- Human engineering

SPECIAL

IS THIS THE HUMAN OF TOMORROW?

HOW WIRES AND CIRCUITS ARE MINGLING WITH BLOOD VESSELS AND NERVES TO CHANGE THE COURSE OF HUMAN EVOLUTION

The world as we know it is on a one-way trajectory to a technological overhaul. With each year that passes, cybernetics and artificial intelligence are finding their way into every nook and cranny of society. Even the human body isn't exempt from this mechanical makeover: our smartphones have become an unintentional extension of our hands, while robotic limb enhancements and nanobot immunity are on the horizon. But why would we let this technology take over our physiology?

The most common reason is to replicate an ability that has been lost or was missing at birth. Prosthetics are the best example of this, helping people regain motor functionality and movement. Since the early 1800s, engineers have created mechanical devices to mimic the function of missing limbs or appendages. But today some of the most advanced prosthetics in the world can tap into the signals zipping around the body's nervous system, allowing the user to control their prosthetic limb by will alone. Many battery-powered prosthetics can use the electrical signals of existing muscles

WORDS SCOTT DUTFIELD

https://www.pressreader.com/uk/how-it-works/20250227/page/26 1/8

DID YOU KNOW? The world's first brain-controlled virtual-reality game, *Awakening*, was launched by Neurable in 2018



HeroWear's Apex 2 exoskeleton can help workers lift efficiently

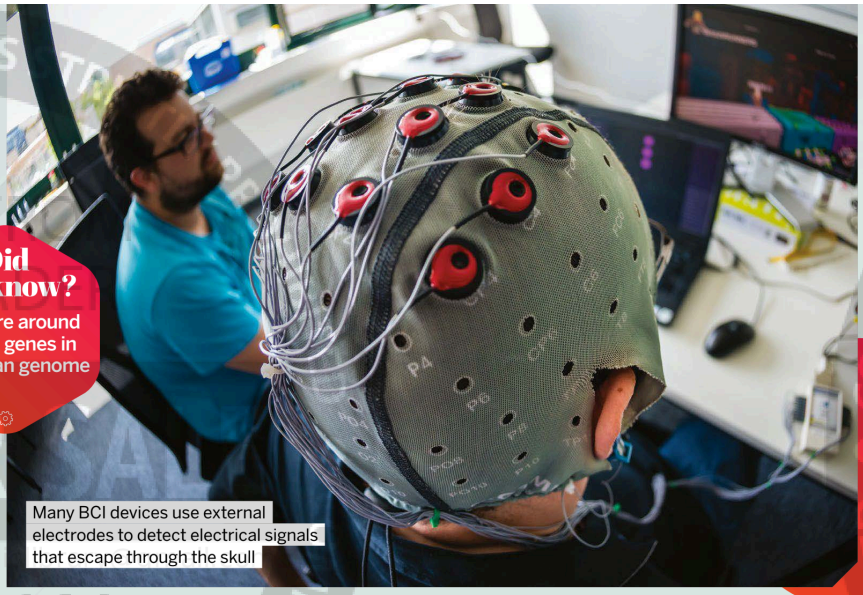
© AdobeStock / Getty / HeroWear

SPECIAL

to operate robotic fingers and arms. They're known as myoelectric prostheses, and they depend upon a series of electrodes in the socket of the device that make contact with the skin and muscle of the residual limb. When the wearer contracts the muscles involved in a certain action, such as grasping individual fingers, bending an elbow or rotating the wrist, the device can distinguish the electrical signal for each action and carry them out.

Then there's the possibility of human augmentation to give an individual enhanced, possibly superhuman abilities. For example, wearable devices called exoskeletons act as an external frame around the body to not only assist those with limited movement, but can also enhance the function of their limbs. With the use of motors and advanced machine learning, 'active' exoskeletons, such as the Apogee ULTRA by German Bionic, can increase our lifting potential. The Apogee ULTRA provides lifting support of up to 36 kilograms, as well as walking support, making walking six miles feel like five miles. 'Passive' exoskeletons like the HeroWear Apex 2 are designed to solve the same problems, but use a system of elastic bands and strings. They can reduce body fatigue while lifting and moving objects before returning to a standing position.

Did you know?
There are around 20,000 genes in the human genome



Many BCI devices use external electrodes to detect electrical signals that escape through the skull

Brain-computer interfaces (BCIs) are a new but rapidly advancing area in human augmentation. The technology reads your brain waves and passes this data to a computer. With the help of electrodes – which can either be spread out over the head or implanted in the brain itself – scientists can pick up on electrical energy emitted by the billions of neurons in the brain. Each signal can be interpreted as an action. For example, signals generated while thinking about moving a cursor on a screen can be identified and then actioned by the computer to move the cursor. This technology has been traditionally used to help those with debilitating diseases navigate the internet and even translate their thoughts into text to regain speech.

Companies such as Paradromics and Synchron are among those leading the way in BCI technology. Paradromics has created the Connexus Direct Data Interface (DDI) to help motor-impaired people regain their voice through computers. The Connexus DDI device uses hundreds of tiny 'microwires' that penetrate just over a millimetre into the brain's cortex to collect the strongest signal, and thus the most information possible.



German Bionics' Apogee ULTRA exoskeleton can help workers increase their lifting efficiency

THE FIRST 'CYBORG'

Since 2004, artist Neil Harbisson has been walking around with an unusual adornment on his head: an antenna. Born with an impairment that means he can't see colours, Harbisson still wanted to experience the full visual spectrum the world has to offer, and thanks to his cybernetic instalment, he can. At the tip of his antenna is a colour-detecting sensor that's connected to a computer chip attached to the back of his skull. The sensor detects different wavelengths of light, and the chip converts the information into unique vibrations. These vibrations then travel through his skull and are delivered to his eardrum to be heard as different sounds. Over the last two decades, Neil has learnt to distinguish the 'sound of colours' and differentiate between them.



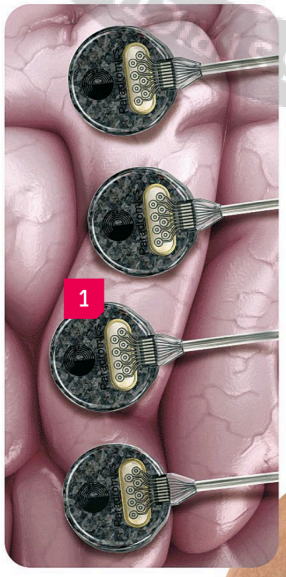
Harbisson spends every day of his life using an antenna to 'hear' colours

NOT FOR SALE

DID YOU KNOW? Neuralink was founded in 2016 by Musk and a team of eight scientists and engineers

READING MINDS

HOW THE CONNEXUS DIRECT DATA INTERFACE TAPS INTO BRAIN ACTIVITY TO REVEAL WHAT A PERSON IS THINKING



1 CORTICAL MODULE
The intercortical electrodes are made from platinum-iridium and are placed directly onto the brain to gather precise data on neural activity.



4 CASING
The device casing is made from ceramic and is hermetically sealed, or airtight.

3 MICROELECTRODES
Each of the four modules has 421 microelectrodes that are 1.5 millimetres long and thinner than a strand of human hair.

5 CONNECTING LEAD
Data from the implanted cortical modules is fed along a thin, flexible lead to the internal transmitter.

2 INTERNAL TRANSCEIVER
Data gathered by the electrodes is fed to an implanted internal transceiver, which can then be wirelessly transmitted to an external transceiver.

"The Connexus DDI device uses hundreds of tiny 'microwires'"

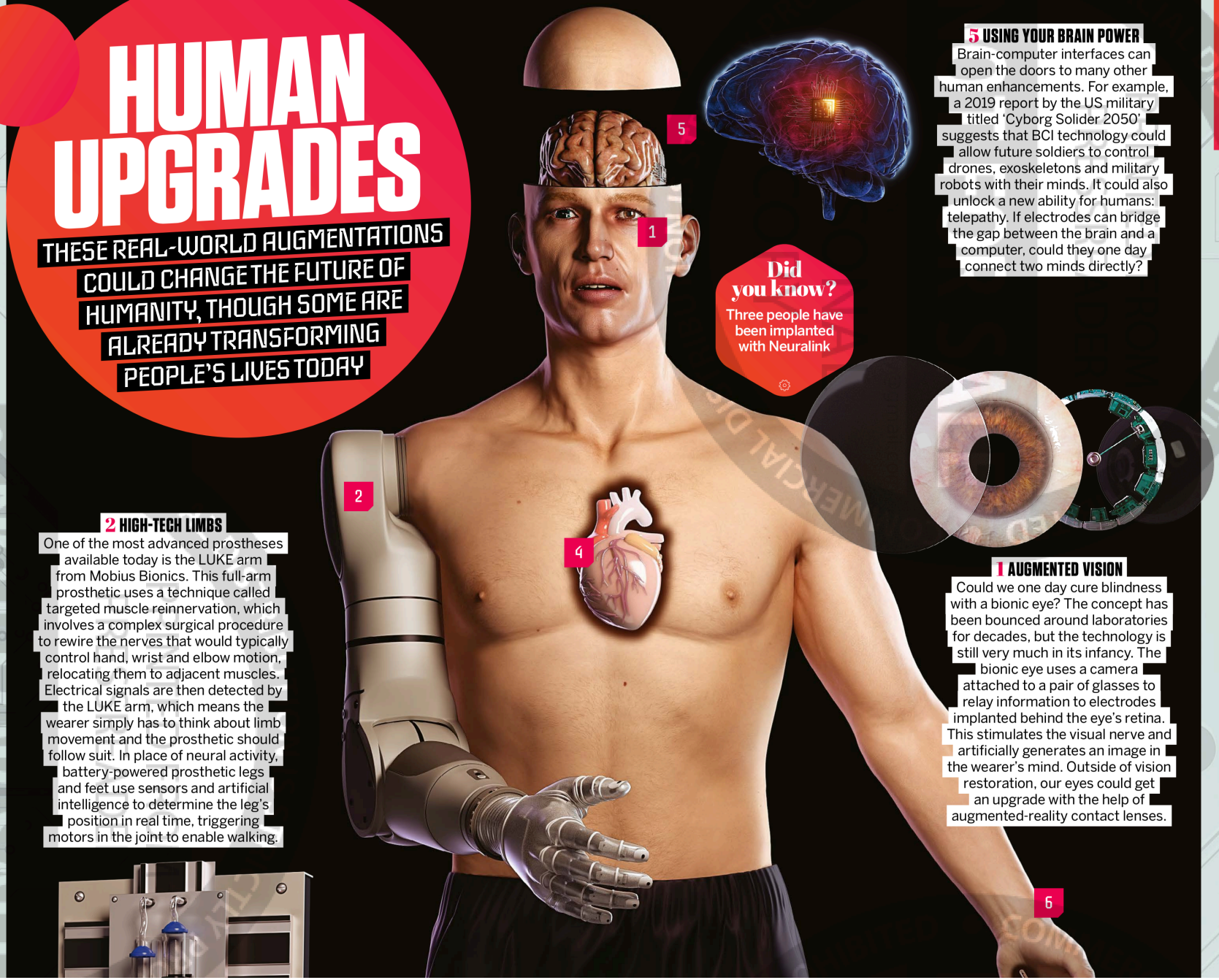
Did you know?
The term 'human augmentation' was coined in 1962

© Getty / German Bionic / Paradromics

PRINTED FROM PRESSREADER NOT FOR SALE COPYRIGHT COMMERCIAL DISTRIBUTION IS STRICTLY PROHIBITED

HUMAN UPGRADES

THESE REAL-WORLD AUGMENTATIONS COULD CHANGE THE FUTURE OF HUMANITY, THOUGH SOME ARE ALREADY TRANSFORMING PEOPLE'S LIVES TODAY



5 USING YOUR BRAIN POWER

Brain-computer interfaces can open the doors to many other human enhancements. For example, a 2019 report by the US military titled 'Cyborg Solider 2050' suggests that BCI technology could allow future soldiers to control drones, exoskeletons and military robots with their minds. It could also unlock a new ability for humans: telepathy. If electrodes can bridge the gap between the brain and a computer, could they one day connect two minds directly?

Did you know?

Three people have been implanted with Neuralink

2 HIGH-TECH LIMBS

One of the most advanced prostheses available today is the LUKE arm from Mobius Bionics. This full-arm prosthetic uses a technique called targeted muscle reinnervation, which involves a complex surgical procedure to rewire the nerves that would typically control hand, wrist and elbow motion, relocating them to adjacent muscles. Electrical signals are then detected by the LUKE arm, which means the wearer simply has to think about limb movement and the prosthetic should follow suit. In place of neural activity, battery-powered prosthetic legs and feet use sensors and artificial intelligence to determine the leg's position in real time, triggering motors in the joint to enable walking.

1 AUGMENTED VISION

Could we one day cure blindness with a bionic eye? The concept has been bounced around laboratories for decades, but the technology is still very much in its infancy. The bionic eye uses a camera attached to a pair of glasses to relay information to electrodes implanted behind the eye's retina. This stimulates the visual nerve and artificially generates an image in the wearer's mind. Outside of vision restoration, our eyes could get an upgrade with the help of augmented-reality contact lenses.

NOT FOR SALE

2/28/25, 9:30 AM

https://www.pressreader.com/uk/how-it-works/20250227/page/26

DID YOU KNOW? In 2024, surgeons successfully implanted the first 3D-printed windpipe

3 BLOODSTREAM BOOST

Nanotechnology might one day enhance our immune system in its fight against infection and deadly diseases by delivering medicine directly to specific organs or diseased cells like cancers. Blood could also get an efficiency update with the invention of respirocytes. These hypothetical nanodevices could mimic the function of red blood cells but carry much more oxygen than them. For decades, researchers have outlined how these devices might operate. However, there are many hurdles to overcome in their creation, including power supply and the body's immune response to artificial blood.

Neuralink hopes to implant up to 30 people with a BCI module in 2025

4 3D-PRINTED ORGANS

Around 150,000 organ transplants are performed worldwide each year, with thousands more people still on the waiting list. But what if instead of waiting for organ donation, we could just print a new one? Researchers across the world have been developing new technologies that could, in the not-so-distant future, make 3D-printed or bio-printed organs available. Using stem cells, which can transform into different cell types, some scientists have created a kind of biological ink that can be used to 'print' organs such as bladders and kidneys.

6 RFID

Would you trade your house key and credit card for a chip implant that can do the same job? Around 50,000 people worldwide have already done so. Using radio-frequency identification (RFID) and near-field communication (NFC) microchips implanted just underneath the skin, their hands double up as keycards and contactless payment devices that can pay for goods with just a wave. The size of a grain of rice, these devices can transmit personal and financial data to a reader automatically.

© Shutterstock / Illustration by Nicholas Forder

SPECIAL

The data is then wirelessly transmitted to action controls on a computer to access speech software. Meanwhile, Synchron has developed a BCI device called Stentrode, a similar solution to the Connexus DDI which instead of brain implants uses a mechanical stent electrode inserted into the brain's blood vessels to pick up neuron signals.

One of the most talked-about BCI technologies is the Neuralink N1, one of Elon Musk's many scientific endeavours. Like other BCIs, Neuralink is designed to translate a person's brain activity into digital actions. About the size of a pound coin, the device is implanted beneath the skull with an electrode that detects neural activity and interprets these as commands for a computer. It enables hands-free access to the internet and playing video games, but the scope of Neuralink may be limitless with the help of artificial intelligence (AI). Like having ChatGPT installed in your head, an AI-powered BCI implant could theoretically allow you to access online data just by thinking about it, giving you the answer to questions you've barely even thought about. Musk has hinted at the idea of humans one day merging with software, saying at the World Government Summit in Dubai in 2017: "Over time, I think we will probably see a closer merger of biological intelligence and digital intelligence."

"Neuralink may be limitless with the help of artificial intelligence"



Mark Clayton Daniel representing the US during the exoskeleton race at the 2016 CYBATHLON

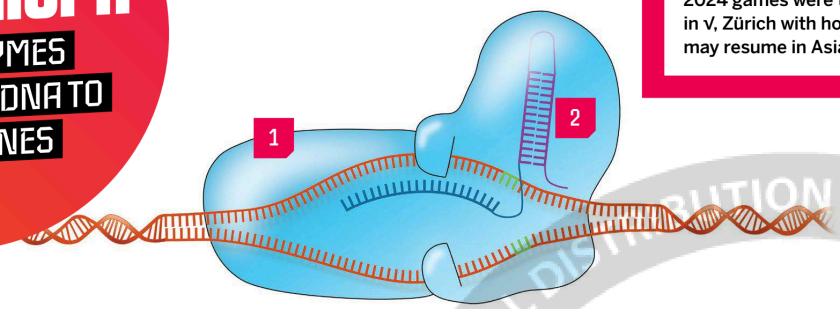
At present, the majority of BCI technology involves completing tasks on a computer screen. However, there have been some incredible advancements in recent years that marry the brain power of BCI with the dexterity of a prosthetic. In January 2025, a research project led by the University of Chicago showcased the possibility of a user feeling the object their prosthetic limb is holding. The BCI element of the technology placed electrodes on both sides of the head, with one half focused on areas of the brain responsible for the movement of the limb and the other on areas dedicated to the sense of touch.

THE CYBORG OLYMPICS

Since 2016, people from around the world have come together to compete in one of the most unique sporting events in history: the CYBATHLON. Founded at Swiss university ETH Zürich, the event showcases groundbreaking technology that enhances the lives of people with disabilities. There are lots of different races at this event, including the arm prosthesis race, exoskeleton race and assistance robot race. There's even a brain-computer interface race, where participants use their brain power to complete ten tasks such as piloting a wheelchair through a course or operating a virtual robotic arm. Last year's BCI race winner was Phillip Mckenzie, who completed all ten event tasks in just over two minutes. The 2024 games were the last to be held in v, Zürich with hope that the event may resume in Asia in 2028.

CUTTING WITH CRISPR

HOW ENZYMES OPERATE ON DNA TO ALTER GENES



1 CAS9
This enzyme is placed into a cell to cut through a double strand of DNA.

2 RNA
Ribonucleic acid (RNA), a molecule attached to Cas9, locates and binds to the portion that needs to be edited.

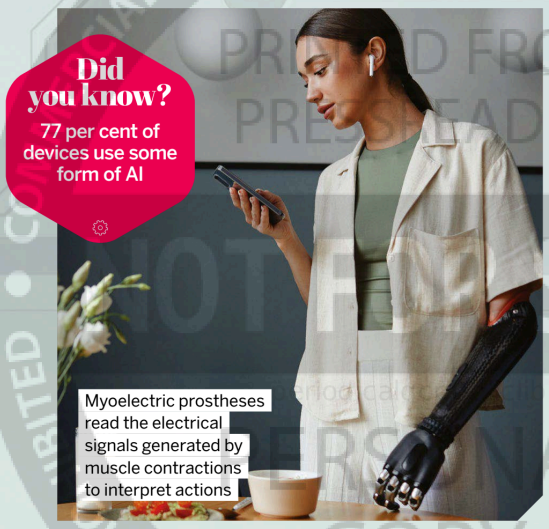


3 ENZYME CHOP
Cas9 cuts both strands of the DNA, leaving a gap in the strand behind.

4 NEW DNA
Scientists insert a new section of DNA into the cell, which will automatically fill the gap within the DNA strand.

PRINTED FROM PRESSREADER
COMMERCIAL DISTRIBUTION IS STRICTLY PROHIBITED
NOT FOR SALE

DID YOU KNOW? Around 100 million people worldwide have a prosthetic limb



Myoelectric prostheses read the electrical signals generated by muscle contractions to interpret actions

Feedback sensors were placed in the arm, triggering electrical pulses called 'intracortical microstimulation' that gave the sensation of touch to the brain-bound electrodes.

In the future, these human enhancements might even extend to our generic makeup. Currently, genetic engineering is mostly reserved for the production of food and medicine. Using a technique called CRISPR-Cas9, scientists are able to cut and paste desirable genes from one organism and insert them into the DNA of another. For example, corn can be genetically edited to produce its own pesticides or pineapple can be engineered to increase the production of lycopene, a red pigment that can turn the fruit pink. While humans aren't currently getting any genetic tailoring, it's not far from the realms of possibility.

One of the biggest issues with genetic editing of the human genome is overcoming the fact that editing or removing a single gene doesn't have a single consequence. But there's also a larger ethical issue at play. Do we have the right to edit the genes of an embryo? And would gene-editing embryos lead to cosmetic changes rather than medical ones? Currently, genetically altering human embryos is largely outlawed around the world. However, this hasn't stopped some scientists from trying.

In 2018, the science community was left stunned when a Chinese researcher named He Jiankui claimed to have altered the genomes of twin baby girls using CRISPR-Cas9. Despite being in violation of Chinese law, the researcher altered the twin embryos by removing a gene called CCR5, which has been associated with increased risk of contracting HIV, in the hope it would help prevent the twins from contracting the disease in the future. In 2024, Jiankui told the Japanese newspaper *The Mainichi* that the twins "are perfectly healthy and have no problems with their growth".

THE FUTURE OF HUMAN AUGMENTATION

DR DAVID CHENELER, SENIOR LECTURER IN ENGINEERING AT THE UNIVERSITY OF LANCASTER, SHEDS SOME LIGHT ON HOW AUGMENTATION MIGHT ALLOW US TO LEARN MORE ABOUT OURSELVES



Could implanted devices monitor the health of different organs?

Absolutely. Some of the stuff I'm working on are sensors for personalised health monitoring, but drug release as well. This will be a system that's implanted and releases drugs on command. You can currently get drugs that are implanted in the skin that slowly release the drug over time as they dissolve in the blood. But we can also have more active systems that can release drugs when necessary. This could be controlled by an external device. It could be controlled as a closed-loop system, as in it could be the sensors themselves responding and therefore could be fully automated. Imagine a scenario whereby the sensors are monitoring health signals, and these signals go up to a doctor or a care provider. They could trigger a response as a result.

How long might it be before this type of technology starts to emerge in hospitals?

It depends. In a scenario similar to that of an insulin pump where somebody wears the sensor, that already exists. But extensions of that paradigm, such as sensors that monitor osteoarthritis over time, are more like ten years or so. The technologies aren't quite there.

How would this technology extend to healthy individuals?

The classic thing will be training athletes – certainly with joint health and muscle health. So things like gait analysis could very much be combined with the sort of data they're getting now. For example, a runner would quite often have a smartwatch that monitors pace, GPS and slopes, that sort of thing. If you can combine that with your gait analysis and also joint health, you can see if you are doing damage to your knees because you're running up hills wrong, that sort of thing. You can change your stance or change your habits.

Could the technology be used in other industries, such as in the military?

Obviously I can't talk too much about specifics, but you can imagine the military are very much concerned about their personnel's health. Again, it's probably more for planning purposes, because if your army is becoming fatigued, injured or under attack, finding out what's going on remotely is of critical importance. Real-time data and the ability to do real-time and obviously predictive interventions is far better. Imagine a complex battlefield scenario where there could be a range of injuries with potentially limited medical personnel nearby. Being able to triage remotely could be quite significant.

© Getty / Alamy / David Cheneler

PRINTED FROM PRESSREADER NOT FOR SALE