligence expert at Sussex University.

The question is: when the technology reaches this level, will it be ethical to allow surgeons to replace someone's limbs with carbon-fibre blades just so they can win gold medals? Whitby is sure many athletes will seek such surgery. "However, if such an operation came before any ethics committee that I was involved with, I would have none of it. It is a repulsive idea – to remove a healthy limb for transient gain."

Not everyone in the field agrees with this view, however. Cybernetics expert Kevin Warwick, of Coventry University, sees no problem in approving the removal of natural limbs and their replacement with artificial blades. "What is wrong with replacing imperfect bits of your body with artificial parts that will allow you to perform better – or which might allow you to live longer?" he says.

Warwick is a cybernetics enthusiast who, over the years, has had several different electronic devices implanted into his body. "One allowed me to experience ultrasonic inputs. It gave me a bat sense, as it were. I also interfaced my nervous system with my computer so that I could control a robot hand and experience what it was touching. I did that when I was in New York, but the hand was in a lab in England."

Such interventions enhance the human condition, Warwick insists, and indicate the kind of future humans might have when technology augments performance and the senses. Some might consider this unethical. But even doubters such as Whitby acknowledge the issues are complex. "Is it ethical to take two girls under the age of five and train them to play tennis every day of their lives until they have the musculature and skeletons of world champions?" he asks. From this perspective the use of implants or drugs to achieve the same goal does not look so deplorable.

This last point is a particular issue for those concerned with the transhumanist movement. They believe that modern technology ultimately offers humans the chance to live for aeons, unshackled – as they would be – from the frailties of the human body. Failing organs would be replaced by longer-lasting high-tech versions just as carbon-fibre blades could replace the flesh, blood and bone of natural limbs. Thus we would end humanity's reliance on "our frail version 1.0 human bodies into a far more durable and capable 2.0 counterpart," as one group has put it.

However, the technology needed to achieve these goals relies on as yet unrealised developments in genetic engineering, nanotechnology and many other sciences and may take many decades to reach fruition. As a result, many advocates – such as

'Over time I think we will probably see a closer merger of biological and digital intelligence. It's mostly about the speed of the connection' Elon Musk, tech billionaire

the US inventor and entrepreneur Ray Kurzweil, nanotechnology pioneer Eric Drexler and PayPal founder and venture capitalist Peter Thiel have backed the idea of having their bodies stored in liquid nitrogen and cryogenically preserved until medical science has reached the stage when they can be revived and their resurrected bodies augmented and enhanced. Four such cryogenic facilities have now been constructed: three in the US and one in Russia. The largest is the Alcor Life Extension Foundation in Arizona whose refrigerators store more than 100 bodies (nevertheless referred to as "patients" by staff) in the hope of their subsequent thawing and physiological resurrection. It is "a place built to house the corpses of optimists", as O'Connell says.

Not everyone is convinced about the feasibility of such technology or about its desirability. "I was once interviewed by a group of cryonic enthusiasts – based in California – called the society for the abolition of involuntary death," recalls the Astronomer Royal Martin Rees. "I told them I'd rather end my days in an English churchyard than a Californian refrigerator. They derided me as a deathist – really old-fashioned."

For his part, Rees believes that those who choose to freeze themselves in the hope of being eventually thawed out would be burdening future generations expected to care for these newly defrosted individuals.

Ultimately, adherents of transhumanism envisage a day when humans will free themselves of all corporeal restraints. Kurzweil and his followers believe this turning point will be reached around the year 2030, when biotechnology will enable a union between humans and genuineley intelligent computers and AI systems. The resulting human machine mind will become free to roam a universe of its own creation, uploading itself at will on to a "suitably powerful computational substrate". We will become gods, or more likely "star children" similar to the one at the end of 2001: A Space Odyssey.

These are remote and, for many people, very fanciful goals. And the fact that much of the impetus for establishing such extreme forms of transhuman technology comes from California and Silicon Valley is not lost on critics. Tesla and SpaceX founder Elon Musk, the entrepreneur who wants to send the human race to Mars, also believes that to avoid becoming redundant in the face of the development of artificial intelligence, humans must merge with machines to enhance our own intellect.

This is a part of the world where the culture of youth is followed with fanatical intensity and where ageing is feared more acutely than anywhere else on the planet. Hence the overpowering urge to try to use technology to overcome its effects.

It is also one of the world's richest regions, and many of those who question the values of the transhuman movement warn it risks creating technologies that will only create deeper gulfs in an already divided society where only some people will be able to afford to become enhanced while many other lose out.

The position is summed up by Whitby. "History is littered with the evil consequences of one group of humans believing they are superior to another group of humans," he said. "Unfortunately in the case of enhanced humans they will be genuinely superior. We need to think about the implications before it is too late."

For their part, transhumanists argue that the costs of enhancement will inevitably plummet and point to the example of the mobile phone, which was once so expensive only the very richest could afford one, but which today is a universal gadget owned by virtually every member of society. Such ubiquity will become a feature of technologies for augmenting men and women, advocates insist.

Many of these issues seem remote, but experts warn that the implications involved need to be debated as a matter of urgency. An example is provided by the artificial hand being developed by Newcastle University. Current prosthetic limbs are limited by their speed of response. But project leader Kianoush Nazarpour believes it will soon be possible to create bionic hands that can assess an object and instantly decide what kind of grip it should adopt.

"It will be of enormous benefit, but its use raises all sorts of issues. Who will own it: the wearer or the NHS? And if it is used to carry a crime, who ultimately will be responsible for its control? We are not thinking about these concerns and that is a worry."

The position is summed up by bioethicist professor Andy Miah of Salford University. "Transhumanism is valuable and interesting philosophically because it gets us to think differently about the range of things that humans might be able to do – but also because it gets us to think critically about some of those limitations that we think are there but can in fact be overcome," he says. "We are talking about the future of our species, after all."