



# Clinical enhancement

Enhanced functionality will shift from an external add-on to an integrated capability to provide the option for superhuman performance.

A potentially controversial topic raised when looking at the future relates to the advances being made in replacement organs and limbs. Different people have varied perspectives on where this is going and what the mass impacts will be. Some point to the high-tech developments that have taken place in prosthetics over the past few years, which have allowed people to regain near full limb movement. Some take this further in a military context and mix in the topic of exoskeletons as a possible option for enhanced battlefield performance. Then there are also developments like those at UCLA where digital cameras have been hardwired into the back of the retina of visually impaired patients to provide first black and white and now colour image recognition. In the world of cosmetic surgery, some experts are talking about sight and hearing enhancement being offered in key clinics within the next decade. If we can replace vital organs and limbs, why can't performance be tweaked to a higher standard with embedded technologies? Higher frequency ranges of hearing and infra-red vision are often mentioned in this context. While this may sound like science fiction to some, a number of recent developments are bringing enhanced performance closer to the market than you might think.

For some context in looking at how quickly the world of clinical enhancement is changing, it is worth considering the massive growth that has taken place in cosmetic surgery over recent years. In the US

alone, the number of cosmetic treatments has more than doubled in the past decade to reach over 11 million a year. In terms of surgical operations, around half a million breast augmentations and liposuction operations and over 200,000 tummy tucks are undertaken each year. In non-surgical treatments, Botox accounts for nearly 3 million a year and well over 1 million laser hair removal and hyaluronic acid procedures are carried out. In total in 2008, Americans spent almost \$12 billion on cosmetic procedures and, interestingly, men accounted for nearly one in ten of these. Globally, particularly as China's increasing appetite for enhancement grows, it is estimated that the cosmetic surgery industry could be worth over \$200 billion a year by 2020. It's hardly surprising, therefore, that many countries have been setting themselves up as centres of excellence – from Switzerland to Brazil to South Africa – and the expectation is that frequent cosmetic changes to the body will become commonplace as more people search for physical perfection.

The desire for the 'ultimate look' is being replicated by a similar ambition for 'ultimate ability' as people seek to improve their physical and mental performance. In sport, the use of drugs to enhance performance is a long-standing problem that, despite all the bad publicity and shame that comes from being caught out, is still a big issue in almost all disciplines from cycling and weightlifting to running and football. Outside the professional sports arena and into

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the world of body-building, the use of steroids to enhance muscle structure has long been widespread. In parallel with this there is also momentum building around drugs that can provide improved mental performance. New lifestyle drugs and the wider use of cogniceuticals are giving us the ability to manage the 'highs and lows'. Not only can individuals control their emotions and senses with pharmaceutical products but they can also get by with less sleep.

At the start of the Future Agenda programme in 2009, an article in *Scientific American* on 'turbo-charging the brain' provided a good overview of some of the drugs that have been designed for one purpose and have proven to demonstrate cognitive enhancement as a side effect. Methylphenidate, amphetamines, modafinil and donepezil were all cited as medicines that have been approved for neurological disorders but also 'have the potential to improve mental functioning in unimpaired people'. The article also suggested that some drugs that are being developed to address and limit Alzheimer's and Parkinson's, and counteract dementia and ADHD (attention-deficit hyperactivity disorder), might be used by healthy people to enhance their cognitive performance. Although students, the military and older people who don't suffer from dementia are the primary markets, the potential for mass enhancement of capability when it is needed is just around the corner. How far this will go is a key question but several companies such as Helicon Therapeutics and Cephalon are already nudging the enhanced performance agenda forward.

Interestingly, significant advances are taking place in the military arena that may soon scale up to the commercial world. Starting with the improvements achieved in areas such as prosthetics as a consequence of injuries sustained in Iraq and Afghanistan, the US military in particular has been trying not only to repair the damage but also to go several steps further towards achieving 'superhuman' performance. DARPA (the US Defence Advanced Research Projects Agency) has been making significant investment in the area of exoskeletons and has already invested in the development of an exoskeleton suit for ground troops. This wearable robotic system could give soldiers the ability to run faster, carry heavier weapons and leap over large obstacles. Within the next few years, exoskeletal systems are expected to give soldiers augmented strength and speed as well as increased endurance; and they will also have built-in computers to help troops navigate through foreign terrains.

On top of this, enhanced sight and hearing is also advancing quickly. Building on some of the pioneering work undertaken in the past decade at institutions such as UCLA (which has been hard-wiring digital cameras to retinas to restore sight in blind people), the same technologies are now being applied physically and virtually on the battlefield. Under such programmes as 'Future Soldier 2030', the US Army is investing heavily in making the idea of the soldier as a system a reality. Alongside such advances as

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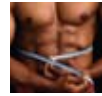
neural prosthetics and embedding magnets in finger tips to enhance sensing, one fast-developing area is that of providing augmented reality vision and data. Integrating many of the established data projection techniques used in fighter planes, information related to where the eye is looking is increasingly being provided to pilots and soldiers. Whether this will be navigational, environmental, 'friend or foe' identification or just layered contextual information on buildings and landmarks, through glasses and active contact lenses or more embedded linkages, what you see could be enhanced both in terms of data and also in terms of the visible spectrum as infra-red sight becomes an added function.

It is clear that an increasing number of people see that the next decade will be one where more and more of us seek to take the option of improving our normal human performance. The symbol H+ is used by some futurists to denote an enhanced version of humanity and for an increasing proportion of the population this is fast becoming a reality. By 2020, permanent rather than just a temporary change of

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capability from drugs, doping, implants or surgery will be available. Experts predict that, led by the advances taking place in the military, wearable robotics will become increasingly embedded in humans and providing this to the mainstream will become part of everyday cosmetic surgery.

The ethical debate surrounding mass enhancement capability is still wide open and, as yet, it is unclear how the regulatory bodies might respond. However, those with the will and the resources will certainly have access to clinical enhancement, created for restorative surgery and then applied to the commercial mainstream. The world of the 'Bionic man' is (finally) not so far away.



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