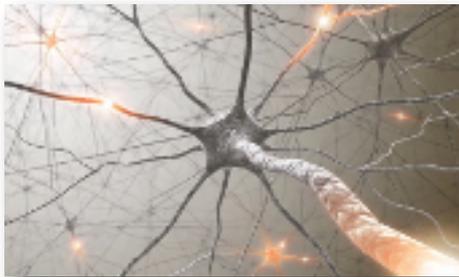


'Your animal life is over. Machine life has begun.' The road to immortality

In California, radical scientists and billionaire backers think the technology to extend life – by uploading minds to exist separately from the body – is only a few years away



Head in the cloud: could our neural networks soon be running via a computer program?
Photograph: Alamy

Here's what happens. You are lying on an operating table, fully conscious, but rendered otherwise insensible, otherwise incapable of movement. A humanoid machine appears at your side, bowing to its task with ceremonial formality. With a brisk sequence of motions, the machine removes a large panel of bone from the rear of your cranium, before carefully laying its fingers, fine and delicate as a spider's legs, on the viscid surface of your brain. You may be experiencing some misgivings about the procedure at this point. Put them aside, if you can.

You're in pretty deep with this thing; there's no backing out now. With their high-resolution microscopic receptors, the machine fingers scan the chemical structure of your brain, transferring the data to a powerful computer on the other side of the operating table. They are sinking further into your cerebral matter now, these fingers, scanning deeper and deeper layers of neurons, building a three-dimensional map of their endlessly complex interrelations, all the while creating code to model this activity in the computer's hardware. As the work proceeds, another mechanical appendage – less delicate, less careful – removes the scanned material to a biological waste container for later disposal. This is material you will no longer be needing.

At some point, you become aware that you are no longer present in your body. You observe – with sadness, or horror, or detached curiosity – the diminishing spasms of that body on the operating table, the last useless convulsions of a discontinued meat.

The animal life is over now. The machine life has begun.

This, more or less, is the scenario outlined by Hans Moravec, a professor of cognitive robotics at Carnegie Mellon, in his 1988 book *Mind Children: The Future of Robot and Human Intelligence*. It is Moravec's conviction that the future of the human species will involve a mass-scale desertion of our biological bodies, effected by procedures of this kind. It's a belief shared by many *trans-humanists*, a movement whose aim is to improve our bodies and minds to the point where we become something other and better than the animals we are. Ray Kurzweil, for one, is a prominent advocate of the idea of mind-uploading.

*“An emulation of the human brain running on an electronic system,” he writes in *The Singularity Is Near*, “would run much faster than our biological brains. Although human brains benefit from massive parallelism (on the order of 100 trillion interneuronal connections, all potentially operating simultaneously), the rest time of the connections is extremely slow compared to contemporary electronics.”*

The technologies required for such an emulation – sufficiently powerful and capacious computers and sufficiently advanced brain-scanning techniques – will be available, he announces, by the early 2030s.

And this, obviously, is no small claim. We are talking about not just radically extended life spans, but also radically expanded cognitive abilities. We are talking about endless copies and iterations of the self. Having undergone a procedure like this, you would exist – to the extent you could meaningfully be said to exist at all – as an entity of unbounded possibilities.

I was introduced to Randal Koene at a Bay Area trans-humanist conference. He wasn't speaking at the conference, but had come along out of personal interest. A cheerfully reserved man in his early 40s, he spoke in the punctilious staccato of a non-native English speaker who had long mastered the language. As we parted, he handed me his business card and much later that evening I removed it from my wallet and had a proper look at it. The card was illustrated with a picture of a laptop, on whose screen was displayed a stylised image of a brain. Underneath was printed what seemed to me an attractively mysterious message: *“Carboncopies: Realistic Routes to Substrate Independent Minds. Randal A Koene, founder.”*

I took out my laptop and went to [the website of Carboncopies](#), which I learned was a

“nonprofit organisation with a goal of advancing the reverse engineering of neural tissue and complete brains, Whole Brain Emulation and development of neuro-prostheses that reproduce functions of mind, creating what we call Substrate Independent Minds”.

This latter term, I read, was the

“objective to be able to sustain person-specific functions of mind and experience in many different operational substrates besides the biological brain”. And this, I further learned, was a process “analogous to that by which platform independent code can be compiled and run on many different computing platforms”.

It seemed that I had met, without realising it, a person who was actively working toward the kind of brain-uploading scenario that Kurzweil had outlined in *The Singularity Is Near*. And this was a person I needed to get to know.



Randal Koene: *‘It wasn't like I was walking into labs, telling people I wanted to upload human minds to computers.’*

Koene was an affable and precisely eloquent man and his conversation was unusually engaging for someone so forbiddingly intelligent and who worked in so rarefied a field as computational neuroscience; so, in his company, I often found myself momentarily forgetting about the nearly unthinkable implications of the work he was doing, the profound metaphysical weirdness of the things he was explaining to me. He'd be talking about some tangential topic – his happily cordial

relationship with his ex-wife, say, or the cultural differences between European and American scientific communities – and I'd remember with a slow, uncanny suffusion of unease that his work, were it to yield the kind of results he is aiming for, would amount to the most significant event since the evolution of *Homo sapiens*. The odds seemed pretty long from where I was standing, but then again, I reminded myself, the history of science was in many ways an almanac of highly unlikely victories.

One evening in early spring, Koene drove down to San Francisco from the North Bay, where he lived and worked in a rented ranch house surrounded by rabbits, to meet me for dinner in a small Argentinian restaurant on Columbus Avenue. The faint trace of an accent turned out to be Dutch. Koene was born in Groningen and had spent most of his early childhood in Haarlem. His father was a particle physicist and there were frequent moves, including a two-year stint in Winnipeg, as he followed his work from one experimental nuclear facility to the next.

Now a boyish 43, he had lived in California only for the past five years, but had come to think of it as home, or the closest thing to home he'd encountered in the course of a nomadic life. And much of this had to do with the culture of techno-progressivism that had spread outward from its concentrated origins in Silicon Valley and come to encompass the entire Bay Area, with its historically high turnover of radical ideas. It had been a while now, he said, since he'd described his work to someone, only for them to react as though he were making a misjudged joke or simply to walk off mid-conversation.

In his early teens, Koene began to conceive of the major problem with the human brain in computational terms: it was not, like a computer, readable and rewritable. You couldn't get in there and enhance it, make it run more efficiently, like you could with lines of code. You couldn't just speed up a neuron like you could with a computer processor.

Around this time, he read Arthur C Clarke's *The City and the Stars*, a novel set a billion years from now, in which the enclosed city of *Diaspar* is ruled by a super-intelligent Central Computer, which creates bodies for the city's post-human citizens and stores their minds in its memory banks at the end of their lives, for purposes of reincarnation. Koene saw nothing in this idea of reducing human beings to data that seemed to him implausible and felt nothing in himself that prevented him from working to bring it about. His parents encouraged him in this peculiar interest and the scientific prospect of preserving human minds in hardware became a regular topic of dinnertime conversation.

Computational neuroscience, which drew its practitioners not from biology but from the fields of mathematics and physics, seemed to offer the most promising approach to the problem of mapping and uploading the mind. It wasn't until he began using the internet in the mid-1990s, though, that he discovered a loose community of people with an interest in the same area.

As a PhD student in computational neuroscience at Montreal's *McGill University*, Koene was initially cautious about revealing the underlying motivation for his studies, for fear of being taken for a fantasist or an eccentric.

"I didn't hide it, as such," he said, "but it wasn't like I was walking into labs, telling people I wanted to upload human minds to computers either. I'd work with people on some related area, like the encoding of memory, with a view to figuring out how that might fit into an overall road map for whole brain emulation."

Having worked for a while at *Halcyon Molecular*, a Silicon Valley gene-sequencing and nanotechnology startup funded by Peter Thiel, he decided to stay in the Bay Area and start his own nonprofit company aimed at advancing the cause to which he'd long been dedicated: *carboncopies*

Koene's decision was rooted in the very reason he began pursuing that work in the first place: an anxious awareness of the small and diminishing store of days that remained to him. If he'd gone the university route, he'd have had to devote most of his time, at least until securing tenure, to projects that were at best tangentially relevant to his central enterprise. The path he had chosen was a difficult one for a scientist and he lived and worked from one small infusion of private funding to the next.

But Silicon Valley's culture of radical techno-optimism had been its own sustaining force for him, and a source of financial backing for a project that took its place within the wildly aspirational ethic of that cultural context. There were people there or thereabouts, wealthy and influential, for whom a future in which human minds might be uploaded to computers was one to be actively sought, a problem to be solved, disruptively innovated, by the application of money.



Brainchild of the movies: in *Transcendence* (2014), scientist Will Caster, played by Johnny Depp, uploads his mind to a computer program – with dangerous results.

One such person was Dmitry Itskov, a 36-year-old Russian tech multimillionaire and founder of the **2045 Initiative**, an organisation whose stated aim was

“to create technologies enabling the transfer of an individual's personality to a more advanced nonbiological carrier, and extending life, including to the point of immortality”.

One of Itskov's projects was the creation of “avatars” – artificial humanoid bodies that would be controlled through brain-computer interface, technologies that would be complementary with uploaded minds. He had funded Koene's work with *Carboncopies* and in 2013 they organised a conference in New York called **Global Futures 2045**, aimed, according to its promotional blurb, at the “discussion of a new evolutionary strategy for humanity”.

When we spoke, Koene was working with another tech entrepreneur named Bryan Johnson, who had sold his automated payment company to *PayPal* a couple of years back for \$800m and who now controlled a venture capital concern called the **OS Fund**, which, I learned from its website,

“invests in entrepreneurs working towards quantum leap discoveries that promise to rewrite the operating systems of life”.

This language struck me as strange and unsettling in a way that revealed something crucial about the attitude toward human experience that was spreading outward from its Bay Area centre – a cluster of software metaphors that had metastasised into a way of thinking about what it meant to be a human being.

And it was the same essential metaphor that lay at the heart of Koene's project: the mind as a piece of software, an application running on the platform of flesh. When he used the term “emulation”, he was using it explicitly to evoke the sense in which a PC's operating system could be emulated on a Mac, as what he called “platform independent code”.

The relevant science for whole brain emulation is, as you'd expect, hideously complicated, and its interpretation deeply ambiguous, but if I can risk a gross oversimplification here, I will say that it is possible to conceive of the idea as something like this: first, you scan the pertinent information in a person's brain – the neurons, the endlessly ramifying connections between them, the information-

processing activity of which consciousness is seen as a byproduct – through whatever technology, or combination of technologies, becomes feasible first (nanobots, electron microscopy, etc). That scan then becomes a blueprint for the reconstruction of the subject brain's neural networks, which is then converted into a computational model. Finally, you emulate all of this on a third-party non-flesh-based substrate: some kind of supercomputer or a humanoid machine designed to reproduce and extend the experience of embodiment – something, perhaps, like *Natasha Vita-More's Primo Posthuman*.

The whole point of substrate independence, as Koene pointed out to me whenever I asked him what it would be like to exist outside of a human body, – and I asked him many times, in various ways – was that it would be like no one thing, because there would be no one substrate, no one medium of being. This was the concept transhumanists referred to as “*morphological freedom*” – the liberty to take any bodily form technology permits.

“You can be anything you like,” as an article about uploading in Extropy magazine put it in the mid-90s. “You can be big or small; you can be lighter than air and fly; you can teleport and walk through walls. You can be a lion or an antelope, a frog or a fly, a tree, a pool, the coat of paint on a ceiling.”

What really interested me about this idea was not how strange and far-fetched it seemed (though it ticked those boxes resolutely enough), but rather how fundamentally identifiable it was, how universal. When talking to Koene, I was mostly trying to get to grips with the feasibility of the project and with what it was he envisioned as a desirable outcome. But then we would part company – I would hang up the call, or I would take my leave and start walking toward the nearest station – and I would find myself feeling strangely affected by the whole project, strangely moved.

Because there was something, in the end, paradoxically and definitively human in this desire for liberation from human form. I found myself thinking often of WB Yeats's *Sailing to Byzantium*, in which the ageing poet writes of his burning to be free of the weakening body, the sickening heart – to abandon the “*dying animal*” for the manmade and immortal form of a mechanical bird.

“Once out of nature,” he writes, “I shall never take/ My bodily form from any natural thing/ But such a form as Grecian goldsmiths make.”

One evening, we were sitting outside a combination bar/laundromat/standup comedy venue in Folsom Street – a place with the fortuitous name of *BrainWash* – when I confessed that the idea of having my mind uploaded to some technological substrate was deeply unappealing to me, horrifying even. The effects of technology on my life, even now, were something about which I was profoundly ambivalent; for all I had gained in convenience and “*connectedness*”, I was increasingly aware of the extent to which my movements in the world were mediated and circumscribed by corporations whose only real interest was in reducing the lives of human beings to data, as a means to further reducing us to profit.

The “content” we consumed, the people with whom we had romantic encounters, the news we read about the outside world: all these movements were coming increasingly under the influence of unseen algorithms, the creations of these corporations, whose complicity with government, moreover, had come to seem like the great submerged narrative of our time. Given the world we were living in, where the fragile liberal ideal of the autonomous self was already receding like a half-remembered dream into the doubtful haze of history, wouldn't a radical fusion of ourselves with technology amount, in the end, to a final capitulation of the very idea of personhood?

Koene nodded again and took a sip of his beer.

"Hearing you say that," he said, "makes it clear that there's a major hurdle there for people. I'm more comfortable than you are with the idea, but that's because I've been exposed to it for so long that I've just got used to it."



Russian billionaire Dmitry Itskov wants to 'create technologies enabling the transfer of an individual's personality to a more advanced nonbiological carrier'. Photograph: Mary Altaffer/AP

In the weeks and months after I returned from San Francisco, I thought obsessively about the idea of whole brain emulation. One morning, I was at home in Dublin, suffering from both a head cold and a hangover. I lay there, idly considering hauling myself out of bed to join my wife and my son, who were in his bedroom next door enjoying a raucous game of Buckaroo. I realised that these conditions (head cold, hangover) had imposed upon me a regime of mild bodily estrangement. As often happens when I'm feeling under the weather, I had a sense of myself as an irreducibly biological thing, an assemblage of flesh and blood and gristle. I felt myself to be an organism with blocked nasal passages, a bacteria-ravaged throat, a sorrowful ache deep within its skull, its cephalon. I was aware of my substrate, in short, because my substrate felt like shit.

And I was gripped by a sudden curiosity as to what, precisely, that substrate consisted of, as to what I myself happened, technically speaking, to be. I reached across for the phone on my nightstand and entered into Google the words "What is the human..." The first three autocomplete suggestions offered "What is The Human Centipede about", and then: "What is the human body made of", and then: "What is the human condition".

It was the second question I wanted answered at this particular time, as perhaps a back door into the third. It turned out that I was 65% oxygen, which is to say that I was mostly air, mostly nothing. After that, I was composed of diminishing quantities of carbon and hydrogen, of calcium and sulphur and chlorine, and so on down the elemental table. I was also mildly surprised to learn that, like the *iPhone* I was extracting this information from, I also contained trace elements of copper and iron and silicon.

What a piece of work is a man, I thought, what a quintessence of dust.

Some minutes later, my wife entered the bedroom on her hands and knees, our son on her back, gripping the collar of her shirt tight in his little fists. She was making clip-clop noises as she crawled forward, he was laughing giddily and shouting:

"Don't buck! Don't buck!"

With a loud neighing sound, she arched her back and sent him tumbling gently into a row of shoes by the wall and he screamed in delighted outrage, before climbing up again.

None of this, I felt, could be rendered in code. None of this, I felt, could be run on any other substrate.

Their beauty was bodily, in the most profound sense, in the saddest and most wonderful sense.

I never loved my wife and our little boy more, I realised, than when I thought of them as mammals. I dragged myself, my animal body, out of bed to join them.

► *To Be a Machine* by Mark O'Connell is published by Granta (£12.99). To order a copy for £11.04 go to bookshop.theguardian.com or call 0330 333 6846. Free UK p&p over £10, online orders only. Phone orders min p&p of £1.99

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