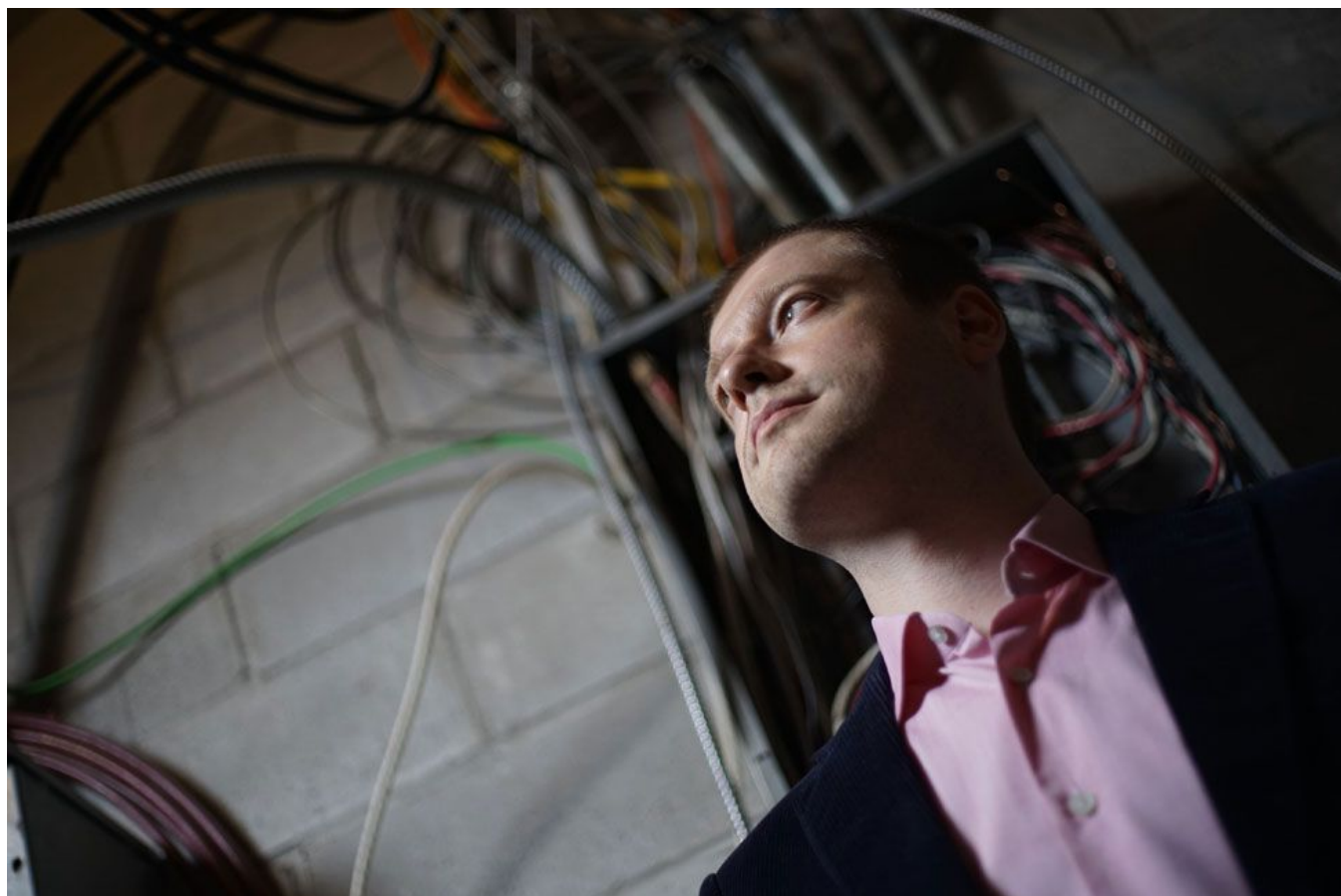


The immortalist: Uploading the mind to a computer



While many tech moguls dream of changing the way we live with new smart devices or social media apps, one Russian internet millionaire is trying to change nothing less than our destiny, by making it possible to upload a human brain to a computer, reports Tristan Quinn.

"Within the next 30 years," promises Dmitry Itskov, "I am going to make sure that we can all live forever."

It sounds preposterous, but there is no doubting the seriousness of this softly spoken 35-year-old, who says he left the business world to devote himself to something more useful to humanity. "I'm 100% confident it will happen. Otherwise I wouldn't have started it," he says.

It is a breathtaking ambition, but could it actually be done? Itskov doesn't have too much time to find out.

"If there is no immortality technology, I'll be dead in the next 35 years," he laments. Death is inevitable - currently at least - because as we get older the cells that make up our bodies lose their ability to repair themselves, making us vulnerable to

cardiovascular disease and other age-related conditions that kill about two-thirds of us.

So Itskov is putting a slice of his fortune in to a bold plan he has devised to bypass ageing. He wants to use cutting-edge science to unlock the secrets of the human brain and then upload an individual's mind to a computer, freeing them from the biological constraints of the body.

All of the evidence seems to say in theory it's possible - it's extremely difficult, but it's possible

Randal Koene, 2045 Initiative scientific director

"The ultimate goal of my plan is to transfer someone's personality into a completely new body," he says.

Itskov's interest in making the impossible possible began as a child in the Soviet Union in the 1980s. "My biggest dream was to be a cosmonaut, to fly in to outer space," he says. One science fiction novel made a lasting impression: "The hero took some immortality pill and he ended up flying the orbit of Earth. I remember myself questioning what I was going to do if I'm immortal."

But does his plan to allow us all to upload our minds to computers amount to anything more than sci-fi? The scientific director of Itskov's 2045 Initiative, Dr Randal Koene - a neuroscientist who worked as a research professor at Boston University's Center for Memory and Brain - laughs off any suggestion Itskov might have lost touch with reality.



"All of the evidence seems to say in theory it's possible - it's extremely difficult, but it's possible," he says. "So then you could say someone like that is visionary, but not *mad* because that implies you're thinking of something that's just impossible, and that's not the case."

The theoretical possibility Randal refers to is rooted in questions about how our brains work that neuroscience has yet to answer. Our brains are made up of about 86 billion neurons, connected cells that send information to each other by firing electrical charges that propagate through this organ in our skulls like waves.

But exactly how the brain generates our mind is a mystery like no other in science, according to the neurobiologist Prof Rafael Yuste of Columbia University. "The challenge is precisely how to go from a physical substrate of cells that are connected inside this organ, to our mental world, our thoughts, our memories, our feelings," he says.

Find out more

Horizon: The Immortalist, produced and directed by Tristan Quinn, will be shown on BBC 2 at 20:00 on Wednesday 16 March 2016 - viewers in the UK can catch up later [on the BBC iPlayer](#)

To try to unlock its workings, many neuroscientists approach the brain as if it were a computer. In this analogy the brain turns inputs, sensory data, into outputs, our behaviour, through computations. This is where the theoretical argument for mind uploading starts. If this process could be mapped, the brain could perhaps be copied in a computer, along with the individual mind it gives rise to.

That's the view of Dr Ken Hayworth, a neuroscientist who maps slivers of mouse brain at the Janelia Research Campus in Virginia by day, and by night grapples with the problem of how to upload his mind. Ken believes mapping the connectome - the complex connections of all the neurons in a brain - holds the key, because he believes it encodes all the information that makes us who we are, though this is not proven. "In the same sense that my computer is really just the ones and zeros on my hard drive, and I don't care what happens as long as those ones and zeros make it to the next computer it should be the same thing with me," he says, "I don't care if my connectome is implemented in this physical body or a computer simulation controlling a robotic body."

But Ken is a realist. "We are pitifully far away from mapping a human connectome," he acknowledges. "To put it in perspective, to image a whole fly brain it is going to take us approximately one to two years. The idea of mapping a whole human brain with the existing technology that we have today is simply impossible." And there's another theoretical challenge. Even if we could create the wiring diagram of a human brain, mind uploading would also most likely require reading the constant activity of all its neurons too.

Here Itskov might get some unexpected help, according to Yuste - who helped bring about the world's biggest neuroscience research project, the Brain Initiative. As part of this \$6bn American programme aimed at solving the mysteries of brain disorders like Alzheimer's, he is hoping to map the continual interaction of neurons - the patterns of firing - in the brain over time, "We want to measure every spike from all the neurons at once simultaneously. Many people said it's just impossible."

It is an approach that does not rely on mapping the connectome first. In research yet to be published, Yuste has for the first time imaged over time the hypnotic electrical flashes that make up the activity of nearly all the neurons - up to several thousand - in one of the simplest nervous systems in evolution, a tiny invertebrate called a hydra. "It was very exciting," he says. But "today we just cannot tell you what these patterns mean. So it's a bit like listening in on a conversation in a foreign language that you don't understand."

Within 15 years Yuste hopes to map - and interpret - the activity of all the neurons in a mouse cortex. But the ultimate aim is to read the activity of the human brain.

"If the brain were a digital computer, if you wanted to upload the mind you need to be able to decipher it or download it first. So I think the Brain Initiative is a step that is necessary for this uploading to happen."

But Itskov is far from home and dry. At Duke University, one leading neuroscientist argues that the brain's dynamic complexity - from which the human condition emerges - cannot be replicated. "You cannot code intuition; you cannot code aesthetic beauty; you cannot code love or hate," says Dr Miguel Nicolelis, who is developing a mind-controlled exoskeleton aimed at helping the paralysed walk. "There is no way you will ever see a human brain reduced to a digital medium. It's simply impossible to reduce that complexity to the kind of algorithmic process that you will have to have to do that."

Yuste is also very far from certain the brain works like a computer and could ever be copied in a machine. But because neuroscience cannot yet explain how exactly the brain gives rise to us and prove that mind uploading is impossible, he believes society should start considering what the consequences might be if Itskov succeeded in his ambition.

For the next few centuries I envision having multiple bodies... my consciousness just moving from one to another

Dmitry Itskov, Founder of 2045 Initiative

"The pathway that leads with the new neural technologies to our understanding of the

brain is the same pathway that could lead, theoretically, to the possibility of mind uploading," says Yuste. "Scientists that are involved in these methods have the responsibility to think ahead."

Mind uploading would usher in a world fraught with risks.

"If you could replicate the mind and upload it into a different material, you can in principle clone minds," says Yuste. "These are complicated issues because they deal with the core of defining what is a person."

Itskov is more sanguine: "I will answer you to the question of ethics by the opinion which was given to me by his holiness the Dalai Llama when I visited him in 2013. His point was that you can do everything if your motivation is to help people."

But this assurance is not enough for Yuste, who sits on the Brain Initiative's ethics panel: "I would put mind uploading in the list of the topics that should be very carefully discussed and thought through."

Itskov is already planning his endless life. "For the next few centuries I envision having multiple bodies, one somewhere in space, another hologram-like, my consciousness just moving from one to another."

It is estimated that 107 billion people have died before us. As our understanding of the brain advances in the decades ahead it will become clear whether Itskov is really the momentous visionary he claims to be, or merely the latest dreamer of impossible dreams.

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