Noah Hutton ([00:00:38](https://www.rev.com/transcript-editor/Edit?token=pxzGxDE1WDyohKInS05UnS0TmHon0Tq5j9LDuIhjj6JZrshdptYcWzztsByQe7BVFfeAJ3hFDxXEraZEqfw8QlQ397w&loadFrom=DocumentDeeplink&ts=38.33)):

A leading theory places the origin of life on Earth here, deep beneath the sea, billions of years ago inside towers of rock. These towers allowed water heated by volcanic activity below the sea floor to flow up to the cooler ocean above. A system of equilibrium and balance. But like everything in nature, this was not a perfectly efficient system. Mistakes happened all the time inside the tower. Things got stuck, things accumulated, pressures built up. And then deep within the tower's narrow rock tubes tiny structures started to form which used these conditions to generate energy. But these structures weren't perfect systems either. They mutated and made their own mistakes, some of which produced new possibilities. This cycle would continue for billions of years until eventually a collection of tiny mistakes came to form the most complicated living organ in the known universe, which would one day set out to understand itself.

Cori Bargmann ([00:01:53](https://www.rev.com/transcript-editor/Edit?token=04LLVz8PkkYYbjnilelWvOoqB2ReScG16ZthdZYH0qtvRbHO3scm6CRhi7R2s6pWgSpA1flD9bXIRDCF_mls9HqJ5EI&loadFrom=DocumentDeeplink&ts=113.77)):

We don't know how much we don't know. We don't know whether we know 1% of what there is to know or 10% of what there is to know.

Christof Koch ([00:02:02](https://www.rev.com/transcript-editor/Edit?token=892FfI12ljYmKyiBHs7Jz85dEDRnKOuvHtz22rPYn6GqueKdbkb7HbEysnoSN3KPkbiOr4mBfZtCHVcoCbo8Xqiko6o&loadFrom=DocumentDeeplink&ts=122.76)):

You've got a billion synapses in this tiny volume and you've got a quadrillion in your entire brain.

Jeff Lichtman ([00:02:08](https://www.rev.com/transcript-editor/Edit?token=HJ2vlU7Ce11GIK0iNodbOq9MOaDg-xqkyU3GBUEa4mOZepNY28Yedl6k_9ruAb5ts3vg9_vM-WlPD3eJVfsHSGTLfdk&loadFrom=DocumentDeeplink&ts=128.22)):

Every part of the brain is different and every part of the brain has a remarkable diversity of cell types and connections.

Terrence Sejnowski ([00:02:14](https://www.rev.com/transcript-editor/Edit?token=uHExLMS3MExzRnQ-eYWeP4sku04BAbwyIxwuZov_pi2SH5qx_Pq2Ybo_EN9mpBeBJjdm8EJc-u59q3t4Uc74A0P4dUc&loadFrom=DocumentDeeplink&ts=134.31)):

Neuroscientists have the questions, but we don't know how to answer them because we don't have the tools.

Anne Churchland ([00:02:18](https://www.rev.com/transcript-editor/Edit?token=mDUjE7VyGEe3FrEmwZ9KRgHsrqssyYZujRW4_yu_dwxPxE8O58yfzIiCh5NAatwoYgW6o2k9WLC1EDNOUpfm_xhdQyM&loadFrom=DocumentDeeplink&ts=138.99)):

And we want to measure every neuron in the brain in a millisecond time scale and know which cell types all those neurons belong to. We cannot do that.

Kathryn Hess ([00:02:26](https://www.rev.com/transcript-editor/Edit?token=ebD5BMySlgcwEvuuOnIsOmgmbg7QrIodrLAcHEAqJeOt0dhMnx2fwrK71TEz4L3uTJQLip3fxNVTz3hlXz_VN-GKX-I&loadFrom=DocumentDeeplink&ts=146.49)):

We know nothing. We know nothing, really, about how the brain works.

Moritz Helmstaedter ([00:02:30](https://www.rev.com/transcript-editor/Edit?token=GTN73Nj0ZhlAEqOvF5_VoQ6KUv2Sz-kYq4-vE32vg21l8okIrZWyVZDhj5KfIqjgrrWY7Nu-FclngRAAhr4ZiH9zi8o&loadFrom=DocumentDeeplink&ts=150.51)):

We need to take long term goals.

David Eagleman ([00:02:33](https://www.rev.com/transcript-editor/Edit?token=hRC3pwTXcWvJnKr1vKSC70vkxXszrdYrGjSWDLeSlwgtaa_LiYAcjV8yWzGWZN3y7My9afBvo4R6u5YWG41vQKg4i-k&loadFrom=DocumentDeeplink&ts=153.16)):

We're essentially on this little strip in between the infinitely small and the infinitely large. And we're trapped on this little tiny strip that with can see.

Henry Markram ([00:02:41](https://www.rev.com/transcript-editor/Edit?token=2NZkruNBYdWTMCV3mT-WtlMDvRQCP47AT-KPSVNlfLalm9CmYgMavbJ94Gn3JYjTmabOdhaIu9Y-jpA1UqesCb4aZbQ&loadFrom=DocumentDeeplink&ts=161.85)):

Well, I think much more pragmatic to that, I think that we have to see.

Noah Hutton ([00:02:46](https://www.rev.com/transcript-editor/Edit?token=Q3Y3AS3aRECoLAAtUZbK5BIPMeW4RfMirbIeVhAdhU1PbpvzJaOqgN56Z7U9MUThu6a_89dZwyVCZhYAK7s0tZxROFk&loadFrom=DocumentDeeplink&ts=166.22)):

This is Henry Markram and he saw things differently.

Henry Markram ([00:02:52](https://www.rev.com/transcript-editor/Edit?token=tq2jZntYk1fVzSpzWVdFT-mG5f07zv7INVmP_dvVMhZm9PUyNCrYF_eN3rTo-untg7qL64w0TCZA9DFu_l_dlZb5rfk&loadFrom=DocumentDeeplink&ts=172.04)):

It took the universe 11 billion years to build a brain. It's essential for us to understand the human brain if we do want to get along in society. And I think that it is a key step in evolution.

Noah Hutton ([00:03:03](https://www.rev.com/transcript-editor/Edit?token=5Egapx1l8VCQ2HW0Id50Z24ILNUIFP8NYZNuul__DYZqX0RPFjOWYTuJDpQeuufB9lihHHuqRm-2xqxrMEgmMRS-UVI&loadFrom=DocumentDeeplink&ts=183.62)):

I first heard of Henry when I was in college, where I got interested in neuroscience. I was fascinated by how the electrical signals and chemicals in the brain could possibly give rise to the consciousness of the mind. In classes, I was assigned papers to read by one of the world's most renowned neuroscientists, Henry Markram. When the field was booming in the 1990s, Henry achieved international recognition for studying neurons and how they work in the brains of animals. But now, on the Ted stage, I was surprised to see Henry talking about doing something totally different.

Henry Markram ([00:03:35](https://www.rev.com/transcript-editor/Edit?token=St9waZsxJGHp-KGBEGcA3wJUq17Jcx9BSMudLgxRCWsqmeZKfCb4WTWIfCbBsWAfDxDSJ3yTZqdgk75MAps4o2yP2gs&loadFrom=DocumentDeeplink&ts=215.58)):

Our mission is to build a detailed realistic computer model of the human brain. We have to embody all our data and all our knowledge into a working model.

Noah Hutton ([00:03:49](https://www.rev.com/transcript-editor/Edit?token=1zoecXkkt9EBDR4NRv8d00m73Y6ja8J4DWhWH-vDQczyCsAQ6CSvfKiDigoCxnhPkPx218kpvtEuJDASiUWNfPfgJT4&loadFrom=DocumentDeeplink&ts=229.01)):

He was abandoning his line of biological research and announcing a new project to build a digital simulation of the brain. After college, I started working on documentaries and what I really wanted to do was to make a documentary about neuroscience. But when every scientist I could find said the answers to the deepest questions might be centuries away, it seemed like not such a good idea. That all changed when I saw Henry give this talk.

Henry Markram ([00:04:16](https://www.rev.com/transcript-editor/Edit?token=IXNqaM9JyKM8B16lo7QDXvQSdc0MJKo133x7sntKTvz3X8kaq9WKqUWJR9gZBgsVyfWSRYM0c46ZO9GHQQnm14lbzlQ&loadFrom=DocumentDeeplink&ts=256.61)):

The brain creates, builds, a version of the universe. Now, this is, of course, a topic of philosophical debate for centuries, but for the first time we can actually address this with brain simulation. It's like a veritable universe. You would be able to step inside the reality that is created by this piece of the brain. So in summary, I hope that you're at least partly convinced that it is not impossible to build the brain. And we can do it within 10 years. And if we do succeed, we will send to Ted in 10 years a hologram to talk to you. Thank you.

Noah Hutton ([00:04:58](https://www.rev.com/transcript-editor/Edit?token=SPy-sIs8jiqS5t9zZQNXNWs5QNtoCaGZhVsI3ig0SIYZs7CQFv3JOTNxUN2loZxl3SIroe_lfRblCmu9536b-GzRoBg&loadFrom=DocumentDeeplink&ts=298.95)):

I decided to follow the progress of the scientist who believed he could build a brain in a decade. I got in touch with Henry and proposed the idea and he gave me access. I was starting my own 10 year project.

Noah Hutton ([00:05:12](https://www.rev.com/transcript-editor/Edit?token=ItTH0ZUqGv3lL4XUO0YAdhkFq_tKYLRy2feo6HBmgaX8ewYVfDgz2ghjY7Tg6AxmA2Ef3Xz_A1ACVYSIor8JDyGpnK8&loadFrom=DocumentDeeplink&ts=312.34)):

(silence)

Speaker 11 ([00:05:32](https://www.rev.com/transcript-editor/Edit?token=kG2GIdUAeP3jcTivzm6nDB0l4xtrrcqUHc5Bj4sASVijS9736ghMuUvL_8CCOMJgoXA4s2VENV8div0zGqk3pEzjsVY&loadFrom=DocumentDeeplink&ts=332)):

[crosstalk 00:05:32] do you want to see where your new home is going to be? Okay.

Henry Markram ([00:05:45](https://www.rev.com/transcript-editor/Edit?token=PctUsy_O8jCVwQxKn_xwQjlksI7M43ZAMTZ-2akt8tJJEIDqP8UQMLZksSGmVONaw6MwJMjOAs04aKtRsv5SKqlQsDM&loadFrom=DocumentDeeplink&ts=345.72)):

Big holographic neuron over there. I'm joking, did not print. We have 560 clinically classified diseases. Even if the ones that are being studied, they're a handful, Alzheimer's, depression, schizophrenia, attention deficit, autism, but there is a lot of them. And in totality it's affecting a lot of people. And as scientists you want to sit back and say, "Okay, it's enough for me to study my microcircuit. I'm happy. I'm studying my [inaudible 00:06:13] because there's funding to study the brain. I don't think it's enough and that's what keeps me going, because I really do think that we need a solution.

Noah Hutton ([00:06:35](https://www.rev.com/transcript-editor/Edit?token=OgmBwYQ2ckSTedorDrUeVDITsJ1PtPusklPkHORj39nf2ia82jmX86ItgtZ146KRwLyQ0qebiX1MJadOC87KXFgEiHk&loadFrom=DocumentDeeplink&ts=395.57)):

Blue Brain is what Henry called his project after the IBM Blue Gene supercomputer, a descendant of the computer that took on chess champion Garry Kasparov in 1997.

Speaker 12 ([00:06:44](https://www.rev.com/transcript-editor/Edit?token=a1EBKGPBfeOvjU0C4Cu_bkEscaY6S9GrU03j5aPW-DofamJJOJ8DTdw2ttHmJBf3kUjxRQTNogubGgGjnROAIFVLSvo&loadFrom=DocumentDeeplink&ts=404.24)):

Whoa, Deep Blue, Kasparov.

Noah Hutton ([00:06:49](https://www.rev.com/transcript-editor/Edit?token=oStqVn6bCxqVK9Ok7YSd6EKn4OwyK5QVBVwQ8PmUYm85BMLo_5A4JFm5w8oD7_wvLSwih0AZ4BP9cTdsHrt8WytxrX8&loadFrom=DocumentDeeplink&ts=409.55)):

In the Blue Gene's new home, water was piped in from Lake Geneva to keep it from overheating in the basement as it began its new task of simulating a brain. In the 19th century scientists realized that the brain is made up of billions of individual cells called neurons. Neurons come in all sorts of shapes and sizes. They have branches called axons and dendrites that they use to communicate with each other at little meeting points called synapses. How all the electrical and chemical signals exchange between neurons eventually create our perceptions, our memories, our sense of free will, and our consciousness has remained a great mystery of the brain. These questions were far beyond the horizon of the experiments most scientists were doing in 2009, but for Henry, creating a detailed simulation of an entire brain, would trigger the seat change in neuroscience needed to solve the great mysteries. Experiments that would normally take great patience, specialized machinery, the sacrifice of animals, or would be too invasive for human test subjects could be done instantly and with far greater control on a full digital simulation of a brain.

Martin Telefont ([00:08:01](https://www.rev.com/transcript-editor/Edit?token=haknI6H3o_trAcAMytbS20TUhAct35RgJWqjo-r6O8WWSyW4W6PKAd7QzKHGD9q0dkBXo-9fAcI_TsJGhJUvCIFpEK0&loadFrom=DocumentDeeplink&ts=481.39)):

Yeah, it gives you all kinds of cool new insights. And that's our signal. That's Henry.

Henry Markram ([00:08:07](https://www.rev.com/transcript-editor/Edit?token=YjGSfnSzafKmVXFAYukh7Y6QSXPMGgZty_HTGpGy9uEYy9s1DEtuSZgx8PdcgK-TntVqVHSOSXY8g4p0IDyD__xRv6c&loadFrom=DocumentDeeplink&ts=487.8)):

That's okay. So if you model consciousness and you simulate something, it behaves as all the properties of consciousness. It's a simulation of consciousness. Is it really conscious? We'll have an intelligence, you'll be able to dial down a molecule and see that you dropped the IQ dial of a molecule, see that you raise the IQ. I believe that we will understand the brain before we're finished building it.

Noah Hutton ([00:08:44](https://www.rev.com/transcript-editor/Edit?token=EpEYSoxIEgVsEvQkeN-QqIkSnKniKDLtmxrq7iNU71ptBWcb0_1qq4Y2CTn24XkPb8PYTKzVWCiZMSq20ymxMORlkc8&loadFrom=DocumentDeeplink&ts=524.11)):

What keeps you going?

Henry Markram ([00:08:45](https://www.rev.com/transcript-editor/Edit?token=LeNijl1g4SF2wrKiONx10eaShzGrEnQxDtagPZIDqfCuJ6Ek6ZJU5FnnrpixycV1ekEP_IcUicJR7xpBdb8mhutSwpY&loadFrom=DocumentDeeplink&ts=525.72)):

Well, I wanted to see this built in 10 years, as I said. It's going to be built. Here we are, the 3D room, the video conferencing room, and then main offices.

Lorenz Wagner ([00:09:02](https://www.rev.com/transcript-editor/Edit?token=mnwJPoB7G_zqH6KQ5F9w0mIC78KRD40MU7TM3EOFqB8FQM-cKln0IEWURBLruM3mjcfoFnjQBbqmem3C8ePWhoVMl5U&loadFrom=DocumentDeeplink&ts=542.91)):

The driving force behind this big career change was his son, Kai. He has a lot of success, but what happens, he see at his son and he can't really help. He even can't understand him.

Henry Markram ([00:09:25](https://www.rev.com/transcript-editor/Edit?token=Txn85JMZsEXT0rxADzF3ygUT8-Kf6XO25sZrvOvRHfNp9-5lY1Pajmbhy26SZ_1zU2rFTczeFweyL6j7YnCvUDPtcBM&loadFrom=DocumentDeeplink&ts=565.75)):

We started to get concerned. We started searching, talking to therapists, and doctors, and going from clinic to clinic. The conclusion came up that Kai was, in fact, autistic. I felt powerless. As a neuroscientist, I couldn't explain what was happening to my child.

Lorenz Wagner ([00:09:51](https://www.rev.com/transcript-editor/Edit?token=BVUrBwDQ0_VPrBhNgMX2u5TRfRz_-3QFoocY5TvDVIjcQ1tjz24qJ6U5tEZXeSlxqKeTQjIdxzm4plLSk57CKHjk3Cg&loadFrom=DocumentDeeplink&ts=591.19)):

It was really amazing coincidence because you have one of the most renowned brain researchers in the world, somebody who knows more about the brain than almost everybody we have on Earth. And he says, "Okay, what kind of a neuroscientist am I?" I know so much about our brain, but I don't understand my son.

Kamila Markram ([00:10:12](https://www.rev.com/transcript-editor/Edit?token=VxqsCPVuqKDW_2hJkzx_FalUqR78PxZpPQblgP2omH7OhOudTxZGy6EgzKfnBKUixolBsLGdWEJp54gkKLPHAcPECSg&loadFrom=DocumentDeeplink&ts=612.8)):

Kai's not the reason why Henry is a neuroscientist or why he wants to build the brain, and simulate it, and understand it all, but he really brought that type of urgency.

Noah Hutton ([00:10:23](https://www.rev.com/transcript-editor/Edit?token=hlJyARtvnXeDcGi6SYuH00AidMM-2y-Z6k3e2VcvewomEQ5C40DwDXO9uFAHBpyRe-D9d-pb6otH3E1MAlIIT6McNAk&loadFrom=DocumentDeeplink&ts=623.62)):

When Henry launched the Blue Brain project, he started by simulating a part of the brain called the neocortex, a thin layer of tissue that is considered the seat of human intelligence and likely the site of the activity underlying autism. Some scientists believe there's a fundamental unit in this part of the brain that evolve once and then simply repeated itself over and over again. This unit is known as the neocortical column, made up of about 10,000 neurons and it was the closest Henry could get to simulating the part of the brain that might be involved in Kai's autism.

Henry Markram ([00:10:55](https://www.rev.com/transcript-editor/Edit?token=iN4Mit7q0-ZytsdBeaFhVtVl850vYlWwmybckUK-R8kbMULFIbLjir3r29yBhO68Ylqp8R2HPYFAnOA23_ti-YUZXG8&loadFrom=DocumentDeeplink&ts=655.75)):

The holy grail for neuroscience is really to understand the design of the neocortical column. And it's not just for neuroscience, it's perhaps to understand perception, to understand reality.

Noah Hutton ([00:11:08](https://www.rev.com/transcript-editor/Edit?token=xPcRNmo5QHd8wlUNAtwH93OHJbSiFD7LhxsXwg3YKrJJ5Yw-BD-9sa6m76PY6C2X5RztxYRqPONxiR3BigiM1wbkg0o&loadFrom=DocumentDeeplink&ts=668.17)):

Henry and the Blue Brain Project decided to start by simulating a neocortical column in a mouse brain, figuring that if they got that right they could then scale up to a whole mouse brain, then move to a monkey and eventually a human brain.

Cori Bargmann ([00:11:20](https://www.rev.com/transcript-editor/Edit?token=5u5h5SRqQCfUZVEyYtTs6kG-PlJsAQv_RMxt_P3l9j677uedcHdjFBkB7KYP5XfWrS61BNI_4FWDg4gfz6EXsNEYtxU&loadFrom=DocumentDeeplink&ts=680.61)):

Well, it's not a case of somebody who's coming from mathematics or physics, announcing that he's smarter than you are and he's going to do this all computationally. It's a case of a very brilliant experimentalist thinking that he'd seen enough patterns in the data.

Idan Segev ([00:11:35](https://www.rev.com/transcript-editor/Edit?token=SW6vhm_CmO_kTPqqmX3Ef2iLcvmbrNR9_EMtlHT-1_0v14e0gwp6v3fGDievDO9N7VzgtAyMwmsjgM1qQKACtcBOYEY&loadFrom=DocumentDeeplink&ts=695.39)):

You see a visionary in front of you. And I never met many like this, but it's clear that this is a visionary who really was dreaming at that point of changing the way neuroscience is being done.

Speaker 17 ([00:11:54](https://www.rev.com/transcript-editor/Edit?token=Ec0qXTQ7Ic2H-rAkdRwsB3ryOtN87ss9m8rA5DIr5uIDTQiri0EC49zxuMpbtdu_Lkbz606VAHmqyTQRTzozkbIvO-g&loadFrom=DocumentDeeplink&ts=714)):

[crosstalk 00:11:54]

Martin Telefont ([00:11:56](https://www.rev.com/transcript-editor/Edit?token=g8hyp7psznBTAgwL9poEAUM_FXwwHGS6piYSQjF7MWJ1DvTPPq3yFoEPiS7zK8oYGXR0gch0HsdKGeWzUJ1jkjt_AnY&loadFrom=DocumentDeeplink&ts=716.73)):

Scary thing is by the end of the movie we could really have a number of these working as students in the lab, but ... Well.

Noah Hutton ([00:12:08](https://www.rev.com/transcript-editor/Edit?token=1TYcvamQ--l4QuAPO-RsAqt25qU2yAu1gbn2RSpp1jXi2W8xJK-Kr1ubSb57rbsM78EzvJ55ipGbMyUD0fSyDt6GIHs&loadFrom=DocumentDeeplink&ts=728.08)):

During my first tour of the Blue Brain Project, I was brought to their visitor screening room.

Martin Telefont ([00:12:12](https://www.rev.com/transcript-editor/Edit?token=Ep-qlsEePuMUJYGVCNNCLCt250X5TeFlzuWuD9CyN08k9CMV--9yUmjI3Owg9nnp2FF6eQd_e_go0bMj3xOLR_q5Mjg&loadFrom=DocumentDeeplink&ts=732.41)):

Okay, I just need this to switch on the projector.

Noah Hutton ([00:12:16](https://www.rev.com/transcript-editor/Edit?token=tPnXBOPA_MXRN5IWShCxubRD_Q80TLg5Im_vvSumxaCXstHmPXOM_cyxgA6sIZB6swrWIXWTHEpqZHzWQffC1Ayt290&loadFrom=DocumentDeeplink&ts=736.07)):

The lights dimmed and the Blue Danube Waltz began to play over a fly through of a piece of mouse brain that the project had already simulated. That was just a tiny piece of the hole. This was the first rendering of the most detailed brain simulation ever attempted.

Noah Hutton ([00:12:32](https://www.rev.com/transcript-editor/Edit?token=GxSVbwKjveeHXwyfiTlwd9hUwkIqYd2Gue3KEKFr0HWuCraUPwUw6G8Oec_00C4grwx5wh9UDa5Po_zGScqXD-6h7eA&loadFrom=DocumentDeeplink&ts=752.83)):

(silence)

Noah Hutton ([00:13:06](https://www.rev.com/transcript-editor/Edit?token=gDj0u6cKaRCl9duYY89VGULQphBxW44gvsq3CIn55VAK6Q3x5hlXBPbEFpiRiixIIXY1-nH6oFllIJ0aZ3iG6sc4sjQ&loadFrom=DocumentDeeplink&ts=786.46)):

The Blue Brain Project was part of a long tradition in science, of building models to better understand the natural world.

Kathryn Hess ([00:13:14](https://www.rev.com/transcript-editor/Edit?token=lf-skytNC6Beo0IaE0dp7B69IqmhZ212OKswWeac-T0DLwCvp67rqBCV6oPEVKrgTUEPL8dGiXks1D-2lqkB-IHFSo0&loadFrom=DocumentDeeplink&ts=794.54)):

In order to understand complex physical reality, one needs to simplify and one needs to find some sort of way of abstracting from the very complex world to some kind of representation with which we can actually work.

Stephen Larson ([00:13:27](https://www.rev.com/transcript-editor/Edit?token=_eWOgzrTwnpGZb4Lss-uPNGxCeJV0qtn2XfnKw9jUe9Hf7korRaCJFPU9j8sRNXwvu-BNwXtHM5V5GKWbNQ9vTAvVBk&loadFrom=DocumentDeeplink&ts=807.25)):

So the weather is an example of one that we needed computers basically to even start to model. And so you look to a biological organism and you say, "Well, how are we going to do this without having computers in the loop?"

Kathryn Hess ([00:13:43](https://www.rev.com/transcript-editor/Edit?token=iIvXiMbOL7v-ump2DyH2DcSQbNVaqAR2UijnlquxVegwKQUv4lpkyvXwjf3RS3Wn4O1mgKJd1Kyr8DzH9oJzxpHMQTk&loadFrom=DocumentDeeplink&ts=823.66)):

One analogy that I like to make is that the kind of abstract geometric representation that we're doing is like what you do when you're in a new city that you don't know and you're trying to get around. So what do you do? You look at a geometric representation of that, which is what you're going to get in Google Maps, for example. So that's the kind of model you take. I'm going to abstract the information I need in order to do what I want.

Noah Hutton ([00:14:06](https://www.rev.com/transcript-editor/Edit?token=xuNsmdxfDt078inGYcgN4h9xjK1Eu3cJrybVpPE-dWRwSzXOMvh6arAPQoKy_jEG0gSs-7V9pLVGvVOtRhn154Iahhg&loadFrom=DocumentDeeplink&ts=846)):

In neuroscience, all sorts of researchers today used models of the brain, but they're usually simplified models of one circuit or just a few cells. And often these models simplify neurons so much, they're essentially just bits, commonly referred to as point neurons. But in real brains, individual neurons are much more complex. So instead of point neurons, Henry's going to build a model from the bottom up, one that accounted for the staggering complexity of the brain all the way down to the molecular level. This meant the project was pulling data from existing scientific papers as well as doing new experiments in their lab to fill in the gaps around genetics, calcium levels, blood vessels, and everything in between.

Rajnish Ranjan ([00:14:45](https://www.rev.com/transcript-editor/Edit?token=IVgg0h0ESGTj9QFe2Fv7ywKN25W-wrUi9rFgkVQ5aKbXbbt5E8ON9uSN4apmDqPfS26J2Ox3ELFfWxHrSDEQqnCOJMY&loadFrom=DocumentDeeplink&ts=885.76)):

What we need is the real data.

Jesper Ryge ([00:14:47](https://www.rev.com/transcript-editor/Edit?token=5z4ryglpiMuhhV9uloiuoxT12tyr112WlF1UY3CMMt4Mb75_HFkiHHVj9O67Qhv-0gskkt4eUbLTNNFcsykLqPH7OCE&loadFrom=DocumentDeeplink&ts=887.44)):

So there's a lot of potential challenge. This is the schematic of what was done.

Emmanuelle Logette ([00:14:51](https://www.rev.com/transcript-editor/Edit?token=nYu4us6By4zkjOvfplWJbbUOdJa4zaVish51LPu14js8-u_kV2Vo6I1VHMhM3wow_y6wrvTAUN-hmHV0Ip035Bfsg_M&loadFrom=DocumentDeeplink&ts=891.1)):

You can then project how could a neuron react to a certain simulation.

Shruti Muralidhar ([00:14:55](https://www.rev.com/transcript-editor/Edit?token=TgB6C3El15CxMy0ckWoEPC8MPZdoZ0WYFzzeCKzqb5LXuOgnTwswI8EY2xctWHHsA6vNiCKCOsu9tV7LGaqsoxRCwhQ&loadFrom=DocumentDeeplink&ts=895.81)):

And one was putting a screwdriver in, trying to tinker it, see what exactly is there, how it works.

Vincent Delattre ([00:15:01](https://www.rev.com/transcript-editor/Edit?token=EMXPilNgaH5TadRqK1PezaN4-UhCt9eV4hroxpxcgwXEsoj2WrJzaZBnmBx84r3kaJWLvG6j96LRWmpjBOQSbIy-TSY&loadFrom=DocumentDeeplink&ts=901.19)):

The first one, when you get the first one to strike, it's like yoo-hoo. And then when you get the first connection, it's like yoo-hoo again.

Sean Hill ([00:15:07](https://www.rev.com/transcript-editor/Edit?token=-MraU2IAOObAWbL7EeDOuHZ2YOAjJqhcrwhSJvGbmn50NH8_ItI4GS-JkfvKKELtDcStm_i0i8PG5X3QTQk0thGaGSM&loadFrom=DocumentDeeplink&ts=907.21)):

It's all of this data from many, many different levels of detail that gives us the raw information necessary to build a computer model.

Noah Hutton ([00:15:15](https://www.rev.com/transcript-editor/Edit?token=T-sFptd-HDb2CByYo8YXbZhTzQGH2ZABVb0D-DGcumimQrX3Dx7WGJ4sOGEboxxMHxKoIaXAAK1i8XEt7AhwK_XI_lc&loadFrom=DocumentDeeplink&ts=915.02)):

Neuroscientists had never tried to integrate this much data at this level of detail. It was a totally unprecedented attempt at a unified model, without knowing for sure what would emerge from all the tiny bits.

Noah Hutton ([00:15:25](https://www.rev.com/transcript-editor/Edit?token=On_6kF96LBHS72tKsQSKijY8P-nGOx-RljhI0uKsuHJ97PVb0pIv8kKhuEPKYHJlSO5ihnVixQaejW5guRqb7r1h_Fg&loadFrom=DocumentDeeplink&ts=925.19)):

(silence)

Noah Hutton ([00:15:38](https://www.rev.com/transcript-editor/Edit?token=AesAgvdNdC3Uwyh6XoHVqAEkbR1NVAGeycDNFJvIAco00S4-lRjTyow7cu885o-4YD7bFF4bLLfzCtm6BQouwlK-Bj0&loadFrom=DocumentDeeplink&ts=938.3)):

That next year something new started to happen inside the small piece of mouse brain that they had simulated. The Blue Brain Project had increased the size of the simulation so that more neurons could be active at once. And when they ran this larger simulation, they began to see glimmers of brain activity they hadn't programmed.

Felix Schürmann ([00:16:01](https://www.rev.com/transcript-editor/Edit?token=mYEH8xDm54cMg6gX1-D-eibLxCXqzmQGfZlr1xrFRK2x3kSc_4kDBxy0J3X_B6tlutoEB0PlPhlZRRQ9_WtRtUNFGN0&loadFrom=DocumentDeeplink&ts=961.92)):

So the people I would like to point out to you is Eilif, who's actually right now very busy because he's running simulations on the Blue Gene right now.

Eilif Muller ([00:16:11](https://www.rev.com/transcript-editor/Edit?token=k4H3UI20J3RVpPpxq7oN5kG4dZuE3Febz2UR9SHLpLo85ifhdMlfZ0U-6ED3mgRnIMTNxsJwOcCzxX2D8ejU3qnQriM&loadFrom=DocumentDeeplink&ts=971.93)):

So this was this first really large simulation that we did also, where we did it for four seconds, which actually took us eight hours.

Noah Hutton ([00:16:20](https://www.rev.com/transcript-editor/Edit?token=WQaCXvgX5fJ9LP9lyH3wXAk0RrhbOFjKSlsjL-_eY7FoGW80J1Xe4XxyBQSDuKLYPmcNjy_jlK7VTaVP7FtuyCaJgQk&loadFrom=DocumentDeeplink&ts=980.28)):

The waves spreading across the columns of neurons seems to mimic the spontaneous synchronized electrical activity seen in real brains, which was an indication that the simulation might be on the way towards acting like the real thing.

Eilif Muller ([00:16:31](https://www.rev.com/transcript-editor/Edit?token=75VebzUEuI6nGF3C-TJCFbm_wN_c-94rNfFld3OQ4Wk2JwSU77CDow8l004apfcx4Pngi-FlWzrgefopLYkyY63l1O0&loadFrom=DocumentDeeplink&ts=991.49)):

This is certainly an emergent property that requires a network of larger and larger scale. Look how irregularly it sits [crosstalk 00:16:56] well, Felix ...

Henry Markram ([00:16:57](https://www.rev.com/transcript-editor/Edit?token=J9Dj8PUdz-Fer9529EVU_JVC4xD_JxhQ_lP21vdXuap9T26gXkWh7AnjHBQvVXg8oiN88RobFow9Ct3TGNF0Gcx7PCI&loadFrom=DocumentDeeplink&ts=1017.8)):

This is nice.

Eilif Muller ([00:16:57](https://www.rev.com/transcript-editor/Edit?token=LVNTIS6pljo0l-1HK_XSmgzhC8ybs4Ct1QRB0xEXNEq_CK6xZ4r6XZkAyvBg78kiMaNMcrlBug_2ksefn5TR8ZrnkEo&loadFrom=DocumentDeeplink&ts=1017.8)):

Yeah.

Henry Markram ([00:16:58](https://www.rev.com/transcript-editor/Edit?token=8e6Pes8zh_0FUdqSO8NkcoQNtloU2LidBIhmWY6ny4qTxbwPorkbfxjdQpO6E0GQhSdp_XLly9h7TFVyewTBXzEckg4&loadFrom=DocumentDeeplink&ts=1018.29)):

This is it.

Noah Hutton ([00:17:03](https://www.rev.com/transcript-editor/Edit?token=z9cx2DBIB2VYyGynUzINhMlKvMjnKLxRyfoayGC6mxVMgj_-Fed7fljZ5VkeemxBAJK1nqs1njPyIaISmDLHDbAz8dg&loadFrom=DocumentDeeplink&ts=1023.93)):

Traditionally, there have been two ways to study the brain. You can study in in vivo, while the animal is still alive, or you can study it in vitro, where brain tissue is kept alive in a Petri dish full of nutrients. The dream of the Blue Brain Project was to create a third way to study the brain, treating the digital simulation if it were biologically real. This third way would be called in silico.

Henry Markram ([00:17:30](https://www.rev.com/transcript-editor/Edit?token=-X5qBWcsVXCyEpexjsxbNMK63Krr6e9C7j6qhqml-amDFgjhZvObKnVJ95_xLU_B5cwpo89JhDzvqiTgPawmP04o8W0&loadFrom=DocumentDeeplink&ts=1050.73)):

I see it now in virtual and I can ask any question I want. So I think that I'm no longer a biologist, I think now I'm an in silico biologist. Next year we will jump to the next level of super computing. Once you can build a brain region, then we take the next step to building the whole brain.

Richard Walker ([00:17:57](https://www.rev.com/transcript-editor/Edit?token=wdytu90sk_GCaEwb7rYGQLyq7M9YfEKGlcsyWWJF1On3UWoflqxOW2zq3AiiLSICxbL0Tw2yvxyIZ75xJKGneIzwvo0&loadFrom=DocumentDeeplink&ts=1077.46)):

This is fundamentally unexplored territory. We know a lot about the mechanics of the brain. There's a huge amount of neuroscience that tells us what neurons do. We also have high level stuff. We can do imaging and we can see which areas of the brain are involved when you do certain experimental tasks. But what we don't know at all is how these two levels fit together. We don't know how the action potentials produced by neurons end up with you thinking, or writing poetry, or voting in an election. This is really a dark mystery.

Eilif Muller ([00:18:31](https://www.rev.com/transcript-editor/Edit?token=Yqpsh4mZn6W-xB7Zwmfbqk2lc7uiGBpZJWvbXYwAgeraFCV-AeHsmaq8rO_vc8fvAs_T8rgE8CKsZIwSAxYRHyJ-1sI&loadFrom=DocumentDeeplink&ts=1111.66)):

There's a bottle of champagne waiting in my desk when you can build a 10 million cell circuit. And we're going to have a little party and ...

Eilif Muller ([00:18:38](https://www.rev.com/transcript-editor/Edit?token=Hcx5wy5LUyy0HQQF5JqvCEJqp81yhy1hpT7PDS5J8etxdFMWmM8mU5oC3FBsYOUG99ZKOnvsIbp2mHtq3o7HOcswWtA&loadFrom=DocumentDeeplink&ts=1118.64)):

(silence)

Noah Hutton ([00:18:57](https://www.rev.com/transcript-editor/Edit?token=ehpRnrpm6X1cX3WuM3AL6aevLOdNBwoKm_msfD43kA24akP8nNlo3VgmokBwJu-VWRoiwkD7Gf9JyqkPevo1OftTXTE&loadFrom=DocumentDeeplink&ts=1137.75)):

That year I read a book that was critical of the project by Sebastian Seung, a rising star in the neuroscience community, who at that time was a professor at MIT.

Sebastian Seung ([00:19:13](https://www.rev.com/transcript-editor/Edit?token=HWqxptNsAYH3h_JpAd86n0Xd7THUfAKYE32NjI-0bqOh4xWcZ5attPUB728bW7-s40RqVxmm8U2DZkBDwexT33i17GU&loadFrom=DocumentDeeplink&ts=1153.43)):

How does life emerge from dead molecules? And a similar question might be asked in neuroscience. How can we get a smart, intelligent brain out of dumb neurons? Big mystery. If we don't have detailed knowledge about the connections in neural networks that we can really depend on, I think that the endeavor of simulating them is bound to fail.

Henry Markram ([00:19:44](https://www.rev.com/transcript-editor/Edit?token=q7RIEYExjz09CcTO2snDfro70FgjeTrQShqZe0F5xhDr3m6Kz-fEdBvY_jCzvfk53IRyFPffM-BlVQGMOYcITTM6ZeY&loadFrom=DocumentDeeplink&ts=1184.35)):

It's not about measuring everything, it's going to be about what's the least amount you can measure. That's the game. What's the minimum I can measure about the brain to reconstruct it? That is the challenge of neuroscience, very much against tradition. Naturally, I need a bulletproof vest. This is not easily accepted.

Noah Hutton ([00:20:11](https://www.rev.com/transcript-editor/Edit?token=36sAbJg_sprdcL9zdjvdWBQpM7eoAHyiniw40R51qZP1mew3SiaDTRaS-wbUAdXCyItp8YTRxqkn5znvrw1wbYWxMHY&loadFrom=DocumentDeeplink&ts=1211.21)):

Most neuroscientists had devoted their careers to generating more and more data from real brain tissue. Many of these scientists I started talking to didn't believe we were anywhere near ready to start building a full scale simulation of the brain because we simply didn't have enough data yet about the way neurons were actually wired up in real brains.

Jeff Lichtman ([00:20:28](https://www.rev.com/transcript-editor/Edit?token=Bjyw17btX1beOb2ulnelvyHZeiCA-VeKHz1pv2mNLgmL3vvXFBrOpOGKsQmyd8SvwPpSROyP5-SSDXLkDOAoVBVy6HI&loadFrom=DocumentDeeplink&ts=1228.7)):

And how are we going to get how they're wired exactly the right way without looking at how at least one or two of them are wired exactly the right way. We don't know for a cortical neuron how it's wired. We just don't know. I don't see any other way around looking.

Haim Sompolinksky ([00:20:44](https://www.rev.com/transcript-editor/Edit?token=owjAVKklcJhpE0oVdeH9Q16rQOrmmWwiq9PGcJEIfjPS9xEOEbmpKe2e9Kmvvn6fz8kEVskoNz4JrqIRROc6fYUzHng&loadFrom=DocumentDeeplink&ts=1244.22)):

The idea of the illusion that we are either ready to establish a project of simulating the human brain, mimicking during the brain cell by cell on the computer or the idea that such simulations are going to replace the effort of understanding the brain, are going to generate an understanding of the brain. Both are severely distorted.

Sebastian Seung ([00:21:16](https://www.rev.com/transcript-editor/Edit?token=oZroqFuiMKIFI_sdGkuvjXzc11WxC6yWaszaUmDQ04DpaekEMwJUdy85quV1W1-PlhvydrQHT1hy9c-04wrKTLPPS_w&loadFrom=DocumentDeeplink&ts=1276.11)):

Blue Brain contains neurons that are realistic in their biophysics, their electrical properties, and so on and so forth, but in the connections between neurons, it's highly unrealistic. I would say that brain simulation is a waste of time. It's premature.

Noah Hutton ([00:21:33](https://www.rev.com/transcript-editor/Edit?token=g5W6LQQn1X37jMOk-21ICWpm9sflGAiVbApAIdRg20uXswlIQfWp6TRqqxqCrPK8qZqhKgbxrU3iRzutqTkTPTacEq8&loadFrom=DocumentDeeplink&ts=1293.37)):

Why is he critical of brain simulation?

Henry Markram ([00:21:35](https://www.rev.com/transcript-editor/Edit?token=3MK5LA4yzOTNN6yUM1l0pGMsXmEj1qVpd5o9hDAxkkzTBBVI9Q6sTzRKs74IhX2jXrLifAkL-j2ChghNImcqYeC0ygg&loadFrom=DocumentDeeplink&ts=1295.7)):

I mean, it's a complex answer. I think at the root of the problem is that we're dealing with a cultural change. I mean, what Blue Brain stands for is really a different kind of approach to neuroscience. It is an integrative approach, it is an approach of using models. And most people have interpreted the models in their brain in the same way that they would think of models that have been constructed in the past. Models of the brain in the past have been models of the brain, which means that they represent the brain in some form or another. For us, this is biology.

Noah Hutton ([00:22:25](https://www.rev.com/transcript-editor/Edit?token=ZuhuXUE88Kzbv3-cUYDySDmZKHNBaF-UPHL0xDYNoE3NhM5fSz2hpC3nKiFCE5WTbXLCE_1Y_hPiAOv45dBkm7CThS8&loadFrom=DocumentDeeplink&ts=1345.73)):

By saying that his model was biology, Henry was saying that this new way of studying the brain in silico was just as good as traditional ways of studying the brain in biological labs. This could mean that labs run by people studying real brain tissue, for example, might one day not be necessary. In silico biology could upend the entire field.

Sebastian Seung ([00:22:46](https://www.rev.com/transcript-editor/Edit?token=XwjOIHf6gyBcmYH13jlClK13hrNlMotxVFAXg8HRU_srs6jGZi0TgqXW9CxQtPntvp-DQMpzn2H5HKStERLjzLixeR8&loadFrom=DocumentDeeplink&ts=1366.01)):

Well, I would ask you this. So they shared you a simulation of some neural activity pattern inside this. Suppose it had looked different. How would you know that that was wrong or right?

Noah Hutton ([00:22:58](https://www.rev.com/transcript-editor/Edit?token=ByeWCi_nx6i4SGSXKu-boZtISgdTLd8FaSX0lZjOl4t2pKXrdSnyYEKT14ze4qwFHhVa2a3any992B_K2kZbaWYxUZ0&loadFrom=DocumentDeeplink&ts=1378.28)):

Well, I wouldn't know, but ...

Sebastian Seung ([00:22:59](https://www.rev.com/transcript-editor/Edit?token=BLhVouV43lixZgdMlv30FJqOXNSjA1i9RvE7kg8SCY6akcDa1dZ2W1gtxwWEzMXiTbUCsWg54bUKBKeZ5eQXw7-WloU&loadFrom=DocumentDeeplink&ts=1379.3)):

Yeah, how would anybody know what was a wrong activity pattern or a right activity pattern?

Noah Hutton ([00:23:03](https://www.rev.com/transcript-editor/Edit?token=FG3dSu1Tz6Doozt-OsnJVRQ7RIwscRnUApwXRVI-4EVKDHQcCWZ8mD46UedK2y72WYH385nUfsx2tWTOiR_SqyqxbRs&loadFrom=DocumentDeeplink&ts=1383.61)):

Well, if they connect it to a rat in a digital avatar environment, and it can navigate a maze, wouldn't you be convinced that ...

Sebastian Seung ([00:23:12](https://www.rev.com/transcript-editor/Edit?token=rVqNGozWvc3rq36WyttcJ6qGORUmc6-0VB08I6ztX1N_B2GLPGIraZiQTqDs1fu_iQreClRM-ANazsyfghp7Ulxx0FE&loadFrom=DocumentDeeplink&ts=1392.21)):

Well, I think one proposal is that if you can simulate the entire human brain and it turned out to be intelligent, and behave like a human, talk like a human ...

Noah Hutton ([00:23:22](https://www.rev.com/transcript-editor/Edit?token=Rwkmiotm4H_PwifSjw2S4_88Hc4oFjFMxj_Z9SSPFNWSFLVLwMa6IxV5kThShVEcLjzIUwuC3vDRD1oQY1LKOgeZYdw&loadFrom=DocumentDeeplink&ts=1402.19)):

So the Turing test?

Sebastian Seung ([00:23:23](https://www.rev.com/transcript-editor/Edit?token=d3bnnqvB5QucM0H_bkyZeaPaU-4dRMTT6_LYy6IPxMfvwe0uL4tOUzk3xMV6uN_qv25r0-I4JfE_6Hlk9cL-BLWFCtg&loadFrom=DocumentDeeplink&ts=1403.14)):

The Turing test. Then we could be satisfied that it was successful. In the meantime, what do you use as the sign you're going in the right direction? So any kind of long term goal requires milestones. What are the milestones that we can propose to show that this project is going somewhere? That is, I think, completely missing. They think they're so smart, they'll be able to figure out, even though they don't have a crucial piece of data. I think that's the real grandiosity.

Henry Markram ([00:24:00](https://www.rev.com/transcript-editor/Edit?token=HvJDp3nGv5k72EHinP_nGToboXFO5bW_0BwZxii6IpU9yl0tI7Xqb_nSMv54HG3ar8RpydnAhhEx3AFxqZwwXBEg--4&loadFrom=DocumentDeeplink&ts=1440.65)):

People don't like the way you come and change the tradition of science or the method of science. So it's sometimes very passionate, very emotional, and often puts up a barrier against people to even wanting to understand what it is that we're really trying to do.

Christof Koch ([00:24:15](https://www.rev.com/transcript-editor/Edit?token=r26pkrzPSXrxFDZYs1SXaJXMnW53ppArnK9I8kWy2kgYChvapoM9TxMkHDEm6X35M_19iMm77bpwOJX4AZU0jNYaMAo&loadFrom=DocumentDeeplink&ts=1455.4)):

Yeah, maybe I should've worn long pants, I just realized, but the great thing about the West Coast is guys can dress all different colors. So this here, this is just the material that you're collecting and then editing?

Noah Hutton ([00:24:41](https://www.rev.com/transcript-editor/Edit?token=HG6H6qo2r1RFpO7bUmBAjJ9GYHDIl21L_IOXbZe-92viT_MEVfca-6j25UhkBgikO_Nh4AkORqfjVs5EJ8xPg_OCu1k&loadFrom=DocumentDeeplink&ts=1481.36)):

Yes, and it'll be a decade of understanding the brain. Now, I might have to expand my timeline if it doesn't seem like there's any point in stopping in 10 years, but originally it was ...

Christof Koch ([00:24:51](https://www.rev.com/transcript-editor/Edit?token=g85e0S_Ot7G2265mH00Ia4roUBCY67qY6WI3K0h7pPbliF90VcbTfXvrCmgXq8MlEbBGbgch4v6vV_i8qxYpoOp4VDc&loadFrom=DocumentDeeplink&ts=1491.46)):

Yeah, in 10 years we'll of course understand the human brain, as Henry said, and the rest is just details. Just for the record, I work with him with a big paper coming out. I'll open on his call and personally I get along well with him. I think he has two personalities. And he has the personality, one is a fantastic scientist, one is very sober. And then he goes into this other PR minded messiah personality. And then he makes these statements that I think are just ridiculous. We'll understand the brain, we'll be able to auto parts of the brain online. We won't need animal experiments anymore. It's all maybe, too, in some fullness of time, century or something. For now, we're very, very far away from it.

Christof Koch ([00:25:41](https://www.rev.com/transcript-editor/Edit?token=BpqFEPhnGweJhFc6aesMwMrAgeSoYRsUgWLPh6JEq_FVB6SiJRNW9NScTg86g31TS6Tl5rfEL0bpRNGRNtIl0ucojkI&loadFrom=DocumentDeeplink&ts=1541.3)):

So some scientists believe that very soon we'll understand the secret of the brain and we'll be able to simulate it in a computer. I think that's illusory. Any reasonable definition of understanding has to be confronted with the fact that today we don't even understand the brain of one of the simplest of all multi cell creatures, namely the brain of the roundworm, C. elegans that has 302. In fact, some philosophers argue that the situation is so bad that we'll never understand it. Which, of course, would defeat us, which I think is also unjustified. So I think there are these two positions, we'll never understand it, we'll understand it in 10 years. I think we're somewhere in the middle. Can I introduce you Count? The Count von Count. His main job is to assure to keep us on the straightened arrow. So he likes, as we all know from watching Sesame Street, he likes to count how many synapses are there, and how much jitter is there, and what's at the function of them. Can this jitter be reduced? It is small in humans and in mice?

Christof Koch ([00:26:40](https://www.rev.com/transcript-editor/Edit?token=zmtD07OZht41_qcHSrGMge2kYFqBMg7MeXPGh9pxqAV6cjdLST42Pb8w5fjCCEjfalL114lCKDq4IyKxFmNCKNRYivs&loadFrom=DocumentDeeplink&ts=1600.17)):

There are all sorts of questions that you can ask. And the scientist, of course, it's ultimately about numbers and getting ... I mean, that's the stuff you work with, right? So that's why he's our [inaudible 00:26:50] saint.

Christof Koch ([00:26:49](https://www.rev.com/transcript-editor/Edit?token=WUEz_bNvCfocBzLt433LS6DRSI84MyCWDxzR9Q_UHDTStd0l_wc6LQrTe7iCHi_-sOhiJAVXhT_hCaXTzu46lpxoMfM&loadFrom=DocumentDeeplink&ts=1609.97)):

(silence)

Noah Hutton ([00:27:12](https://www.rev.com/transcript-editor/Edit?token=Ku3rH8H0w_idL_2pvNeUleC-SCxh5bN8hky7Az3-J0NyjVLAh9GaHtKoJ5iuPKmlMhnOu5N6KLrchlP4DnP9zwkgwsw&loadFrom=DocumentDeeplink&ts=1632.79)):

Garry Kasparov was confident that a computer was no match for the top chess champion in the world, but late in that first game of his 1997 match against Deep Blue, something unexpected happened. Deep Blue issued a move that seemed baffling. It sends an important piece across the board for no apparent reason. Rather than defend its position, the computer's move seemed more like some kind of an emotional reaction to an imminent loss than the carefully programmed strategy that Kasparov expected. And even though Kasparov then finished off his checkmate, he found the particular move so surprising that he and his team stayed up late into the night at the Plaza Hotel dissecting its strategic value, but they couldn't find any. In the days that followed, Kasparov didn't seem himself, reading into Deep Blue's every move, his own careful strategy falling apart in real time.

Speaker 12 ([00:28:19](https://www.rev.com/transcript-editor/Edit?token=GVZxHsgb_fzTdKNriAl44XI_-QUf5zB1GvLZLZ2R8Mz4Y--do7d__UNmosPuRhBsdKW-_a0ciLeMzFKCgouW8MR0wkw&loadFrom=DocumentDeeplink&ts=1699)):

[inaudible 00:28:19] and he should get $300,000 for it. Whoa, Deep Blue. Kasparov, after the move C4, has resigned.

Noah Hutton ([00:28:31](https://www.rev.com/transcript-editor/Edit?token=YK6Rpj5taf2S3Q5c4tJykfSQv6RRG7Ut0_KgjehypgnCw0qRj4ZoAYZqQM_A-vEjwY209a5OTpEyakq5igrO-Y1IfpA&loadFrom=DocumentDeeplink&ts=1711.59)):

It seemed like Deep Blue had outsmarted the human.

Noah Hutton ([00:28:53](https://www.rev.com/transcript-editor/Edit?token=OM9O_4E_ODP50ztryqXtJUc4q88d_WOHVxFw-M7Iw2oN2FE4duEc7CWIyyCpzjHH1hHcZOV-kF15uDaU054Hdfo_Fhs&loadFrom=DocumentDeeplink&ts=1733.55)):

(silence)

Noah Hutton ([00:28:53](https://www.rev.com/transcript-editor/Edit?token=pcaMoryulG82XnvI0DN4nF8zUdE9Cc3RCFo9liE1rm0z2Jwc-Czgx5sNGDAKavO8p_MwY89QFQMaYhvogkqNkX7UH1Y&loadFrom=DocumentDeeplink&ts=1733.55)):

The next year with the Blue Brain Project was a tense visit. When I arrived, Henry sent one of his project managers to talk to me before I started filming. They hadn't liked that I went out and talked to their most outspoken critics without telling them, especially because it was a particularly sensitive time for the project. The European Commission had just announced a flagship grant to award two scientific projects from any field with one billion euros each. Henry saw it as an opportunity for more resources.

Henry Markram ([00:29:24](https://www.rev.com/transcript-editor/Edit?token=eRxLobZFHTciCBc7b1U6ouy6PhztBDtWowGhQVzbTeiWRC9rN8CpHk92twjZmpA623ExP2DW988VZcUMCu3t4Ad43kc&loadFrom=DocumentDeeplink&ts=1764.74)):

For software engineering and for what kind of supercomputers we're going to need. And it's really about having a unified goal, where theory, modeling, computer science, the data, in the informatics, these all have to be coming together to make in silico biology possible as fast as possible.

Noah Hutton ([00:29:45](https://www.rev.com/transcript-editor/Edit?token=qPqY6LFuCacsQebdL6NhSPxr6-7xZS29lzG8hNWQNz8mMC7GiN-h-S6Jy169yWb4GpoGRtFIxRp-oI8uEMvKBwjiQKc&loadFrom=DocumentDeeplink&ts=1785.61)):

He would have to win over some of his critics and rally the scientific community into a shared proposal for the one billion euros. And to start, he was going to give a talk at Europe's largest neuroscience conference.

Martin Telefont ([00:29:55](https://www.rev.com/transcript-editor/Edit?token=gdrOvWkgLjaArblF4zFXSzKhfUcB4e7tBel4fPvbVW56BXL14qgaCv7-2wn2IE9q6QZ78eD90drdQpKiDVa7OInaARQ&loadFrom=DocumentDeeplink&ts=1795.72)):

Henry, when are you finalizing your talk? When is your talk done?

Henry Markram ([00:30:03](https://www.rev.com/transcript-editor/Edit?token=SCSpQQqgDe1UyL1mnJTw9Qgv-g658O5FfOLu5EalS9wv64Pxo94FGPrvDMq0llzGCGTHd8B2XuyQYvptt3JMAoP70Gs&loadFrom=DocumentDeeplink&ts=1803.93)):

Tomorrow morning. The reason why I'm putting a bit more effort into this than a normal presentation is because there's a lot of misconception about what this project is. You have one spontaneous, you leave it like that. Then the other one, you see it like that, and then you just slowly start going in. And so I think that it's important at this point in time to try to really lead them through the science of what we're doing.

Martin Telefont ([00:30:27](https://www.rev.com/transcript-editor/Edit?token=pvKuYIWKXNoQnVDs1SAkcUu12NRag5c12hkoNiifDnxlcQzyKxtjcR5NXMJrl1pRa-kqYDxegwl2kAAWWkJMg1D1Euw&loadFrom=DocumentDeeplink&ts=1827.17)):

We can get the top view of the slides and then we can go [crosstalk 00:30:29]

Henry Markram ([00:30:29](https://www.rev.com/transcript-editor/Edit?token=uPIid1cdbm_9q9DcDr66LFNUMFZIRsyOIRtkgqxip0pJBk7O4Ml0mmJk10Lt-BQHoddLBBp8eJSlgVgaUU-JOTqCSdY&loadFrom=DocumentDeeplink&ts=1829.37)):

No, just this one we have, now you just have to zoom and you'll see the top of the ... See how thick it is.

Noah Hutton ([00:30:39](https://www.rev.com/transcript-editor/Edit?token=GlAkIBBcR8jf3L0esfQCsKigZu7HL-xC1-fvyhx_K-o6kTJ9dxGauVwOHvyvg3XY-j6m5VbuDM72PQnEZPZLk0NzDUw&loadFrom=DocumentDeeplink&ts=1839.12)):

The one billion euro proposal to the European Commission would be called the Human Brain Project. And if successful, it would mean over 100 labs working together in a brand new 10 year timeline.

Srikanth Ramaswathy ([00:30:50](https://www.rev.com/transcript-editor/Edit?token=BTR8sCNmrBDlksxU7UzReEVQ-7YZc94QvPxe5wpYcVF0z-Xk2CX_5yfCq5pa8ZAe2iFZzxUfq-2bG2rIl7R6hU3afAA&loadFrom=DocumentDeeplink&ts=1850.27)):

Henry's talk is going to blow the audience away simply because there has been no such thing shown to the world ever before. I don't think the community's braced yet for a talk of this magnitude. So if there could be a Richter Scale for these talks, then I think nine would be the minimum for this talk. Yeah, it's going to take the community by storm, I'm certain.

Srikanth Ramaswathy ([00:31:16](https://www.rev.com/transcript-editor/Edit?token=QnBmgjMFMn_gf0g_LG0gSUmdXlpIxYMB-EaKuHdUQ1IAx1_nu4VCgCwqBF9q6hqDxeP4tqgUwp9Mz0KUIvbofebTIp8&loadFrom=DocumentDeeplink&ts=1876.04)):

(silence)

Henry Markram ([00:31:16](https://www.rev.com/transcript-editor/Edit?token=kCtX-8QgcqPiMzETGwJiGzBUKuYW64-Ms5W6L6cza27_rPYvCtAmWj2sClbN4P7UE3Juy1ediFWt3Ovi9b4YMU2BCyg&loadFrom=DocumentDeeplink&ts=1876.04)):

This is scary.

Henry Markram ([00:32:09](https://www.rev.com/transcript-editor/Edit?token=i8WK6hKDs1sD5VpoG74fXZPpg41IZdZeaRO3rqj7h6E00JRQ3ifh4o76P3Iqbrfg6SrW-bA8h5P9LrrREV7CylHfwY8&loadFrom=DocumentDeeplink&ts=1929)):

[crosstalk 00:32:09] and this is the reason why we've been driving Europe and pushing Europe to launch a [inaudible 00:32:25] what we want to do is build a CERN for the brain because we feel it's critical to trigger a massive, globally collaborate, and very focused effort of understanding the brain.

Speaker 32 ([00:32:37](https://www.rev.com/transcript-editor/Edit?token=G-gV99HSExzZhkOB7alW2qP51MbsK_45UPfBLoiYvyXerK2klPQ5VkEZzCnCecdAlBzcaWrim5XY-NzJKg3Ab5cAquE&loadFrom=DocumentDeeplink&ts=1957.93)):

You are not modest.

Richard Walker ([00:32:40](https://www.rev.com/transcript-editor/Edit?token=zYVOUTbj87RYZD4K4Ml-UN4_sTg8iAxOCnMEWKrpCrVniQ9gDbrLlo-vi0KthcDUey857hxj9oghnhcK7VHQRuMLwzc&loadFrom=DocumentDeeplink&ts=1960.16)):

There were six competitors for two projects, so two out of six will win. And the European Commission thinks they can tell us that in the early months of 2013.

Eilif Muller ([00:32:55](https://www.rev.com/transcript-editor/Edit?token=q82nNvmcBRJpeUjP6-R7sBJ7qITEsbGytBnfZctbCqrupqyTDsS9JR2OSEP39IHu9hFYkR-TAhtH4djjVw1XZBRxp7c&loadFrom=DocumentDeeplink&ts=1975.8)):

That's where it stays.

Henry Markram ([00:32:57](https://www.rev.com/transcript-editor/Edit?token=-ABM1aKAAKsL-MDjTRsA2aiLkPHxsTdiIGCpd7E2bjSY1lNuk7xQC9Inzoe67lHd0MsKU3OzmA4y9fRsZm-CY9-jXZY&loadFrom=DocumentDeeplink&ts=1977)):

[inaudible 00:32:57] and I thank you very much for your [inaudible 00:33:10]

Speaker 33 ([00:33:11](https://www.rev.com/transcript-editor/Edit?token=z-ao9hYq4zbygtgRB--8mp__Fl64aL24XulUS2FSX0gVJ40kW86q6K3ifG1WpGmO4B1uDr7TfRCt1W84fFcha0WkZiM&loadFrom=DocumentDeeplink&ts=1991.01)):

Another thing that you sometimes do is a small sign of salesman.

Henry Markram ([00:33:14](https://www.rev.com/transcript-editor/Edit?token=89fViy-Q_vOWGb0A9-gHTSW155iNX5ZzJHNXadDUI3Dq283ro1rVVWNDgzY6B__gOsT_aVNxSx_FmBFylRureELlUVY&loadFrom=DocumentDeeplink&ts=1994.14)):

A little bit of selling.

Speaker 33 ([00:33:16](https://www.rev.com/transcript-editor/Edit?token=4Q_JULSBJkfIo4UStZ4bOv3CA4m7cvmezgwGCN9vFJh8JSKpsqYj1WjNOLrpD794zfEC01ocPmIQXeJPMjmDOZGZEko&loadFrom=DocumentDeeplink&ts=1996.29)):

But those people are not deciding.

Henry Markram ([00:33:17](https://www.rev.com/transcript-editor/Edit?token=RuoYeZi7UO4pAUqC70xUVNJ9FzZZBbZro_4nJ8-rDCf9Q93UG-o-v-ak-eWqpnayFNrXF1jTGgP61i6Bl02tb3EdF94&loadFrom=DocumentDeeplink&ts=1997.56)):

That's right.

Idan Segev ([00:33:32](https://www.rev.com/transcript-editor/Edit?token=1LByl-5REHDBZiEITbPQyD2z4DAfoG6x2CRBzV_a1hLNQT85RssVX-YG_mdofatoNSU3URaRkEPmabtHisVrkpKTM6g&loadFrom=DocumentDeeplink&ts=2012.61)):

You put 10 years of your life towards a project. You believe in Henry Markram that can lead it, and he can. He proved it, he can lead big events. And suddenly there are these critical moments where six finalists are waiting for the billion. But it's not the billion, waiting for the dream to be fulfilled in a sense. The day before the announcement, there was this uncertainty that killed us all.

Henry Markram ([00:34:03](https://www.rev.com/transcript-editor/Edit?token=DWX3ezsgwmCmFVy7uc39AfazNLSz36yANl6GntYHZTJwMIwAprYTCj9g0ssrgfVyCefHCwYHA2IEkEda12plMeB3OfY&loadFrom=DocumentDeeplink&ts=2043.45)):

We heard a very significant rumor from a very reliable source.

Idan Segev ([00:34:07](https://www.rev.com/transcript-editor/Edit?token=W9tpZbcoldM0Y_ng-3uV9Wr6mOwspnKQQbQerIdqndB6eaun2sGrdyI7-AWmk0kcYfhFmIJBRro753bm11os3tygRMo&loadFrom=DocumentDeeplink&ts=2047.2)):

From significant people who said we know for sure that it's not going to be you.

Speaker 32 ([00:34:13](https://www.rev.com/transcript-editor/Edit?token=gDcrmqypbU1M04lILsYyCwmnXPfKsT5Pwcw7Ru2vHxMPhp4KPbio0K-kDRRBdQ2nsvSDmWrwgexGUDGllBqw_sVXcHg&loadFrom=DocumentDeeplink&ts=2053.88)):

23 proposals and then a short list of six. And now, two winners. One of the two winners is for research into graphene. The other winner is The Human Brain Project. Congratulations, Professor Henry Markram.

Speaker 34 ([00:34:36](https://www.rev.com/transcript-editor/Edit?token=9Yb1b84SZD-mWy3_XHa6yhYI5SZi9zmr8pnbAQpok913oU5-NmhduMh919oXz-tVXnnYrOloV80ZwSnGGJyC2FuqCWk&loadFrom=DocumentDeeplink&ts=2076)):

[crosstalk 00:34:36] Human Brain Project.

Speaker 35 ([00:34:37](https://www.rev.com/transcript-editor/Edit?token=kqfgQ8bWO5DB05SUzv6vlhxXANjX5hoBjBnPekKMntCR2iXdouPcefK0Z6BEaHxIuXoZbPNR1HZH44vo941B2zdjjFM&loadFrom=DocumentDeeplink&ts=2077)):

[crosstalk 00:34:37] Human Brain Project.

Henry Markram ([00:34:39](https://www.rev.com/transcript-editor/Edit?token=NWcxCib7DrMioNYYlpAr815uHylgykYnLAWUffu-_X7UWfeZpSJZaJuk5dSewBtfMo78CoKWWgUaqxvQU8Iyzyl8vSQ&loadFrom=DocumentDeeplink&ts=2079.13)):

It's an amazing thing.

Speaker 32 ([00:34:39](https://www.rev.com/transcript-editor/Edit?token=G3vvUytTwr7ykSDhIsEBfzaD1MMLIq4kst1XvlVWctIj0DSH6GPe36g40nH5h4uLfVIOjDG1HrbnbN6dD8iXhG28Sw8&loadFrom=DocumentDeeplink&ts=2079.98)):

Okay.

Henry Markram ([00:34:54](https://www.rev.com/transcript-editor/Edit?token=eMPypipd6xHBGStcNip8W_xXMGCTf8ZlBrhePQUa-e-z1tm6aRmdt20zNu3kSnCFruxNGnbgX_UOeGmdQkyvAHovYss&loadFrom=DocumentDeeplink&ts=2094.65)):

The scientists that never even knew each other existed have come together in this project and are going to now work together on a common plan.

Speaker 36 ([00:35:01](https://www.rev.com/transcript-editor/Edit?token=1eIO3IyBVZwNkptvbucP2RQ-rMu9gpoiLfnSXt6ROBNY0xEo8g8KB98bZzr0xbil4Ld2EYHUEM2gDXv06N2Uwfv1kCI&loadFrom=DocumentDeeplink&ts=2101.091)):

[inaudible 00:35:01]

Speaker 37 ([00:35:03](https://www.rev.com/transcript-editor/Edit?token=tRjR0r7n-FmxN105H0If3KGH1kd1Ry-8uKBZACsRu55r3XLYGXlnH6agyT8M0v9F5Vg2UjFLtqv__SZhsD9MSVU4NTU&loadFrom=DocumentDeeplink&ts=2103.6)):

We've made it.

Speaker 38 ([00:35:04](https://www.rev.com/transcript-editor/Edit?token=yLTmoQQbi4WbFiNVORFAUkt8QRPDsd0yCIYSdvVmBABDXpLCz5XwJWvzNGnG9mwXVGyS7pkC7uZVjoz-JY7ieL4r2zQ&loadFrom=DocumentDeeplink&ts=2104.37)):

It is really something to discover.

Speaker 39 ([00:35:05](https://www.rev.com/transcript-editor/Edit?token=NLFxbYEK0a-MPX2N4K3PZ94lihAZe6Yli1d10l4en2HOefYZX-e0Lsg5-2ngxILO4Rf5h3n6UiSvBZ4LqngqRe7a7_E&loadFrom=DocumentDeeplink&ts=2105.87)):

It was just what we were waiting for.

Sean Hill ([00:35:07](https://www.rev.com/transcript-editor/Edit?token=Tv6fpinehLNeQSZXeTnQslPncpntOiFw0Dnu-lEeYc-eWX34MWfPk-fQcS1QCBBNUjMt5rGFme41yHXYtHZPT-65bB8&loadFrom=DocumentDeeplink&ts=2107.64)):

The first thing I think about is all the work we have to do now.

Speaker 40 ([00:35:09](https://www.rev.com/transcript-editor/Edit?token=sa5ESI53FHucHY23BPzQ8ct2pnNS7IzThv2jXrssd1w1E7051s7x3hfKO14gAxVjUPcBDoahjLScC1cShic0NeULMdw&loadFrom=DocumentDeeplink&ts=2109.33)):

We belong to this project, but we also feel that we are enhancing our own science.

Speaker 41 ([00:35:10](https://www.rev.com/transcript-editor/Edit?token=dJLMEa3sIEPO1v-MM4hPaPfrhiTBgUp_yV-DAC-Mga4-k-vB_dvyWq5ZOBcaXzVwwVuKYX40055C1a5iFnV6coNX8lQ&loadFrom=DocumentDeeplink&ts=2110.04)):

Mathematical criticals.

Speaker 42 ([00:35:15](https://www.rev.com/transcript-editor/Edit?token=uIYXAwVK81eNMqEUQNCOOYWD3XCFo80QfL0kFOn8ChAZFgudHE2CFgZJUvOdOdnYcFNxwm-_6qdBEtBccFGQluYLy-U&loadFrom=DocumentDeeplink&ts=2115.35)):

Robotics.

Speaker 43 ([00:35:16](https://www.rev.com/transcript-editor/Edit?token=gcuzozDO4tvoqhAAYs5lnWSbcUXGA2L3LnC97Bfrq5Wal_NSy8DBjtYmKLTwq2Mf4kU8KRQUWvS7DA0ni5FgSURoerI&loadFrom=DocumentDeeplink&ts=2116.03)):

Brain images.

Speaker 44 ([00:35:16](https://www.rev.com/transcript-editor/Edit?token=Uxbo7vmMPOBb03PEXxzjFhqPQXCDAixXRBpuewoj1VTNp2vvmlfUC5aIhyLI72WkgoqzaP99N-06yeAHCxPPDZb7uqE&loadFrom=DocumentDeeplink&ts=2116.92)):

It extends society.

Speaker 45 ([00:35:18](https://www.rev.com/transcript-editor/Edit?token=ypNEd6vHABT9os7loc8nBt72wy-uUeU1h01CROWqNeJJXQD5Xj-pJVgDoRI0UnIBMAcUwWxFAjftGyk9DwgGo-RQ0G4&loadFrom=DocumentDeeplink&ts=2118.34)):

These chips.

Speaker 45 ([00:35:31](https://www.rev.com/transcript-editor/Edit?token=JciTz6M4IKa2wzzBZxIPH4acOlgSvTbis5czz57-dFlAVeSWGFEeWLKWAb__YWqLOYHmzrn5y5XiRzJg_Y5fRWd8t58&loadFrom=DocumentDeeplink&ts=2131.39)):

(silence)

Idan Segev ([00:35:35](https://www.rev.com/transcript-editor/Edit?token=UYl155Fh0HDm_wF-rK4ZxQ3GyyO151HtDp_uG6powPXUhnbe-rEtT2MHJbDZG2zxf671v8UPiCr6llbI3hjanuK5wfY&loadFrom=DocumentDeeplink&ts=2135.39)):

Now it's serious.

Barack Obama ([00:35:39](https://www.rev.com/transcript-editor/Edit?token=4D7homYT3p8m1UkrMP4XvCg5ehlSrJc-NpSoXszv3zuI_g6Uig9OFlZH7WyJhmJQ_CEYiJcnZPgo3UI23Ems241BnKc&loadFrom=DocumentDeeplink&ts=2139.21)):

The next great American project, The Brain Initiative.

Noah Hutton ([00:35:41](https://www.rev.com/transcript-editor/Edit?token=c-eqPoDDrS8hl0v9SdngLT5vqYtvcrjFoA-PTMyHU94P6ZfLZimCo8Ebb1yElUk-Um_n1tPlRUeTX8-QrBvzs7MM-Bw&loadFrom=DocumentDeeplink&ts=2141.78)):

The European investment in The Human Brain Project seemed to kick off a flurry of activity around the world.

Speaker 47 ([00:35:46](https://www.rev.com/transcript-editor/Edit?token=KJxHeR3cgSPBZ6GyhxQ_G93rOzh8y4z9ElpGh_MIULSI0fN4KWOQPoHFgzlQ8SojnMO3DEGpY2uURv6lk_6bO7ySXJI&loadFrom=DocumentDeeplink&ts=2146.4)):

In the US, the brain initiative focuses on neuro technologies. In Japan, the Brain/MINDS Project on brain mapping for brain disease studies.

Speaker 48 ([00:35:55](https://www.rev.com/transcript-editor/Edit?token=ZZPbeKRxfhK07r6Lv1kZUYwtK0x74Y6-4s_3GiNx8HytJ0Rmbh5b8XUGeqRqFPyePoWHUgPZNH-SYIwS1uxMFyc9hUA&loadFrom=DocumentDeeplink&ts=2155.19)):

What is the China Brain Project?

Speaker 49 ([00:35:57](https://www.rev.com/transcript-editor/Edit?token=YWvQ2Yk3O1AdOxbu3GjNwwzVdBpPbiR17J2HMlzgSaQ907lX9t05mmyZyAumZ5J38PGrzaZZO2ZwpkaR-3RI28aGWDw&loadFrom=DocumentDeeplink&ts=2157.57)):

10 years with international collaborations, mouse connecting.

Speaker 50 ([00:36:02](https://www.rev.com/transcript-editor/Edit?token=8XeQRAgRDdAr9wTlsXkO0i0CHA0orWo1Co1Tq33bIqmUYVI7ao6uPcWdzh-LEjQ39LFPh4PcZKge69hzYnZE3OJf1Z8&loadFrom=DocumentDeeplink&ts=2162.92)):

Mapping the human brain and making a digital copy. It's not the basis of science fiction, it is the long term work of scientist Henry Markram. Markram's work is being documented not only in scientific journals, but in what will be a 10 year documentary film. Let's bring in the director of The Blue Brain Project documentary, Noah Hutton. How does one commit to a 10 year documentary project?

Noah Hutton ([00:36:26](https://www.rev.com/transcript-editor/Edit?token=Y5nCMqnrcOi9BG8VLqgteN4Y7QEL7g2G5s1YHaXG-Xm13lKKlupr7cAkMKqVhKkyMfE6bbULyMp0kqOYV53YFg-EF2E&loadFrom=DocumentDeeplink&ts=2186.15)):

It is. They became The Human Brain Project last year, which was another 10 year reset of the timeline. So now I'm 15 years in. Well, I'm six years in to a 15 year film.

Speaker 51 ([00:36:36](https://www.rev.com/transcript-editor/Edit?token=n1Rp0mPhhG5C_7LFriApGOcJ1a-ba4l7nOPfw-57U3z8lOh2w8QADbBuNzAD26bJX5CP0um9Kd9cI8ru2oY9sbAzEdw&loadFrom=DocumentDeeplink&ts=2196.17)):

Picture a cultural change that would tear down scientific silos and build in their stead unprecedented levels of integration. And through all, picture the potential to unlock the most mysterious and fantastical entity ever to exist on Earth. What would that be like? Well, ladies and gentlemen, we're about to find out. Welcome to The Human Brain Project and to the first of over 3,000 days on the road to discovery.

Zach Mainen ([00:37:19](https://www.rev.com/transcript-editor/Edit?token=ORMpQLb2mhO_MpjwDX5yEIQuUTMav8jIYO5UNSwOgKL18ufJCxw1yps2bIbTHvGh6YJEGboFcEP3DQ3bfuadf7KvJIg&loadFrom=DocumentDeeplink&ts=2239.39)):

It just all never made much sense. When I was a graduate student, I published papers with detailed simulations of neurons, very similar to what Henry does. However, when you step into the problem a little bit deeper, what you see is a conflict which is often simply put at top down versus bottom up. Bottom up person says we don't know how the result, which is intelligence, say, is going to happen, but if we catalog all of the bits, then if we put them together in the right way, then it will emerge naturally. As if, for example, you are facing a broken watch. And if you could just put the pieces back into the right places, it will now tell time again.

Zach Mainen ([00:38:11](https://www.rev.com/transcript-editor/Edit?token=jzKwqj6OpKipvJ5UVQbWjwsYpy75hxYjWUIqorPnc9jtq2lgD2bqxcOKSdLErhS8GZUEoO8Hg0KCg57tWiKyhdJ3u2g&loadFrom=DocumentDeeplink&ts=2291.46)):

So, indeed, if you knew all the right pieces and you knew all their interactions, then in a simple case, like a watch, you really should be able to reconstitute it, simulate it, whatever. So now you take the brain and it's a bunch of neurons. They hook together in certain ways that are going to do certain things when they're hooked together. However, most people think we don't know what all the relevant bits are. So if you take this bottom up approach, you'll end up with something that's a bunch of parts, but doesn't tell time.

Noah Hutton ([00:38:42](https://www.rev.com/transcript-editor/Edit?token=t8Immbywub-bYzPXfXYNtjYxp5nZxMp-ObHUSLdLU8tma4UZQoh20Xk_geOR158Dx6GPrh2aGxylo8L9f4ycGvs75uo&loadFrom=DocumentDeeplink&ts=2322.54)):

Cognitive neuroscientists like Zach Mainen saw the idea of simulating a brain with a pure bottom up approach as flawed because it didn't take into account the behaviors that emerge from this cacophony of tiny parts. This sounded similar to other criticisms I had heard. A question of whether the electrical activity in the model would ever be relevant to the complex behaviors of an animal with a body in an actual environment.

Zach Mainen ([00:39:05](https://www.rev.com/transcript-editor/Edit?token=LGafSbx9bReRjp_mPKJCsK8UhswiJgKJRsgiOKYHgbpJzCMISUhA-nfYJI3IcBx6TdoYSGEFHQtsSiqlUvbHd0dltOA&loadFrom=DocumentDeeplink&ts=2345.17)):

Is the point that you can now point at a beautiful simulation or a particular neuron and see spikes in the dendrites? No, we don't really care about spikes in the dendrites. That isn't the point. We don't want to predict spikes in the dendrites, we want to predict what it's going to do. I thought at first so maybe our behavior tasks will be modeled on the simulation. And then, if by building up all the circuitry we could have an artificial rat brain doing the tasks that they would do in my lab compared to data back and forth, but nobody was talking about doing that.

Peter Latham ([00:39:38](https://www.rev.com/transcript-editor/Edit?token=MGIzrOU7u3Vld1dvta7uHvhbkUNjIOuxvRhJGoQrnewdhP5ZlC7ndptCR4LS3H5c9QgQ7WrxpH89bfE1Yu261n0xnYE&loadFrom=DocumentDeeplink&ts=2378.49)):

In a nutshell, the plan is to collect a bunch of facts, put them into a computer program, run it, and hope it tells you something about how the brain works.

Speaker 54 ([00:39:48](https://www.rev.com/transcript-editor/Edit?token=KLtN3QskceqQRAY3MK0O9mxYWHj9vlI-N6zTnlcC3mF92GN-jRIjv5GPMG2xr5axTxtrl-sc2P5zUvEjWZ_-9CkgsAA&loadFrom=DocumentDeeplink&ts=2388.05)):

And you're skeptical of that?

Peter Latham ([00:39:49](https://www.rev.com/transcript-editor/Edit?token=r7aLVE398aUXVNnXruvXbGIJjoXKKTiUpn6TW1niG_I70ay1i4Qq4gCrzy1EPZMDQPfA6geC4cZwbGSrWz2sEHevhSY&loadFrom=DocumentDeeplink&ts=2389.69)):

They're skeptical.

Anne Churchland ([00:39:50](https://www.rev.com/transcript-editor/Edit?token=WWTN9fQS0NCVSLb9cNXPyDG7ftF8KHKWj1UBBKH1dA8yWP_VOvBrw5BdhA_cCFCiPi9BaMD4-r6fRip3tUYuP3Lv_LA&loadFrom=DocumentDeeplink&ts=2390.44)):

I think if we really had unlimited resources, we would have room for more people that have super open ended experiments because, the super opened ended experiments, they have a place.

Zach Mainen ([00:40:00](https://www.rev.com/transcript-editor/Edit?token=BAMiBURaXf3bpXanhtWNH9KiAcfp10oJjA4QsuqduW9E9-a85BIoc7lPs351L9XhCwxxR9Z1UwU_XbW6_rqJUga9InU&loadFrom=DocumentDeeplink&ts=2400.61)):

I think people would be okay to live and let live if the project was being represented fairly as a project and there was money for other projects, et cetera. No, instead it was this is the game and you're either in it or you're not in it. And that naturally makes many people almost double down their negative reaction because he's being so aggressive in saying this is the way we have to do it.

Anne Churchland ([00:40:27](https://www.rev.com/transcript-editor/Edit?token=uTI4aWeM_tcO3Btpf21Un3IVMS9Kzhc9EKASRgy0l8L7RzI_GO3fqM0nApaFObwbzpSZTJdVKSMYX-ndpK-SFQ8m6BU&loadFrom=DocumentDeeplink&ts=2427.6)):

We should hope for the best kind of structure for science possible, which is that there are a group of people that are really excited and really dedicated to a problem. And they come together, and they push hard on each other's ideas, and they are critical when someone's going the wrong direction.

Zach Mainen ([00:40:42](https://www.rev.com/transcript-editor/Edit?token=sk4AqHbYvIp82EQuCTN8S87FI_MZ7MbIqrd0vSbJi19TwkfgEThaAfIQhbeUns4NHysBunZCmh9BI-7QOdyNzaYcMng&loadFrom=DocumentDeeplink&ts=2442.31)):

It's rare for people to be so aggressively promoting one particular approach. Even that approach has some merit, I wouldn't say my approach to serotonin is the only way to study serotonin. I would say I hope we make some contribution to this problem. I could certainly benefit from interactions with people thinking about it other ways. And you just never heard anything like that. This was not the way that it was going to work, so ...

Speaker 55 ([00:41:16](https://www.rev.com/transcript-editor/Edit?token=WqShEZmRGu09TjHVOonUCxEFfi0WfIk7fKcucmnYtQqxJNswV0bbQoOjqSGlAnoW5K5-lf2hSxEap4Q7tWuGZaPV6JU&loadFrom=DocumentDeeplink&ts=2476.55)):

Scientists have signed an open letter, calling for Europe's massive Human Brain Project to be reevaluated.

Noah Hutton ([00:41:24](https://www.rev.com/transcript-editor/Edit?token=jSF9NMhXuPv6SbczwePjYh9TGKmNTKnJ04MRmCSL2-0xCe4dYKhlx0_w72VPADK7lof8puNa1QK1My8q2oGTtjrTlEw&loadFrom=DocumentDeeplink&ts=2484.06)):

Zach Mainen coauthored an open letter that called into question the scientific direction and leadership style of The Human Brain Project under Henry Markram. Over 800 scientists then signed on in an outpouring of criticism I'd only seen glimmers of through the years. As Henry's billion euro triumph was thrown into question, the project attempted to hold their second yearly summit and focus on the science.

Speaker 56 ([00:41:49](https://www.rev.com/transcript-editor/Edit?token=YL45r5vZt4bEXFc1GnfRHILWjbRqKiC4ALY3UC8Lwxx2-97Z_7YQAD_SIgJDSjUXqsJXVWFFkRd5_4wHnnp8evu_FVE&loadFrom=DocumentDeeplink&ts=2509.97)):

Some may describe the goals as overambitious. I keep reminding the enthusiasm that was there when we launched HBP and this enthusiasm needs to be kept.

Noah Hutton ([00:42:06](https://www.rev.com/transcript-editor/Edit?token=-0kEgMakdNr-XXV9ayitUTzz8Ua__MaY2blY3YLnxjxS-i5D74sb3YHdeSCmoYghxnWzL-wMhv7C7wF8LNdFShJvcSI&loadFrom=DocumentDeeplink&ts=2526.13)):

Henry had allotted a significant portion of The Human Brain Project's budget to the computer infrastructure needed to simulate the brain and the more traditional cognitive neuroscientists within the project felt like they got the short end of the stick. Simmering intellectual tensions have been set aflame by money.

Speaker 57 ([00:42:26](https://www.rev.com/transcript-editor/Edit?token=k0jJVKxakw81QfLgH83iL_LuTzxLlMikVC8MTpLQcPgYQWlZ6tUdkzqb6eBWNC8-WXGzJnrwrl0DAm9bqdgGU7jrFSM&loadFrom=DocumentDeeplink&ts=2546.63)):

Welcome everybody to this press conference.

Henry Markram ([00:42:27](https://www.rev.com/transcript-editor/Edit?token=zU51XEk9ZLoD9Z5XjTNNCucmb-k4yh670EFaEhz9DMKvQ5XJ1FDgbRd8tU32CpVKx5-J0yFIw-1bSmk7ND8lFON625Q&loadFrom=DocumentDeeplink&ts=2547.7)):

First with a brief summary and then I will go into much more depth. It's been off to a great start. It's a big step, it's our first step. Let's have fun, let's [inaudible 00:42:42]

Speaker 58 ([00:42:41](https://www.rev.com/transcript-editor/Edit?token=VNMZ_HJ5Tvk2h5ofX-tmurDyQ2SQGIBTFWsAlWeB2XHqoOHZqGYtYdsU232HHJexzL1YIVT_e0luKKHnEfR6ocR_Wlo&loadFrom=DocumentDeeplink&ts=2561.83)):

In your presentation earlier, you said there were expectations that need to be managed now. I think you were referring to the open letter by almost 800 neuroscientists by now. I'm wondering where those expectations were coming from. Is it maybe because you sold a technology project as a neuroscience project?

Henry Markram ([00:43:14](https://www.rev.com/transcript-editor/Edit?token=uGxYm-hT0_8vB_HAZEwBCGmLA-LIgk4zj2wbn3sp4FZJDFtBC4rpw-OtO_bQKEYoOIS0gGnkc6eGrnwcL2c_57EexyA&loadFrom=DocumentDeeplink&ts=2594.66)):

I think the notion whether it's a neuroscience project, it's an IT project, let's get on with it. This was a disastrous press conference. We messed up. We just wanted to talk about science and we should've realized that we can't.

Noah Hutton ([00:43:35](https://www.rev.com/transcript-editor/Edit?token=aGZOuvpaBWXXR7P7wxsdPN0CJ4Ij1M_9tM6_fBVJk2RqbY8CENjg7BNzL-zn887556LkAxh6q8LcV0v-zizwAYoZ4kM&loadFrom=DocumentDeeplink&ts=2615.14)):

Henry's critics resorted to the open letter after months of disputes behind closed doors. At the summit, I was hearing whispers that there was a bitter disagreement over funding between Henry Markram and a cognitive neuroscientist named Stanislas Dehaene.

Stanislas Dehaene ([00:43:49](https://www.rev.com/transcript-editor/Edit?token=ZnEE-Ge2yTm1DcE6gBruVWLBNXrWV2aWjwbFYhTTUgNv_6d1tB2WbxqQr5atFf34poGHSX9s2HVZ_F8KJpw2zL7H-lM&loadFrom=DocumentDeeplink&ts=2629.27)):

You learn that after three months essentially they wanted to kick me out of the project. And so I know you heard about these all stories.

Henry Markram ([00:43:57](https://www.rev.com/transcript-editor/Edit?token=ySRhdY_ZYM9aR6rfQRfeZG8i79TYRSK2rvKwrBl6H94jD-lPDMjJBTjSe9KAjHiYb4bzY3Mkd686gmwXvLaZ_JQsBD8&loadFrom=DocumentDeeplink&ts=2637.3)):

Why did you come into the project if you don't agree? Why do you sign and come into the project? They said, "Because we thought we could come inside and change it."

Stanislas Dehaene ([00:44:06](https://www.rev.com/transcript-editor/Edit?token=A9laolsOfpG5WMBVHXJ5ek6ptxMsnrWzXVcG9QD06ezVdDrKVT_v2dINUT0ZobwwoEKtx08s_W6TwcMwEzOety00eN8&loadFrom=DocumentDeeplink&ts=2646.55)):

Maybe there is a connection because it's a special kind of scientist that goes for billions. I was not interested in the billions, I was interested in the science.

Henry Markram ([00:44:14](https://www.rev.com/transcript-editor/Edit?token=_p8I_ePc1aFkNcKoYiSCukBPuf2vT5adlt7IiSbtKR4Ev70Hs2Zb3mjgKINLqmEC_KCkQvuV9qTl2HYgXLLha7qu66g&loadFrom=DocumentDeeplink&ts=2654.11)):

It's the era of the social networking. One neuroscientist that's frustrated, not getting funding, is now going to click the button. Come on, everybody, click the button. So it became a click the button thing. If anybody hasn't believed by now or doesn't suspect that it's just maybe possible, that in four years we're going to have an exquisitely detailed reconstruction of the mouse brain, they've got their heads in the sand. I try not to talk about the human brain, but it's going to be the same. Everybody thinks this is just unattainable. I have to tone down the message, I have to keep it calm, but this is going to happen. It's just no question.

Noah Hutton ([00:44:59](https://www.rev.com/transcript-editor/Edit?token=pYjXCS7ICXnKaNkww8Ut4a8NuYOOSDeIyM4Pb5NiFsacBgSfQkaAW0NLH4u1CkJWRHM7f2XBUlYVCn_MujlXTeb0fxs&loadFrom=DocumentDeeplink&ts=2699.37)):

Do you need him or are you ...

Speaker 60 ([00:45:03](https://www.rev.com/transcript-editor/Edit?token=y4YhByEf2VjoKUvJ69zEge3IAJ3zsCgzcfAxtanbx8mjU6bZdglRdSymVT7DjjytuYDiViZook8dJuEAiHDguqsuUWw&loadFrom=DocumentDeeplink&ts=2703.57)):

No.

Noah Hutton ([00:45:03](https://www.rev.com/transcript-editor/Edit?token=YbQIU-NELj9vS4o1ACfILeJihe06ejVm87kWTddudwbI_IjtV7y9aB8PpZZnnnIoxG2coGMnbSpk_Xa1HEpjM5U7xrE&loadFrom=DocumentDeeplink&ts=2703.64)):

Okay.

Speaker 60 ([00:45:04](https://www.rev.com/transcript-editor/Edit?token=B1tnHTBBf2tbEDuUjXBrNRreENT5HL6ijEvDzxrUkv6GqQPg-CnxtL0YHRNbtSNAAwiZcDcAzcSly-DK7ELcSk_Jm_k&loadFrom=DocumentDeeplink&ts=2704)):

[crosstalk 00:45:04]

Henry Markram ([00:45:04](https://www.rev.com/transcript-editor/Edit?token=4nGZynWlj2_V7nsgIxMKhW0NpVbeil9WR4v4Ij6oRSCIeFfUf2B5y1720CsCbpvrpK6zodPD6BYRS0HHirEbb3_9Fak&loadFrom=DocumentDeeplink&ts=2704.57)):

It's only going to be in 10 years, so I can say whatever I want. I'm telling him the truth.

Henry Markram ([00:45:57](https://www.rev.com/transcript-editor/Edit?token=b7Fc9jwUf-QGWjjUzmSBwra95ZarD5sSiGhif-sOnnBF61ZI3W1QtKM4YktVNLq_HDsuLm9tjTpRGfpA7jDxiSfl00w&loadFrom=DocumentDeeplink&ts=2757.95)):

(silence)

Noah Hutton ([00:45:58](https://www.rev.com/transcript-editor/Edit?token=OFatEywTtwXjo_MKbX06EKbH7dHOUOM45Z5s1IxZ4ma8S_bzqT8kThcXeTgp5AzqKp816SN1s_MIpwZkiNqdlwliQb0&loadFrom=DocumentDeeplink&ts=2758.01)):

When I went back that next year, the shake up was complete. An outside mediator had recommended that Henry step down from leading The Human Brain Project.

Eilif Muller ([00:46:13](https://www.rev.com/transcript-editor/Edit?token=XiCOikhse7h1T54Q2KdupET69DIRP33lR2WPtx3Sohpgh0k6GgEQZGOdTuco8-e9p_gfGk1MbPfR4i0nvuBaw4Z5xrc&loadFrom=DocumentDeeplink&ts=2773.14)):

Being here and witnessing what it took, and the amount of personal energy, for example, Henry Markram has put into getting this project off the ground, it's super human. It must be incredibly painful for Henry to basically have put so much personal effort into something that I really know he really fundamentally believes has to happen in neuroscience. I also fundamentally believe it has to happen.

Noah Hutton ([00:46:46](https://www.rev.com/transcript-editor/Edit?token=wCI08OpguGH0-UpIC4QNRx_hOQpfI6pnptg4u6wcBU6yxSPLdNVxX1LHTfFaEJzj-EgtI34x1aYPwrbkJ_ltNWsf7DY&loadFrom=DocumentDeeplink&ts=2806.2)):

The sixth floors of what was supposed to be the new headquarters in Geneva were now a reflection of a messy break up.

Speaker 62 ([00:46:51](https://www.rev.com/transcript-editor/Edit?token=D2nar4jqcipprjLPng3LYRxesVEwxlb9rcL491We1zEQSDRVZSO_OXSrAzDpibRhBdO4jE5aT5OQnRKQEEIbVS9klbw&loadFrom=DocumentDeeplink&ts=2811.85)):

Blue Brain is now third floor, fifth floor.

Noah Hutton ([00:46:52](https://www.rev.com/transcript-editor/Edit?token=HPcH2qoizDkN-iN4DzK7MsZdfjQ9K7G7F1_U79rKWb9kyGiNiEFTuPaEQ82tolv2hB-xWtWIJnFlwEr0AnZ-72xwCW8&loadFrom=DocumentDeeplink&ts=2812.88)):

Okay. Where did the HBP people go?

Speaker 62 ([00:47:00](https://www.rev.com/transcript-editor/Edit?token=RlU4eLuzs3UM4f0TOrpt7HJTx0PG5ug8XRMnCUfWiIiPHfPHH9mw6P9xUiRhAQkrQxeN2kVhcWD6t2Z_rAjN13moIfY&loadFrom=DocumentDeeplink&ts=2820.97)):

They don't like to say. They're on the first floor.

Marc-Oliver Gewaltig ([00:47:01](https://www.rev.com/transcript-editor/Edit?token=DZzYoVtzeg1AzJUIa1LP9dxgrd-td5Xdg3N_9fz_TNYS0whMs_XYimJ4p4VmC2XdMIqelkUECpE68EBtzZM6_TNXcoQ&loadFrom=DocumentDeeplink&ts=2821.8)):

This document describes The Blue Brain Project and this document describes The Human Brain Project.

Noah Hutton ([00:47:09](https://www.rev.com/transcript-editor/Edit?token=G2eE6ZQ1hYIocw3A3r3dFXd6pZrX2UwzPyx5fLpBPPByp-MQkD0nyCUcLqgzIWWd5VEiCQyIkoVtc3uA_MGV0aiB8SM&loadFrom=DocumentDeeplink&ts=2829.24)):

Henry's vision for a big budget expansion hadn't really worked out and, in a sense, we were back to where things started. The Blue Brain Project, the original vision to simulate the brain.

Richard Walker ([00:47:19](https://www.rev.com/transcript-editor/Edit?token=QibGihHXk2uwHZUUB2IJy2lWiTnF4RhNO7N2zBqymFLpCEBmH5mbAP3VfpdwXCA6_qw6Gur62J1stO0RqDIeeGpEjvs&loadFrom=DocumentDeeplink&ts=2839.06)):

This is a very, very dangerous time for the project. The vision does come from Henry Markram, but we have to conserve that.

Noah Hutton ([00:47:27](https://www.rev.com/transcript-editor/Edit?token=E90xeo5gBA_kn0gNueWyhLo50VSrciVFRC6rbijzY5oqhyLQrDmZVkA-9MXg-lRDhj_6i1eP2EVpbT47SaDObWvtF9M&loadFrom=DocumentDeeplink&ts=2847.59)):

Henry had survived, securing his support from the Swiss government, who continued to audit The Blue Brain Project with a group of outside experts year after year and continue to believe in the vision.

Henry Markram ([00:47:38](https://www.rev.com/transcript-editor/Edit?token=sTMcaZhPWuq1GTfProyMvmm-B20RTo4uB-X6sL3znvCzjqL3vJq4RHr-LWOK7kestPaplKOM2CCZLlCy-a0hY2Gjj7k&loadFrom=DocumentDeeplink&ts=2858.35)):

There's no scientific argument against why you cannot reconstruct and simulate the brain. We did our first reconstruction in 2008. We're now in ... What are we? 2015. Of that period, we were refining, refining, refining, and adding new biological detail, and checking and validating. We did seven years of validation essentially.

Noah Hutton ([00:48:00](https://www.rev.com/transcript-editor/Edit?token=-KRfb-wEyA_EKdDQhm7LS-XQX66pQZTQkCAjvW3WgJPSwq_XyljFB7xA0ybAgZxuQAoNMgBw8VTAgi06Eth8IFtznfY&loadFrom=DocumentDeeplink&ts=2880.15)):

One of the things the project had been trying to do over those seven years was to connect their brains simulations to a body. Because they had simulated a part of a mouse neocortex, they were trying to build a mouse avatar in hopes it could eventually navigate a maze and pass a behavioral test, something the critics had been pointing to as a marker of success. But for the robotics team, it seems progress was slow.

Speaker 64 ([00:48:22](https://www.rev.com/transcript-editor/Edit?token=p3D3U9q_lAZDxJ_HuUkbw-OWq7eP9_QoIL-mEo_OC_0jY2lYqi2Ri1kPJqSzyTxABG9hyiJEP8UriTIpmIugrORJvOw&loadFrom=DocumentDeeplink&ts=2902.13)):

You have always the problem that simulated robotic experiment is too perfect. Let's say you have just a simple robot arm. You hold it out like this. A real arm will bend a tiny bit on the weight, whereas in a simulation a stiff arm is a stiff arm, and it will not bend. And making it bend is extremely difficult. And the reason really lies in the imperfections of all the parts that we have in reality as opposed to the perfect mathematical models that we have in the simulations.

Noah Hutton ([00:49:04](https://www.rev.com/transcript-editor/Edit?token=YYKGmslBiIPn4X6hAg_cwmCR8RrguwlXfdyzXjLKCJJoUMkqFW8Jn9VBF4WpC-jK-F64uiMfR5Fixy-5ueeLGJacQyI&loadFrom=DocumentDeeplink&ts=2944.89)):

So instead of waiting for a behavioral task, the best foot forward for the project after the open letter would be to publish a paper that showed how the electrical activity in the simulation could replicate the electrical activity seen in a real brain. Such a publication could prove their copy of reality was real enough to matter. It would mend the damage of the open letter, it would give everyone involved proof that the vision was still on the right track.

Richard Walker ([00:49:29](https://www.rev.com/transcript-editor/Edit?token=ZyGy4JjfUgrjUP11TGnD67Emk57bXMvbD-tzcD5QSE1IJApQXzo2jVC_oTSy4_xt6Cyl68OeV7TvrW_t4aNtGj3ddr4&loadFrom=DocumentDeeplink&ts=2969.14)):

This paper, this would mean we are recognized as part of mainstream science and that we are a paradigm legitimately competing with other paradigms.

Noah Hutton ([00:49:43](https://www.rev.com/transcript-editor/Edit?token=yrkKJK_zaLR_irpk02XDAi47aXlcX7_JjWc9uIDz9H6Qou1reS4LQphwQBwtMVx-EojftTcwg_b-NnX1K-MCMh4P4u4&loadFrom=DocumentDeeplink&ts=2983.86)):

On October 5th, 2015, Henry and The Blue Brain Project team published Reconstruction and Simulation of Neocortical Microcircuitry in the peer reviewed journal Cell. The Cell paper was seven years in the making and received a mixed response. Cori Bargmann told the New York Times that the Cell paper was an amazing tour de force, but that the simulations are in their infancy. Zach Mainen told Science Magazine what he thought about The Blue Brain Project's major publication. There's nothing in it that is striking, except that it was a lot of work.

Henry Markram ([00:50:30](https://www.rev.com/transcript-editor/Edit?token=hWwrYOCWhXpz2MIgE13M-KgBVSqgKcXgzaVTzXqWxcwZ9Zc2NKSMdIuH4HJXr6LBk4eHKyC_yLLhA_hJBOfzrwdyrxk&loadFrom=DocumentDeeplink&ts=3030.32)):

We built it from the bottom up, tested against a different experiment or protocols and we see the same phenomenon. You can't explain this and fight this out scientifically in the media. It's better just to keep quiet.

Noah Hutton ([00:50:48](https://www.rev.com/transcript-editor/Edit?token=sEvEqGKHxcQkw0PE2R1zivkgUuuZdI2m6KWaHEl-C9Btq_sCZNPyPERLnp3mMh8B-94gF2GmIGFfDnIkSJWU0vvDn1A&loadFrom=DocumentDeeplink&ts=3048.85)):

These are the silent years.

Henry Markram ([00:50:49](https://www.rev.com/transcript-editor/Edit?token=qsOps5fajj1PGR1O0GUHLuupRl518Oy7Roofy051JbQQ-ueAghNFNUpQqAmkwXaNmj7H2HGZchX5fm4K6lxIppzD6Mo&loadFrom=DocumentDeeplink&ts=3049)):

This is my silent year. I'm going into hibernation. We can talk some more a little bit later. It's amazingly exciting. And what you can tell already from just this microcircuit, it's just a measurement. When you get a brain region, you get the whole mouse brain.

Noah Hutton ([00:51:14](https://www.rev.com/transcript-editor/Edit?token=wjdM6AU2WOSGTEERyISA2X9QOCuSJkq6-H2SvGwGc3NSA0MF9HcOY09nJ_pnai8_Drw1NLSB0fO4EeNRuHNhylmFq40&loadFrom=DocumentDeeplink&ts=3074.15)):

All right, I'll see you. Thank you, Henry. All right, I'll see you later. When I would talk to the critics, I'd leave feeling critical. When I would talk to Henry, usually I'd believe again. And when I'd go downstairs to see the latest visuals, usually I would've believed even more, but something else was starting to creep in, a sense of multiplying touch screens, curve screens, headsets, but a lack of meaning to anything and anyone outside this glass and steel building in Geneva.

Cyrille Favreau ([00:51:49](https://www.rev.com/transcript-editor/Edit?token=Fw8ueuOrOQwtXmPXLqwK-d909nOEuxeDNgugAvIxtoH5cpa9lyvwbxs-1fXPRvvS7p2xds_xd27yySAKrp9AmeuQB5I&loadFrom=DocumentDeeplink&ts=3109.84)):

We want business people to get used to be in the brain, to make the brain your home, and to see it as if it was something real.

Cyrille Favreau ([00:51:57](https://www.rev.com/transcript-editor/Edit?token=XJbZeX6bdmJyzxs1IN_csm9mULy4tF7IoJeehkLI6wVyU6LRXRHPfHAWwrKtoZGd_1G6wNBY2gyehbiNEzSoqI-gQMU&loadFrom=DocumentDeeplink&ts=3117.56)):

(silence)

Noah Hutton ([00:52:17](https://www.rev.com/transcript-editor/Edit?token=6sB-rqkV49bgsNa0uAK1XWXAyxWw-i_JyyjRBkWAT_LXEBieL8RpKX0rzvlKvt3sPOona6sj2dQw_AMcCZB_pRcvQTM&loadFrom=DocumentDeeplink&ts=3137.11)):

If the outside world wasn't convinced by the scientific papers, the ideas seem to be that the visuals could be made to look real. This is how a neuron looks when it's stained with chemicals so it can be seen under a microscope. And this is an artificially simulated neuron from The Blue Brain Project.

Nicolas Antille ([00:52:34](https://www.rev.com/transcript-editor/Edit?token=ztramD_UbV4_aFRy08wlv8LvMbUtQueUPPJtPHu_XaAgCwDUmxDAPRWuNvNXj_1zxBgZA61FoUCvR8YBSAUNzywLm1I&loadFrom=DocumentDeeplink&ts=3154.47)):

This fleshy tone is fake. We also chose a stain that is not a pure black because pure black is not a stain that you often see. It's a very dark brown and that's what tricks people into believing in this image.

Nicolas Antille ([00:52:55](https://www.rev.com/transcript-editor/Edit?token=7FUctF2L7Ny34XZQi1gAp41FCe30dmEkQd3Kux100tP8rvwlWXxv3qj4CsmYwBBHKZ11w-QyeBVECZkdicrEVYPDcMU&loadFrom=DocumentDeeplink&ts=3175.12)):

(silence)

Speaker 67 ([00:53:21](https://www.rev.com/transcript-editor/Edit?token=4xSnG9vZpW51KaPxfEUCJPOOXRzWp7CkmhU2uHnWIfNJHOYpf27z2PrI0Zwb9yOVlywXPZh8plISszAfDjzuo7-mPKE&loadFrom=DocumentDeeplink&ts=3201.57)):

You were mentioning this lies a thing here. We can try to lower that one. And you can see how the [inaudible 00:53:34] replicates?

Noah Hutton ([00:53:35](https://www.rev.com/transcript-editor/Edit?token=WMjMPAghpkh4lwBGrp8UVcY8S-oVk7CrBwoDhUXzbjm6aOTvxQDrBbCRwZlhxmIk-A-qBLtei2DJxHf3eTLIvgFap5g&loadFrom=DocumentDeeplink&ts=3215.04)):

Yes, so this I've seen before, right?

Speaker 67 ([00:53:37](https://www.rev.com/transcript-editor/Edit?token=JhLfS4eNTxuyzZiO6ugFjh2wyPRYCIGDzRLUM8ThxMrkXydFpNepGsa9vGnAqnf85XRszJBMZOiaAHCSEDO-4fVGX_Y&loadFrom=DocumentDeeplink&ts=3217.44)):

Yeah, probably.

Noah Hutton ([00:53:37](https://www.rev.com/transcript-editor/Edit?token=fF_ojD-7WlEvMnyhDHjH9ORlQ36IgnpTao5EeKE4Dw-mnaVl2PHm9rqktsoLbnqpnHKDj-pYMNZUpsFHQQEJfG2VE_o&loadFrom=DocumentDeeplink&ts=3217.75)):

Yeah.

Srikanth Ramaswathy ([00:53:37](https://www.rev.com/transcript-editor/Edit?token=L-xNscsnfYRaTztrJ1xtPhHel0L0nQvdwbGzmZtjZjSzsqOS1IcP-f7TonF-QNrlTJ-tBC0AErBTDeacRc_FeVgFETk&loadFrom=DocumentDeeplink&ts=3217.77)):

The N equals one, but they are pretty much the same as layer four cells. It was funny because Randy was right behind me and he asked the next question, which completely contradicted what Marcia said.

Eilif Muller ([00:53:56](https://www.rev.com/transcript-editor/Edit?token=YqmJogYYOKmG0WbFoALi1RnBfWza3uQrEvSTxeXNb1VoGa7pfu3iyvHI0eM3frkGrXAYRYSBZ3EGziVDYTeT8442qJ0&loadFrom=DocumentDeeplink&ts=3236.14)):

Well, a model is never correct. You can only prove a model is wrong, but in the aspect of continue having a continuous instrumentation to know what is the current state of ... What does the model account for and what it doesn't?

Speaker 69 ([00:54:09](https://www.rev.com/transcript-editor/Edit?token=vAWQCZgLT7Z6OrAmMuZPzxNE8df1ogRqopTWHfadGM8ZPmvO7VUO620wNQ5EzolJ866jhK8WqkcvKin_k3ueKuEQEsU&loadFrom=DocumentDeeplink&ts=3249.89)):

That's an interesting thing and you can challenge people to prove us wrong instead of saying it's validation. Prove us wrong.

Eilif Muller ([00:54:15](https://www.rev.com/transcript-editor/Edit?token=ITWLIQvhBo0teJmhuOORsUoZ6-OMwqAPTdsTGLsaOBBRm1u9gw2qrAtz79MzGedDKSZf6ZgWLltZgJD-dVt3wDxzHo4&loadFrom=DocumentDeeplink&ts=3255.95)):

I mean, when you sit down for a good read, are you reading a neuroscience book or are you reading Harry ...

Srikanth Ramaswathy ([00:54:20](https://www.rev.com/transcript-editor/Edit?token=YYOh0H5eeiXTvWiMHT0eTPXCamVQc3js6sTT-sFn2y07_3B9_YB2WXD_8QnYIwkv_few6DB9o23ZoIw__kXRKqBwlfM&loadFrom=DocumentDeeplink&ts=3260.54)):

Neuroscience book. I mean, reading neuroscience is part of work. So outside work hours, it's not neuroscience.

Eilif Muller ([00:54:28](https://www.rev.com/transcript-editor/Edit?token=1JV9r4VqflSOCtlBjkewm30rJznQfwUXGtJGF9PTh2q1DRDXSBnTZ4fEX9ZIsqSGfNTsB7QTxYtub1TXWKmnHFxrp-c&loadFrom=DocumentDeeplink&ts=3268.12)):

A 9:00 to 5:00 sort of a guy?

Srikanth Ramaswathy ([00:54:30](https://www.rev.com/transcript-editor/Edit?token=lNrgWNuxq7a0LX0kV4IDbMhenJB1Z8I1RVFTo6QXJyj614OCusXVonG4Bp2vYfdDFZrglbVXqojy99W1lddGLW62b5k&loadFrom=DocumentDeeplink&ts=3270.01)):

Yeah, I think so. I mean, until we're all fathers and husbands, the 9:00 to 5:00 sort of guys now. So yeah.

Srikanth Ramaswathy ([00:54:37](https://www.rev.com/transcript-editor/Edit?token=YGdVXAT1c00ztevYp5SS_rGIKEdxC_a3ho-U0ughAaEIw--9Vcfhvxga0ZoHSZPpndO1mVQf63ogATEDdCnr6amaJLc&loadFrom=DocumentDeeplink&ts=3277.69)):

(silence)

Speaker 70 ([00:54:59](https://www.rev.com/transcript-editor/Edit?token=x4gpSuCl3gC4w7-DzFhyPyvOeLxPyJseIiJZazosA0nq7PwhYHwdx_pYMamyRtU9jF9dx-aB5_Epaes95qVJbQDl6hY&loadFrom=DocumentDeeplink&ts=3299.75)):

So what did you think? Would you feel like you were going into the voyage into the brain?

Speaker 70 ([00:55:25](https://www.rev.com/transcript-editor/Edit?token=Sq-EoeBdPUhQLaAwwcwQjQRrBCsMYRyBoCiO0FMORjW8d5zQV29atAQ2JY9mwThatOZEEEKz4HfPBIxgZLEHjZobqqU&loadFrom=DocumentDeeplink&ts=3325.85)):

(silence)

Noah Hutton ([00:55:25](https://www.rev.com/transcript-editor/Edit?token=z69Eufub8mNQaNiAazRAIasjuX_gn5KJlajC2peMuQPWfMrIiFNwfQ_3nSoCypvFp0xzfVCcxFsmPQbQdK-9VO1gbwc&loadFrom=DocumentDeeplink&ts=3325.91)):

A lot of milestones have been set in the project and I'm trying to figure out which ones to shape my timeline.

Richard Walker ([00:55:34](https://www.rev.com/transcript-editor/Edit?token=wLFP3Dn31KXaG6LbUVdH6AheJ7bUetp7DWfN_-jKcDJKXfZRRHk06_W102ZFHEw1yU8BLDWc1Na7ZST2Nm3WSdW2Dn0&loadFrom=DocumentDeeplink&ts=3334.49)):

Yes, we can make the milestone. I'm certain. [inaudible 00:55:37] this afternoon. The question is how good it is.

Eilif Muller ([00:55:41](https://www.rev.com/transcript-editor/Edit?token=w-agsDpUswJlY9Dv3mLOxFZ7Q3aeL3wJ3qGdxK3_tLSSPLJQkwvGzS_ejZyG1BYblG9HnH1ROAp-gS7sfWdc5Ri5fd0&loadFrom=DocumentDeeplink&ts=3341.18)):

I think Henry said we're going to stop in 10 years. Well, he did say if you give me enough money then we could reconstruct it in 10 years. I think the 10 years was set at some stage in his own career.

Noah Hutton ([00:55:54](https://www.rev.com/transcript-editor/Edit?token=VI9Z1Nt9PGNigSubKCXIzbTg7JGoy2OF3r25vgORbKSQjdxOcHHElxee_mgtrg8O6sOyuEaAkQqYSfMh2n7SsIRRLyQ&loadFrom=DocumentDeeplink&ts=3354.95)):

I don't remember any mention of money in the Ted Talk.

Speaker 64 ([00:55:58](https://www.rev.com/transcript-editor/Edit?token=k7R98VuPexduxiL2EUkKF7GZNJpkfNN_IE7NNlphZSKVd8bwEMZMDUbIyzQD3YqYIrucQh4IuB79L8r9JkoOV_gBHgg&loadFrom=DocumentDeeplink&ts=3358.31)):

The milestone is 2020.

Noah Hutton ([00:56:04](https://www.rev.com/transcript-editor/Edit?token=J5BatLEg4hYYWuFBVNAy74ooM39g6VKNeRW_DM3eVyMy727d4wF4Hydy_-N4fzeXfSFW0F27xj1u2mruj7x0grWs7-Y&loadFrom=DocumentDeeplink&ts=3364.3)):

I'm pushing everyone this year to tell me what they really realistically think is going to be done by 2020. I'm finishing the film.

Speaker 71 ([00:56:11](https://www.rev.com/transcript-editor/Edit?token=IkfkaB8MTM5YrH0XyWQm3C_toIEhYJ2381Vg1-ShGm4y7oxyNuD2w_5726YkE4bnkKPbep2wGBxbCdGSmZrL1u_-e6g&loadFrom=DocumentDeeplink&ts=3371.62)):

Yeah. I feel so sorry for you. Let me just quickly ask Christian if she has any [crosstalk 00:56:24]

Noah Hutton ([00:56:24](https://www.rev.com/transcript-editor/Edit?token=zLE-SeJ4lM4kzw6pT-O1IcmtZeCyr4mJf7poGYA4jhT6eRjDGZ4j-1FfUvlvQmzAJbhBIeABK9lplQEZxHJT69u1p54&loadFrom=DocumentDeeplink&ts=3384.43)):

Okay.

Speaker 71 ([00:56:25](https://www.rev.com/transcript-editor/Edit?token=EKqfPqSf23LJaUjJqd-Bgw4jUt-q-3GMOediF2MXZDU9CqR0fxLJu4G-9hwiKEJUOk678NG4Uo_vAWpdXHfkaSEEgu0&loadFrom=DocumentDeeplink&ts=3385)):

[inaudible 00:56:25] I'm sorry.

Noah Hutton ([00:56:33](https://www.rev.com/transcript-editor/Edit?token=8V1RHaMk3pJYY7pozgxYzI4xvDJJwjBhBVv2Nu5Xol5mHSo1ehP3b6FynX_34KrXfmLJ7Fz3jWzqPYQUbCulmANuils&loadFrom=DocumentDeeplink&ts=3393.81)):

It's okay. Henry didn't show up that time.

Noah Hutton ([00:56:43](https://www.rev.com/transcript-editor/Edit?token=9Zfjd8AjobtFQIEBmeVF-NEkfux_pGdGXRz4QAgEflNeWD7zr7zfEMebUw_NcT5tk-RLmetFsVV3x28Mt4GJVX4kxIs&loadFrom=DocumentDeeplink&ts=3403.01)):

(silence)

Noah Hutton ([00:56:43](https://www.rev.com/transcript-editor/Edit?token=wViVRt8FvVkVcd6J37ziG_pLFk4NghrWmtT6c_0w3nEsFE98iCIQLZroXp66iIry3wTFwKyV0zz-E2eyUrH75SZw7fc&loadFrom=DocumentDeeplink&ts=3403.07)):

When I looked at the field as a whole, it seemed computers were creeping closer to brains in every sense. Translating signals from inside our bodies out into new digital languages. This had its effect on the imagination and the metaphor of the digital computer had taken over as the dominant metaphor of the human mind. When the Spanish scientist Santiago Ramón y Cajal discovered neurons and set the course for modern neuroscience, the metaphors were different. Cajal used natural language, calling neurons the butterflies of the soul. Now, in a world enamored with the potential of computers, we saw ourselves in terms of how we believed we could best understand our brains.

Henry Markram ([00:57:51](https://www.rev.com/transcript-editor/Edit?token=p905usxD3h6qKlnZs0eoiH26RobJIv1FoDZlr8Mp2rUHPMoFTg6KPVoNbIEe1Tcd6N5_jwjRVkP0pdHZXk64xkoNeoA&loadFrom=DocumentDeeplink&ts=3471.02)):

The brain holds ... It's an information processing machine. It's a computer.

Speaker 72 ([00:57:55](https://www.rev.com/transcript-editor/Edit?token=bjhIH0WJZkt-yxT3N1TTXeyka5sx_UgIVTDXAwll2GBxTmvpW2kJjwPNOb-UYfRpxb1aeaFd6VcuKZmyxzNFUgXHz_8&loadFrom=DocumentDeeplink&ts=3475.23)):

It's the universal computer.

Speaker 73 ([00:57:56](https://www.rev.com/transcript-editor/Edit?token=pCzjiz8JAl00QnYdK0R6vtqxsIPhwegQ44V1KrgkqWkV628FJzsU0Ecmz5Gmi3HOVdrFAo7AeUW_c-mt0epkLAEL3xM&loadFrom=DocumentDeeplink&ts=3476.19)):

Biological computer, so to say.

Sebastian Seung ([00:57:58](https://www.rev.com/transcript-editor/Edit?token=lT6957AwhMfzBoZOlO3v0QKn47YmAZ75D9uBKWlq3RMbl3fSsjbX_-i5g5tALfNQ1Niy7rbFXOxV-XvStQzSxNbXgW0&loadFrom=DocumentDeeplink&ts=3478.45)):

It's a computer that somehow builds itself.

Christof Koch ([00:58:00](https://www.rev.com/transcript-editor/Edit?token=4vsgqwPtz8nsH4LJUc1Et2nR36Bg-jKpSVDtdUVe4z3aFkgEFV3RSbdDm3WKchq4Be5U2LPLjaM-BKBuhCtX5dHepAE&loadFrom=DocumentDeeplink&ts=3480.64)):

Computational tissue.

Anne Churchland ([00:58:01](https://www.rev.com/transcript-editor/Edit?token=9kLh15iWMjA2F5_J9bYrXX7XOZ1b4XXYTcp8al435qz4V-jyPp3j9pYZ6MnsHnV-Mg99ZuAvvbH9SJ9os9eT_YQcusQ&loadFrom=DocumentDeeplink&ts=3481.87)):

Computational motifs.

Idan Segev ([00:58:03](https://www.rev.com/transcript-editor/Edit?token=X8IVBz6tna5sgy8KHSv0-XPSGLPzR4oC1YmlU4PrJr4-lomBce71Mt-cPx2fr2jw44SCkPwjT3-6F03tCx7VK0inBsk&loadFrom=DocumentDeeplink&ts=3483.38)):

Born with these microchips.

Richard Walker ([00:58:04](https://www.rev.com/transcript-editor/Edit?token=wuXcbjSePw-WoarIdc3_FDM5EHtI3QOc0xQX7LNA8ZnB8x5aWwTakD621JwCTTJ-XWcE4sMlhjMkIFCycpxdsldm0eQ&loadFrom=DocumentDeeplink&ts=3484.53)):

Rat cognition is a Windows 95 machine.

Henry Markram ([00:58:07](https://www.rev.com/transcript-editor/Edit?token=ISU-LwXho6H2MNGEJBe4ACKt7chUpZAc9bDiaKsIMj3M7OIZwH01dQkqPvaUUezWwMjSvr9WMRTqPWV30OnT528iu70&loadFrom=DocumentDeeplink&ts=3487.17)):

And this can be turned into an algorithm, an algorithm that reconstructs.

Terrence Sejnowski ([00:58:10](https://www.rev.com/transcript-editor/Edit?token=qnebOdSmzDsX8aNrJ9sjnUZfMd3MaUe4RtfotIZ7HyNiKuvHGEt-XDiO7ID47N5oBo8plcR6GadI-XUlALktGDTNIbM&loadFrom=DocumentDeeplink&ts=3490.92)):

What is a neuron computing?

Henry Markram ([00:58:12](https://www.rev.com/transcript-editor/Edit?token=jKejsFp486BsQzMW-3p2NkmnTvPczNEQmWwmlOXVbw5bljHSFwid5oZ6PGQxUzLbhGA60MtmZOtqoYLsVph-da5aEcU&loadFrom=DocumentDeeplink&ts=3492.57)):

Algorithm.

Speaker 74 ([00:58:13](https://www.rev.com/transcript-editor/Edit?token=iPPri9Ok2l0RX99ByBY1rw5r7EpFyH3MW2C4qDUlhAW72GU8b2NVpI8u-bmsJwNqOoY-5fkZL2Qji2pag8mUoPHE1UQ&loadFrom=DocumentDeeplink&ts=3493.21)):

Algorithm.

Speaker 75 ([00:58:13](https://www.rev.com/transcript-editor/Edit?token=YQivr0QEIS3O01jlsR7M35tV61lWHQZS4KQ1cIPiTSpao2B9BcAQCu8mtYgeZtZ1aqFZz6EIZ1AbY_rEW770AGHIXlU&loadFrom=DocumentDeeplink&ts=3493.4)):

Algorithmic.

Eilif Muller ([00:58:15](https://www.rev.com/transcript-editor/Edit?token=DatFCiEzlQ9BDe569mNx8OwluyU8PcTsHTKXsg_PiIWlQl9yQIrucXaNM52f-UXHiNiHCR3jM2rtYLE7eT3-ECC0mP8&loadFrom=DocumentDeeplink&ts=3495.35)):

Coding principles.

Terrence Sejnowski ([00:58:16](https://www.rev.com/transcript-editor/Edit?token=42TlBJC_lWCLy1K-xLDDUF0sfr2I-nrCeqkp65z-1-ZDRxMG--S5Cg8m40wkngKfQOQuG1S-q7qNI4T-EAAHwW1UdDg&loadFrom=DocumentDeeplink&ts=3496.52)):

Codes, neural codes.

Jeff Lichtman ([00:58:17](https://www.rev.com/transcript-editor/Edit?token=NSETeeAtVHj7o5k9lPmxqJ1HV6iW-NLh2o-NeQ0jHTX0eZ-oQkKTK300UtHeDwPW9C3G7NNfWnOBdPOBLb86etlIxaU&loadFrom=DocumentDeeplink&ts=3497.55)):

Code.

Henry Markram ([00:58:18](https://www.rev.com/transcript-editor/Edit?token=6vvWsfGidy_uIkiKt3xd4WVaCa1YcHvxvGBz39JZvRIpXshsYILvRM4bK206MzmBlJIaYEeMlj1Fm_c24cZcAYWwsHM&loadFrom=DocumentDeeplink&ts=3498.32)):

An algorithm.

Speaker 76 ([00:58:19](https://www.rev.com/transcript-editor/Edit?token=79Mtfkpu1MTHY-Q_9YXkmYmUnyvueveIs0wPyPuNBlezt-TRPctabhveitCAMNZTSA33jv1CWfju14acaOG5rjEqrjg&loadFrom=DocumentDeeplink&ts=3499.2)):

Broke the code.

Speaker 74 ([00:58:20](https://www.rev.com/transcript-editor/Edit?token=Ds3AQpjSMxbo3aoGOdin6b_AqIZ_960huiOEV5qLtMfi4JfuAfqkxZbW3iUtDuOGhh0dGYJ4eo4m7UoDSWoB_T9-QEw&loadFrom=DocumentDeeplink&ts=3500.32)):

The reverse engineers.

Cori Bargmann ([00:58:21](https://www.rev.com/transcript-editor/Edit?token=zqe21hYTwWA0BA806kFSOfMAL7_cbNgT35aF0HvSD6UkmN-9Ey2WpoYkWTmjhfK0qHrxgnLH6mfhGFu1D3UU6JqluMs&loadFrom=DocumentDeeplink&ts=3501.6)):

Circuits.

Sean Hill ([00:58:22](https://www.rev.com/transcript-editor/Edit?token=chF5ZpBTm5q7ruQhDCMr2hWV8zCH6ddLyXmra7PC4Wve-mc62KVjbPUv3kxfynavjDq8II2mZE5vt3eSKIO-RKiwxhA&loadFrom=DocumentDeeplink&ts=3502.43)):

Brain circuitry.

Richard Walker ([00:58:23](https://www.rev.com/transcript-editor/Edit?token=p7i2Z94wAiF9aP3EH01fUP6yauETymzouZ4eoXCHuANzZ1i613k2mYMbfmBsMxY3tEIym1QuByYcigG9QLXynOWuu8U&loadFrom=DocumentDeeplink&ts=3503.35)):

Cortical circuity.

Speaker 74 ([00:58:25](https://www.rev.com/transcript-editor/Edit?token=GEeFj7jBKO8a3-ncecM-nE2UKTerfVduoQ2IrLdXUHbvS01PiAcbI767aKFiuGniLPk4khJzAe8WPa4Et6xdcJZBQsY&loadFrom=DocumentDeeplink&ts=3505.18)):

The entire bloody circuit.

Noah Hutton ([00:58:30](https://www.rev.com/transcript-editor/Edit?token=s3WVLBik_GCvdW-5j6zXBLKtt_FBQ5Dh7M-c6pYAmkW2AxrBOwibVGXsF3NAI75p84AExD-YG192dVRudekL9wn_UBU&loadFrom=DocumentDeeplink&ts=3510.7)):

Computers are engineered to be perfect and mistakes are quickly corrected in search of the perfect code. Biological evolution runs on a different type of engine. It's an engine built from imperfections, tiny mistakes in DNA known as mutations that allowed life on Earth to diversify, survive, mutate again, become something else. There seems to be a great fountain of tiny mistakes everywhere there's life, especially in neurons. For the scientists and engineers trying to replicate a brain on computers then, it seemed that the challenge was to build a perfect simulation of these imperfections to somehow engineer what scientists call true variability, or noise, in the brain. This was the gamble of The Blue Brain Project. And as long as they were seeing activity in their simulation that resembled the statistics of noisy biological activity, they and the Swiss government which funded them were encouraged to continue.

Idan Segev ([00:59:26](https://www.rev.com/transcript-editor/Edit?token=oGhdNEamnd2h1576vZBbGt1gVaHyyzPNeGfmv5g3a0j0BDFyKW1cqv4_ZF9mbFURKWi8aP0u2x-kEvY0kEW4SOj9Bn0&loadFrom=DocumentDeeplink&ts=3566.78)):

First of all, you are right. I'm using a machine that it was built to be noiseless. I build a quiet machine and then I make the machine noisy in order to replicate my noise, so to speak. It's true that we don't completely understand all the origin of noise in the brain. For example, we know that one of the most noisy element in the nervous system are the synapses.

Noah Hutton ([00:59:47](https://www.rev.com/transcript-editor/Edit?token=jlQZXov810Ngu60d6h01PYxAiQJ7LB5bDFivuVQeIYD0JEYvFHuHq1OMHEqlSlgTeoLX0GRrLGJFFlSGpfb1aMQeJjE&loadFrom=DocumentDeeplink&ts=3587.6)):

Synapses are the places where the electrical signals trigger a release of chemical signals, known as neurotransmitters. If the brain were a perfect machine, you would hope this would happen the same way every time, but it doesn't. Often, a very similar electrical signal arriving at the synapse fails to trigger a release of neurotransmitter and this is one source of great noise and variability in the brain.

Idan Segev ([01:00:07](https://www.rev.com/transcript-editor/Edit?token=0vAl10zKzB8pOVtnW_HEo12OmwEkKfqgJYIZjacBVvNK6ee3KsIUmjUJU7ZYbL4Yo1zifZ4GlcgCtVcciyOxr-HyHcQ&loadFrom=DocumentDeeplink&ts=3607.99)):

These are the most noisy elements in the brain, really, are these synapses. They're very nonreliable.

Lida Kanari ([01:00:13](https://www.rev.com/transcript-editor/Edit?token=Lxaya8dWjm2wIRP2KmdAR2cnV_--3EfECZZ1QLsLalE5VpYp8fVZd_p7l8NDK064HcCaGb9I2kc6yNQCK3INGJIj9a4&loadFrom=DocumentDeeplink&ts=3613.22)):

We want to use the features that are consistent and exploit them. So generate structures that have the same main topology, but also add some noise, so add the variability that you see in biology.

Noah Hutton ([01:00:28](https://www.rev.com/transcript-editor/Edit?token=c7Yo4LVs-NMfS_UJOcRvQzGkWpi4hu9RXNCwVP81bY5ifyo2pVbgwpk2BVZxpQYQvWAXilg7jXPjv28ErRf6HKtYhps&loadFrom=DocumentDeeplink&ts=3628.96)):

How do you add the right kind of variability?

Lida Kanari ([01:00:32](https://www.rev.com/transcript-editor/Edit?token=CYl5OxTegwECrv_BsfPtj-tBwvLx3-BRn4ez1renIjbjIo1O6ZxhPuHiXXMmbQYdqv-V7EpRBYOzT2irWg_SfyTOOE8&loadFrom=DocumentDeeplink&ts=3632.41)):

That's a good question because we can never know what's the right kind of variability.

Speaker 64 ([01:00:39](https://www.rev.com/transcript-editor/Edit?token=92yi7A92zuoGWgCeMfKIZgzQzAxNrFBzhle0iHfWL1wD9Jw7kaktmBCSpUCSHFUcITgVQLXJIgX97xx-9_mryGKuYyc&loadFrom=DocumentDeeplink&ts=3639)):

This is actually a big discussion we are having here in the groups. What is the right model for the imperfections for this, or that, or this? You can replay Go, play like it was played 1,000 years exactly, move by move. That's why it's easy. You can't do that with a soccer game. It's impossible. You can't replay a game that was played even five days ago. Why? Because it's all in a chaotic system. This is in the nature of nature that makes it much, much harder.

Noah Hutton ([01:01:16](https://www.rev.com/transcript-editor/Edit?token=X1l_5bvs9waL11eui5Wul2cCuxRIlHKaatpGlnlADylGaT3-6pXad17Z6FKjfqHTIE3Gca7BwbPW-34Ozibj5dsxYbw&loadFrom=DocumentDeeplink&ts=3676.81)):

Even if it all works and we simulate the chaotic system of a brain on a computer, a question arises about the identity of a simulated brain. On one hand, we had done something like this before when scientists studied the human heart to such a degree that they were able to design a universal model and produce a piece of machinery that would work equally well in your body or mine, keeping us alive. But when it comes to the brain, what is the universal model? Who's identity would be represented in a fully simulated brain?

Idan Segev ([01:01:48](https://www.rev.com/transcript-editor/Edit?token=X_sycrVjQ4-4dHFy5YmKHjOup7kNiDzqWx_oDLoNKrxTwCNcL2GNEhRgmLV5SllQvpvp3wsrhkT66hCK5XXMlxAqK0U&loadFrom=DocumentDeeplink&ts=3708.15)):

This network that we build in The Blue Brain is built from many ingredients of this one mouse and another cell from another mouse. It's not one brain of one mouse, it's a brain. It's some brain. Whose brain?

Speaker 78 ([01:01:59](https://www.rev.com/transcript-editor/Edit?token=g2Au1hgtIoYgmQ6lcCAuqcQOvpbgw-O6SipNp4L7QsJYtcPokthiTQjQ0Ku7QwY-JiJooMj5WRcTEkybGw22VP246PM&loadFrom=DocumentDeeplink&ts=3719.47)):

It's possible that every brain is snowflake. Literally at that level, but when I say that, people push back and they might be right. Even snowflakes have regularity. They seven arms, right ... Whatever. Spiders have eight arms, I think snowflakes have seven arms. Whatever that is, but there is that regular pattern over which there is some unique to each snowflake. If you record from 10,000 neurons from 10,000 different mice versus recording from 10,000 neurons in the same mouse, how is that different relative to each other?

Idan Segev ([01:02:29](https://www.rev.com/transcript-editor/Edit?token=Mto1Ny3mqlgdXlWcYzwd2sKMzSMcbvlzQ4hW-1J-F7MlmjwjE2s6Z07lSdTeo2432-e4T1uhEhTwckT7IYJRpoxlCX8&loadFrom=DocumentDeeplink&ts=3749.52)):

It's like thinking in some sense Mercedes combined with Volkswagen and another thing, and it may be another car eventually. And it they won't fit, but we do hope that there are certain general principles between one mouse, another mouse. Cell types, the variability, between animals will not destroy our generic brain. It's a generic brain.

Noah Hutton ([01:02:52](https://www.rev.com/transcript-editor/Edit?token=P0DgSZ35yIdYM4donPj5geKW-yLterlBf9kzktyBODxE3pSkn__npLrVjr6bwmrZ2NxX_OiQvc3VDmdHmD3Q3uSYOYQ&loadFrom=DocumentDeeplink&ts=3772.54)):

For our generic model of the human heart, it was quite clear what the criteria for that model should be and what we wanted it to do. But who gets to decide what the ideal brain should be? What is a generic brain? An ideal, healthy, productive, and safe brain? When we say the human brain, whose brain are we building? Half of the initial investment in Obama's brain initiative came from DARPA and IARPA, secretive agencies within the defense department that are known to fund basic research for military applications.

Idan Segev ([01:03:26](https://www.rev.com/transcript-editor/Edit?token=NxDNjwX6yGxkKWbGfdLdmR-28YV3c1w72qPw50NVl67TZQSM0xrRTSTr1TRRSxocPaudfrDk9FwEgE5ze4VbHyAfPNw&loadFrom=DocumentDeeplink&ts=3806.22)):

DoD pours money into brain machine interfaces. Scientists say, "Well, if there's money for it, I'm going to go ahead because I'm trying to work on that," but there's not a really big discussion about why the Department of Defense want brain machine interfaces. I'll give you some time to think about why the Department of Defense wants brain machine interfaces and it's not just to cure war veterans who have PTSD.

Noah Hutton ([01:03:51](https://www.rev.com/transcript-editor/Edit?token=HOzgrAdW-ACeAtklV08KAcpu_aFw20QfMgn3ZVJI42BS-uuY_DfCGvWIDepIkKb8fBAlCRTtzAcrKLxZlGO76EGKQLI&loadFrom=DocumentDeeplink&ts=3831.38)):

Even though The Blue Brain Project wasn't taking military funds, it was still funded by the same upstream source, the public. So if cells in our bodies still bear traces of tiny mistakes from deep under the ocean, how will this simulated brain bear the traces of its creators? A scientist's vision, an academic project, or perhaps better described as a corporation with limited relations to the outside world. Curing diseases and disorders will always be a reason we need basic science, but science is done within a context and within an economy. So what would really happen if we figured out how the brain worked in this age of personalized technology?

Steve Jobs ([01:04:33](https://www.rev.com/transcript-editor/Edit?token=HMfb2aNEAMy27P01bG4hY6IZcvz8B3m20EB3w7kOx5bam-R4WqZ1TYkDYafXpAkebbYFo0Lvn3qw-vvTpu73p645ivA&loadFrom=DocumentDeeplink&ts=3873.07)):

We call it the pinch. I can bring them closer together or move them further apart to make it bigger or smaller. And so I can just move them further apart and stretch the image.

Henry Markram ([01:04:41](https://www.rev.com/transcript-editor/Edit?token=A1iW-E4QU1NrePGTRIlzLCNQC8mluwMF4e1FpYf-5XPTR_pYYeclvYOL-Y1q8grlqNwZWBi8m6yo5JUVJhpkvLH6EiM&loadFrom=DocumentDeeplink&ts=3881.36)):

There are many applications. The most exciting thing is that what we're really going to feel probably more concretely than anything else is that we're just not going to need to go through all these settings that you have to put your preferences. In an iPhone or whatever application you go into, it's going to get more and more complicated and you get very irritated. I fill in my preference, I don't want this, I don't want this ...

Noah Hutton ([01:05:09](https://www.rev.com/transcript-editor/Edit?token=mFMOZDueNuG-DbSEeTaAgnA2QSAkvHaxKZaCPnsEyOr0FuPuFO6czf02GKJe3OgaSRbuMpihplsBdWKDx6FkMSvrcII&loadFrom=DocumentDeeplink&ts=3909.14)):

So what is the vision of the widespread benefit of neuroscience to society now and overtime? And how close were we anyway to the real thing? I started making this film because a scientist attached his bold idea to a timeline, but that timeline kept drifting further and further into the future.

Claude Shannon ([01:05:25](https://www.rev.com/transcript-editor/Edit?token=ULuSM1QLsublvtVxrZIbx6Jndbyc25XCyqerwnD8nZlEjYHz62d2o2uAbvX_PnxnLghGBkzNoDO0dvGcjWMkQYfFMfE&loadFrom=DocumentDeeplink&ts=3925.95)):

I confidently expect that within 10 or 15 years we will find emerging from the laboratories something not too far from the robot or science fiction fame.

Ray Kurzweil ([01:05:34](https://www.rev.com/transcript-editor/Edit?token=dim0461xiBSGqRukm1XPu6UwT4LxILC3BF7eRMSUfvBp8Tmfc1MMO-jbDLiKNoKNOhwoEx7OU925nncQKmudO_oL6c8&loadFrom=DocumentDeeplink&ts=3934.72)):

About 2010 computers will disappear. They'll be so small they'll be embedded in our clothing, in our environment. Images will be written directly to our retina.

Henry Markram ([01:05:41](https://www.rev.com/transcript-editor/Edit?token=IxpAc792zFuvV8WHzm2CSiyFuwpwcoxY7zByjneE8isIuilMisA1Waq46HrrwDY94NhEq-jHk2KeQY7v7z9vURxciMI&loadFrom=DocumentDeeplink&ts=3941.47)):

We can do it within 10 years. The agenda is 10 years. Our goal is to have a human brain simulation within these 10 years. 10 years. I mean, it's like just because one says that it's a 10 year project doesn't make it a 10 year project. And the idea that it is a 10 year project, is it a 15 year project, is it a 20 year project, I think that may be something that ... What do you think?

Henry Markram ([01:06:05](https://www.rev.com/transcript-editor/Edit?token=L_PviNI9qQvvmSxJUNbKbtaWfa8KWiortV-1d748y1-kRAtg_EdyZdmTWlFqxi-EDliHMqbbtaGCELoIdefpXMeSQhM&loadFrom=DocumentDeeplink&ts=3965.98)):

(silence)

Eilif Muller ([01:06:32](https://www.rev.com/transcript-editor/Edit?token=4NI4KIcd5p2narOD7ZDkUUFZzF1RZ_P2yeN-IJAGqrEDFA5xDbPIeGlyHgOHCdAxyzdRFJTMqlV4b-2xqV08TuAB-xA&loadFrom=DocumentDeeplink&ts=3992)):

[crosstalk 01:06:32]

Noah Hutton ([01:06:38](https://www.rev.com/transcript-editor/Edit?token=9Vn3JMyJaMNkGQPYpiUpukIojdxR3xVoT9iCS_8TJwSB0lLAqtRD2pU2nW1VHMjWOuuG9ovqi1bqGwHa5e_StLqYqqM&loadFrom=DocumentDeeplink&ts=3998.39)):

In 2019, Eilif, who had joined the project the same year I had started filming, decided to leave Blue Brain. Marc-Oliver, head of the robotics group, decided it was time for a change as well. Though he continued to work part time for Blue Brain, he left to join a telecommunications firm. These were two principal figures of the project who had made the case to me year after year that they were on the path to simulating the brain.

Eilif Muller ([01:07:05](https://www.rev.com/transcript-editor/Edit?token=MldT69WMcw-rQYhyFSfrMePQXZYbMwACaIxqe_Lvd2YQDNRjQ-tsSRemItg9jy5jxMabxFzjjvqJj2qe5Q_FVLDFLt4&loadFrom=DocumentDeeplink&ts=4025.24)):

It's a great framework here at Blue Brain to lead team science, but where the institution [inaudible 01:07:10] seems to be struggling is recognizing that there are scientists here in The Blue Brain team that are making unique contributions. I realized that if I wanted to have a continually developing career perspective, I had to unfortunately leave. It was a really tough decision. I'm going to go join Element AI in Montreal that's an AI startup. You want me to talk about the shirt? I think this image really characterizes what team science is about.

Noah Hutton ([01:08:00](https://www.rev.com/transcript-editor/Edit?token=fLsSZfvNGbunLruFQkcafaxpOFjW3-leCeSFin87IIIi9HpLLHzIaDvd-Lq9RNwEyi6thN70ijUHDoFtwc_Zz2B9bxs&loadFrom=DocumentDeeplink&ts=4080.04)):

Which one are you?

Eilif Muller ([01:08:11](https://www.rev.com/transcript-editor/Edit?token=l7xaDnJmXanz3RUPvH6vjyfJ-uk7ChNg4bj12pPOUMCWEJkm5Tlx4iImfub2OTrpthtqop91ACuaxC3cUNdUZkJSt9M&loadFrom=DocumentDeeplink&ts=4091.55)):

I don't know. Well, that's Henry.

Eilif Muller ([01:08:34](https://www.rev.com/transcript-editor/Edit?token=CoZ5upcD3c-Sjr-avTzKmPOP61cLGSiua0wqpVgfM_Www4h6qaet4T-DziM4Xq588gCkFSwWrMa97EhHLs278GMl-Y8&loadFrom=DocumentDeeplink&ts=4114.32)):

(silence)

Noah Hutton ([01:08:37](https://www.rev.com/transcript-editor/Edit?token=0EIBMypUY3Ife3MKOQuur2J4hcsLjNxY8FYx_Fyml908A4lr84NhBaTebd2HIY2HyPRsH9dGOjUnx01tJ6XoSj4FawY&loadFrom=DocumentDeeplink&ts=4117.35)):

Despite critics and the ups and downs of political fights, The Blue Brain Project had continued to steadily build a simulation of the mouse brain. And after 10 years they had published over 150 scientific papers and had a working model of an entire neocortex. What had started as a single column of 10,000 neurons was now a model made up of 10 million neurons.

Noah Hutton ([01:08:57](https://www.rev.com/transcript-editor/Edit?token=tVI0g9a7cSTN9n9RlBPZ9DsdBIQvpCgQ5nNPQ3e4rf4pzBww63OMWlSp9JXo-YIidDdZoYXogx0CO9Zz9p_anQy4eQM&loadFrom=DocumentDeeplink&ts=4137.85)):

(silence)

Noah Hutton ([01:09:09](https://www.rev.com/transcript-editor/Edit?token=ESWagZhael5vZDpFVF_eoMv83InlSxrZAp9AqMvFnOunT-vsve1RRs494FgBnJfhcGqavb6kfzyyApsloLDTOJX5ARU&loadFrom=DocumentDeeplink&ts=4149.2)):

The new visuals were stunning. And even though they didn't have a full mouse brain inside of a body that could show any sort of behavior, some skeptical voices seemed impressed.

Christof Koch ([01:09:18](https://www.rev.com/transcript-editor/Edit?token=BYnXpFroBWC-8Q31-ldHb4MPXbf3xZmugDTr8EzSpN-gRXpPqNujqvBQ8KGmhZSvog1X0z59B8qIsgBOKCVORAnCHXQ&loadFrom=DocumentDeeplink&ts=4158.26)):

You can see there are different types of neurons here. So these are neurons from the cortex.

Noah Hutton ([01:09:25](https://www.rev.com/transcript-editor/Edit?token=HnoU20ZfqL0M6mYPnWpvLcsOgNLiYVIldoZ_DP1TiAgAk4IZ-AabBbWn-fHuMTKHaso4hWfniYBI685aloEZevsRQHI&loadFrom=DocumentDeeplink&ts=4165.78)):

When I visited Christof Koch again, he had just finished reviewing The Blue Brain Project for the Swiss government, which renewed the project's funding once again.

Christof Koch ([01:09:33](https://www.rev.com/transcript-editor/Edit?token=cOfGYfiRyxltC-36t3kQlYapiXmy9xnzkwditkx9BKOLV662aYa0I6Ck31RqqqVaSuCCW2a1WjPkuG1X6IcC0UiPgkU&loadFrom=DocumentDeeplink&ts=4173.41)):

There's a technological challenge, which I think they're beginning to master successfully, but then there's a scientific challenge of endowing it with really authenticity. That's going to be more difficult. Except for the question is particular if you fast forward by 10 years because of course the ambitious Henry Markram was not limited to the mouse, but goes to the human. It's not unplausible given the ongoing rate of computer evolution, of maybe quantum computers. That by 2030 you'll have the ability to simulate a human brain. And then how do you know whether it feels like anything? There, the answer is certainly, according to me, that consciousness can't be simulated. Consciousness can't be computed. It's a little bit like gravity or wetness. You can simulate a rain storm, but it's never set inside the computer. You can simulate gravity of a black hole, but you never have to be afraid that your astrophysical simulation's going to suck you into a black hole.

Christof Koch ([01:10:25](https://www.rev.com/transcript-editor/Edit?token=Cmg3ZVThNtA0lG9uJdY5U45AOE5K0iHfeRnzeDeNzNJI0ex5BXfTYioewlgYdmeNsxmtFq8UpNrhP92TvYz-38cg_hU&loadFrom=DocumentDeeplink&ts=4225.51)):

So likewise, you can simulate the behavior associated with consciousness, but that is very different from actually being conscious.

Terrence Sejnowski ([01:10:33](https://www.rev.com/transcript-editor/Edit?token=acfACDLzxJ-nvPakJcjp1C15FfZuW8J2UpZ0M8fZYeXQcWQYpOHa3faoKz7LFpk2qvzTuWiaQ5d79ctGLtNxoyF41ys&loadFrom=DocumentDeeplink&ts=4233.48)):

Okay, so here's my take on that. Let's suppose Henry is wildly successful and he's able to model every neuron, every important molecule. I can see Henry firing up the simulation and often the speaker comes a squeak. What have you learned about the brain? In other words, your simulation is every bit as mysterious as the brain itself. And so really what's needed is a way to analyze the signals coming out of the brain and the simulations will help us a lot. And I have to say that I admire Henry's fortitude and the fact that he stepped forward so boldly. Do you know how to distinguish pioneers from followers? The pioneers are the ones with the arrows in their backs.

Terrence Sejnowski ([01:11:37](https://www.rev.com/transcript-editor/Edit?token=eoBA8bIVZq6Cy8_f66yIdMdq7H9ds-IWfavf-VtaY5zpspOrFwaiKgf-xmbFxlDQP3Dlo8wgO_q_D9iilhUW9ito6bc&loadFrom=DocumentDeeplink&ts=4297.76)):

(silence)

Henry Markram ([01:11:40](https://www.rev.com/transcript-editor/Edit?token=TLoWdpTuesRd8Hn_J-9nJgB-Z4ptHGxv3gRif8w1p1gS4uRM0wJemY2pygm4-0GqP0yJX4jxUzH2x5wBNy2krXBvew8&loadFrom=DocumentDeeplink&ts=4300.4)):

One shouldn't expect a general consensus view to change the world. It's not going to. This journey, and landing and completing this journey either by us or by the future generations is going to be more significant than landing on the moon.

Noah Hutton ([01:12:12](https://www.rev.com/transcript-editor/Edit?token=1nFJHoeG1jcUl0Gk7hXn2fyJsQRcN1dh2SDDuMHlaY9PV7PaabKItqzQwDTI8mFPq6-fC7QHetGu7_EeEQZr6Ru_9TY&loadFrom=DocumentDeeplink&ts=4332.81)):

The story of science is often a story of belief. 10 years ago, Henry believed The Blue Brain Project could simulate a mouse brain and then a human brain. What he's left with after 10 years is the belief they still can.

Henry Markram ([01:12:27](https://www.rev.com/transcript-editor/Edit?token=g5jAThMwHKr8knOMq8QgunC_3uXWec040630NyorLssSUIgofZrCyjDpymXSnvq3lKWwxS8qJijDHDe5xGnflXSR7pg&loadFrom=DocumentDeeplink&ts=4347.84)):

I will always find a way to keep doing this because I think that this is the way. It's of course much harder, much longer. It's not going to be in time for me to help Kai, but I think it's going to lay down a very important foundation that will help kids like Kai in the future. Sometimes people don't realize that the way you improve is through the number of iterations. The one thing you can be absolutely sure of is that it can only get better. There is a perfect reconstruction lying at the end of that railroad track.

Henry Markram ([01:13:05](https://www.rev.com/transcript-editor/Edit?token=JMPxlCW9fV4zqnPmG4vIOjqcizeky0y7Twn0VXsAkC6VtogJG7VdQauLRsDAf1IWvrW8vKIDET-9Xf0E6zH4sVYe4-o&loadFrom=DocumentDeeplink&ts=4385.4)):

(silence)

Henry Markram ([01:13:14](https://www.rev.com/transcript-editor/Edit?token=13AAYBHCoLfZHwR5yrbDctWmfp6VHN4TUYTcc7u3eDRfjQCieaq3Qg1PBkGndJ9c3QsN4e9vCBxOx0jXr0iqNfMKkCs&loadFrom=DocumentDeeplink&ts=4394.81)):

You have to put an urgency onto something and you have to make it happen. And if you can't, okay. You have to take a detour, it has to take you a year longer, but it does not change the trajectory and it does not change the inevitability that we're going to get there.

Sean Hill ([01:13:31](https://www.rev.com/transcript-editor/Edit?token=MCbDIbgVCkNZnAUhXaifJqc5rGCWk4elsQsnMbzvQTJxn9jmusIc5oLMo7x7BMAWovmuNDunAfsreePxiz4pEPFzVKY&loadFrom=DocumentDeeplink&ts=4411.48)):

I don't know about the timelines, but it hasn't happened.

Noah Hutton ([01:13:43](https://www.rev.com/transcript-editor/Edit?token=K3PenJarnbiIVEWEAYineWey1aXLrDlaJZlyc23Mhwk84EVHUPZM5KQwpUKvw5ughvqOf16GiZlVrL8JwQr06-qRHG0&loadFrom=DocumentDeeplink&ts=4423.23)):

Right, but then if you can get swept up. And if someone comes along and says, "I think I have a way to do it in 10 years," that's fucked up.

Sean Hill ([01:13:52](https://www.rev.com/transcript-editor/Edit?token=Y1pMv_0brRe7tST5jfTG23FXpMB09T8Y-0hiRWSYG8bPX1dmCvdNUCbrm5u6wKS2iyOJu-rsN7TPzhCkjmVsCdEBWxQ&loadFrom=DocumentDeeplink&ts=4432.93)):

Is that you that we're talking about?

Speaker 82 ([01:13:55](https://www.rev.com/transcript-editor/Edit?token=fG0Prw_LxNkrAazZycI4_DJ_FwdtHXTSFog-bkWpC2UGKyUOZorC5S-58UsT4J0hZgrPpmr5_CffZPQ2yXqNlZlPZXs&loadFrom=DocumentDeeplink&ts=4435.16)):

It's too far away, 2050.

Sean Hill ([01:14:02](https://www.rev.com/transcript-editor/Edit?token=TRK5Fp_U-Pc2yGe-zoKpyjVZXyRiKJKPcDFj17LZAJm8GkMAoiZFTy24MNxQpAHJvmExxytEyPzq5N3CoZADwMC8l00&loadFrom=DocumentDeeplink&ts=4442.2)):

Yeah, for computing.

Speaker 82 ([01:14:02](https://www.rev.com/transcript-editor/Edit?token=SUC7TQy-naPaWy6wc1lWRAPS4zCCqdCt5QyDipR6md8e_gfRrpsa94qnqNG9FouQ1MXu5zXguWLAo8IDW6D1Mqn4ozA&loadFrom=DocumentDeeplink&ts=4442.64)):

For everything, I suspect, because it's 30 years.

Sean Hill ([01:14:07](https://www.rev.com/transcript-editor/Edit?token=XEgbRq0cDdqPer8kJkgk_Trw_-SUYC7Z8EqjFMoOUrmAk3YMtYi3R5FPjdVVNwU9VJOOpD2ShAGURqfhMlb-YrvrIDg&loadFrom=DocumentDeeplink&ts=4447.23)):

There's a story to be told about the next 20 years in computing.

Henry Markram ([01:14:10](https://www.rev.com/transcript-editor/Edit?token=uxdLyHx5VY4VBwWMZqLPzSosNxvaYJoSjtqhaQxVKi15KnDCDDiAVYftPLW1s8pVbsENWCn_y3Pgg9g-N71kZXL7VQI&loadFrom=DocumentDeeplink&ts=4450.37)):

2030's really just around the corner.

Speaker 82 ([01:14:11](https://www.rev.com/transcript-editor/Edit?token=Rd-2hhh9kp4DuueRU6Uco76MVx9yN4jH1ZSD2QMxbQK1n0Z4Ew8tJKLfac_y88ey8pOmcwE7ffeG4DQFcLrnliI6ueI&loadFrom=DocumentDeeplink&ts=4451.37)):

For once I'm in agreement with [crosstalk 01:14:11]

Henry Markram ([01:14:11](https://www.rev.com/transcript-editor/Edit?token=zs4YDfH4UhvaFT3Wi3n1e_12Iu9MGh2YLjXQt8dH5rnFtaIARPxRcvh9-UTD1yIC4JGdLIfKU5NlnJsz0iaObyBGw9c&loadFrom=DocumentDeeplink&ts=4451.37)):

Okay. 2030.

Speaker 82 ([01:14:17](https://www.rev.com/transcript-editor/Edit?token=xy0o2Pc9jg4AGSDuMQEfqyBJNdWLx8aobuRB5zBBVdzv5bjb-NZBQvqZ2Ldy7E3izgkc52y8UN1fVwQjEJ3_7iMm998&loadFrom=DocumentDeeplink&ts=4457.01)):

2030.

Sean Hill ([01:14:22](https://www.rev.com/transcript-editor/Edit?token=qf96AcyQ_5hW3HsUuJa_WvJhBvw8JzZ0qpO54mkJazGdyIG6kdErJBlWxYaBaibaT9p2WoP_HkIfaqJwasNfXvcAEuo&loadFrom=DocumentDeeplink&ts=4462.98)):

This is [crosstalk 01:14:24] 10 years.

Henry Markram ([01:14:31](https://www.rev.com/transcript-editor/Edit?token=y6peCkXj_xBi2T46NvAJOmE-MX6f-K_ddwb6uORR20-4plVVsn-77_j7ZbRTyWLGrjYrLzRPCSw_mIaGqLlimtF6ii0&loadFrom=DocumentDeeplink&ts=4471.14)):

Yeah, that's right. I mean, 10 years is really I think ...

Speaker 82 ([01:14:32](https://www.rev.com/transcript-editor/Edit?token=e4sIF4vpATnUZ2xwGh-nY_gKeyYOKYtF82H0sM6Qu8dQ1Ocpzj7a68c8rLdvlWzKv8QWZ7rzq51v0ijSa413yWq-oZ4&loadFrom=DocumentDeeplink&ts=4472.81)):

Should we do 2040, get a good compromise for everybody?

Henry Markram ([01:14:36](https://www.rev.com/transcript-editor/Edit?token=Qj_N-n2nO5FYcvxH3DCwovUlvVhpGsHzYCWMHkE9HuDlkdqAIFtXHKPlQEfr8qLYhP4LOMBLAJZM-z-yO1ImzWdzODA&loadFrom=DocumentDeeplink&ts=4476.63)):

When you say 2050, it just makes people think beyond the boundaries.

Speaker 82 ([01:14:50](https://www.rev.com/transcript-editor/Edit?token=9Jp4dKZUIzazxxO_gMPetgQ4KZh6GLPs6ncXUczXT-84wc8jA24GNh4nnvawnKB-eHK2o2aHr49Ygi5ezhz4KLrS5r4&loadFrom=DocumentDeeplink&ts=4490.91)):

I understand. No, you have reconvinced me.

Henry Markram ([01:14:51](https://www.rev.com/transcript-editor/Edit?token=v8KqLeK1d1EWzfwYf5mYtwHFd_srF5OsAozsAQmsY3hxns8njESSM_WrMhOI5ftkxuk8zxshXwfQ7aQMoGoQDUOqDMA&loadFrom=DocumentDeeplink&ts=4491.06)):

I'm reconvincing you to put it back to 2050.

Speaker 83 ([01:14:51](https://www.rev.com/transcript-editor/Edit?token=neHtRXPjA0U-tkOt7RY59k_wx1UsDZNGMJmB_LIYXxuxHIFZ9Qy1Zussbtm85yacUlOwLuWGAsRcZX-05HDByMxUbv0&loadFrom=DocumentDeeplink&ts=4491.06)):

Look, I'm not [crosstalk 01:14:51]

Henry Markram ([01:14:51](https://www.rev.com/transcript-editor/Edit?token=TJFPAyhrZv4wpGdTXSK1oQp336SRytlshp4nPPiNlwpUI5OXE9IrauBIMoeoTfv2zyUqN_O18K9iSwyzzLz_qoGpvow&loadFrom=DocumentDeeplink&ts=4491.06)):

You can start talking about 2030. It's okay.

Noah Hutton ([01:14:59](https://www.rev.com/transcript-editor/Edit?token=fCPU4HnaQyydIm33qAUGWDNbyIlmUs0djKCcI5uJBBvCEXq7G1JNEnxW62OZNbe2OtFrBjvpPJk0Qs_AL_2EGYTGj3s&loadFrom=DocumentDeeplink&ts=4499.2)):

Even though I decided to stick to my original 10 year timeline, in my final year filming with Henry and The Blue Brain Project, I realized how arbitrary it was for a 22 year old, believing in the powerful words of heroes, to have taken Henry's 10 year timeline literally. The years since felt like both forever and a blip on the scale of scientific progress. They were a 10 year model of someone who had been trying something and working towards something, which some day might benefit all of us, just some of us, or it might fail entirely. But failure is everywhere in science, just as it is in any chaotic system. What I was left with after 10 years was a belief in much of the criticism, but also a belief that to say open to the scientific process is to stay open to the possibility of being wrong. I appreciated Henry letting me in the door all these years, but my 10 years were up.

Noah Hutton ([01:16:06](https://www.rev.com/transcript-editor/Edit?token=q2IxTUwsnAkZQcHS4ZIKscfdgFsFqucnDUrIGmdjswY9OZ80GIWi4XkjG-WYN6RYPdFP67d-tI2YcV4QfFz7q4Oma4I&loadFrom=DocumentDeeplink&ts=4566.81)):

Henry would continue to believe in The Blue Brain Project's vision to simulate the human brain. And to tell that story, he decided to make a film of his own.

Henry Markram ([01:16:15](https://www.rev.com/transcript-editor/Edit?token=ULv7orV4H8HY7lkAiZAQY2fvG5XfRgPJYROxxoDwpkUATpns9tLfQ_ZZ7qGq9AuguaLydrc-jeE4qNpPzdNVkZETafI&loadFrom=DocumentDeeplink&ts=4575.63)):

Excellent. So that means the images are anchors, but we have other anchors related to the videos.

Speaker 84 ([01:16:24](https://www.rev.com/transcript-editor/Edit?token=u3g3Jq_XwoytkQcNBxiYetECtV2ulzu9JMYQg__7xQ_144pc8U-u0j5-M1DnT0jvNQbhem8z-naFCsgiYtDrWYTripw&loadFrom=DocumentDeeplink&ts=4584.18)):

But we do want someone to basically outsource the voiceover.

Henry Markram ([01:16:31](https://www.rev.com/transcript-editor/Edit?token=Dpv_s428aafh_JftzGhlW84UjBeSucpTMlucGSULu0q60GTz8aS98mDYarkfrLTsHpvRjeiyY6t7b8-ef6dCCoUig0U&loadFrom=DocumentDeeplink&ts=4591)):

[crosstalk 01:16:31] you need a professional voice.

Speaker 84 ([01:16:35](https://www.rev.com/transcript-editor/Edit?token=IWJoqrLntuiBfl2gJ3uN0HQ_bDexwjeg4qJ248GN1AZVeTplhqWgo96Ljh07lqdeLBSX4YP5AgPTtl-6vJ3L8e9Pr0g&loadFrom=DocumentDeeplink&ts=4595)):

[crosstalk 01:16:35] Jay suggested Neil deGrasse Tyson and is doing a [crosstalk 01:16:43]

Speaker 84 ([01:17:56](https://www.rev.com/transcript-editor/Edit?token=TP0VqxUPrd_O-oJi9BNvVzfzgU8qrCq8Ifw2rv__nGWj_-G6VjWYZsy6gdRNUAqIpXvJdQ0GY_kKW6_116F8vMwd7kc&loadFrom=DocumentDeeplink&ts=4676.88)):

(silence)

Noah Hutton ([01:17:57](https://www.rev.com/transcript-editor/Edit?token=8RFsacsXu5Rh3bmmOrKdczTqcKKxMQhKRP-qzNdpZg_roOp4EfboFCbyd168Dz3AAnfulIWHPbD0OwDqzBI0paqbqeM&loadFrom=DocumentDeeplink&ts=4677.02)):

Sometime after Deep Blue had defeated Kasparov in 1997, the IBM programmers wondered about that curious move near the end of the first game that seemed to throw the human into a tailspin. After extensive analysis of Deep Blue's logs, the programmers were surprised to discover that the strange move that baffled Kasparov and his team was a mistake. A bug somewhere in Deep Blue's dense code had frozen its software and then a backup program kicked in to generate a random legal move to keep the match going and prevent a forfeit.

Speaker 12 ([01:18:31](https://www.rev.com/transcript-editor/Edit?token=9g6MeZ0N-V6KBFlP_I8sZ_2WMnXyDTlBuk6buzzfv-iVkXh-DT2RAX7mF6G8CFi93bB8agAZ0D_otITT8kOmSSN4uPw&loadFrom=DocumentDeeplink&ts=4711.36)):

He looks disgusted, in fact, like he can't believe what's going on right now.

Noah Hutton ([01:18:40](https://www.rev.com/transcript-editor/Edit?token=r9GUaNvP1Ff757ESv5oYkc5jkyIcIzLltBdGeTUUPf-Ovp6TPvWdnhXv6Hc9W3k9kzk7h8QgAvIRq5hxjBgbclJI6hA&loadFrom=DocumentDeeplink&ts=4720.47)):

In its first great victory over a human, the machine's triumph was sealed by the mystery of a tiny mistake.

Noah Hutton ([01:18:47](https://www.rev.com/transcript-editor/Edit?token=QS1IZ0BZElUsAUtDptt-QYV3g3WAplGL5Nur0OjWSs8MFH9LhyAqQEEghb9PABlxFS3xh0Ps5lz_LZVkl65Qo--6dXc&loadFrom=DocumentDeeplink&ts=4727.19)):

(silence)