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Artificial Brain (& Body) Life Extension Introduction

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~~*Note: this material is being updated.*~~

Most people would agree that the most important thing for a person is his life: life is the very existence of this person, and without it nothing else can make sense any longer to him/her. [1] We all want to live healthier and longer, and the development of our civilization led indeed to safer and healthier lives. The average life span for example has increased during the last couple of millenia from about 30 years to about 70 years, but these numbers are mostly due to reducing the high mortality rate in childhood, and improving the quality of life after. That is to say, evidence points to humans as a species having a limited, genetically predetermined maximum, effective life span just as any other species does.

The question is: can we exploit the recent tremendous advances in science and technology to extend the life of an individual *beyond* any natural limit? And, equally important, can we find a way to do this *within our lives?*

The traditional approach taken by medicine has been to try to maintain the health of an individual as a whole and in its natural, biological form. This includes different chemical (pharmaceutical) and physical means to fight infections, to influence processes in our cells, surgery to remove failing organs and parts, and recently even regenerative means like stem cells to repair/renew tissues. However, the principial difficulty with this approach is that one has to understand the huge complexity of a biological organism, in all possible details, in order to address all known diseases and the aging process itself. (As prominent examples are cancers, autoimmune diseases, HIV and other viruses.) Every life sustaining subsystem of the body is highly interdependent with other subsystems, and we would have to understand *all processes down to the molecular level*, in order to maintain the health of the entire body down to this level. While we can hope such an understanding will be achieved (and we totally support it), the question is: *When?*

A different approach is taken by the *artificial organs* direction (bionics and biomedical engineering branches). Instead of trying to understand and keep the health of *every cell* of failing organ, one identifies the main functions of that organ and replaces it with an artificial one, executing the same main functions. Not only the artificial one is easier to maintain (due to its inherent relative simplicity), replace if needed, but it removes the dependency of its function on the proper functioning of other parts/organs, shall they fail at some point. While not new, this direction is progressing very quickly lately, following pretty much the progress in computer and material science technology. Thus, there are there are people with artificial/robotic limbs, kidneys, hearts and other. In addition, some neural prosthetics are developed as well.

[1] This, and all ideas hereafter, are from a non-religious perspective.

The idea of main function separation can be taken further: we should ask, which part/subsystem of an individual should be saved, as to still be able to say we saved the individual? First of all, it is probably the brain, as it holds our identity : memories, thinking and so on. Second, it is probably at least two ways, *in* and *out*, of communicating with the brain: a means of transmitting signals to this brain, like visual/audio/touch or other sensor, and a means for the brain to emmit signals out (like audio, or a movement means). The area of artificial sensors and actuators is actively developing, and there are already artificial eyes; audio sensors/ cochlear implants have long been around, and robotic hands which are linked to the central nervous system.

The main focus then should be on the first part: the brain itself. And here comes an important consensus in neuroscience: that *all this processing in the brain is done mainly by the individual's specific network of neurons.* All[2] we would need to know well is the functioning of one neuron, and the way it interacts with his neighbour neurons. All the complex cognitive functions are then produced by this interaction and the transmitting of electrical signals through the resulting huge network, while the memories would lie in the particular connections/synapses of the neurons, and the strengths of these synapses (and probably some other details). Note that we would not need to understand *how* these cognitive functions are produced by the network, as neuroscience traditionally focused on, but just the functioning of *one* neuron, how it interact with others and the specific parameters of one's neuronal network. Then, if we could replace this network of neurons by a network of artificial ones (or an equivalent processor) which will perform the *same* function (as close as possible), it means this artificial brain will continue to think the way that particular individual did. Importantly, this new brain is no longer susceptible to all those life threatening causes, internal or external, as the previous biological one. Together with a minimal communication way, mentioned above, the life of the individual is saved, for as long as he/she will desire to keep it.

Envision the following futuristic scenario: at the end (or even earlier?) of one's life, a person undergoes a thourough scanning of his brain's network, and one (or several) surgeries to replace his brain, section by section, with an artificial processor. Then, as his/her eyes (and other sensors) begin to deteriorate, these are replaced as well; new limbs are added. The individual will chose to replace his brain either entirely at once, or gradually, a section at a time; same goes about his sensors and actuators. Obviously, the rest of the body will be no longer needed and it will discarded when the person decides to.

Returning to present day reality, we agree that this scenario seems science fiction. However, comparing it against the traditional medicinal approach, it is still more reallistic due to its *minimal necessary system* idea: for instance, we cannot talk about sustaining the life of the brain without sustaining the life of all the other interlinked biological subsystems, with all the difficulties mentioned above. Same applies to the natural sensors and limbs.

Moreover, the proposal seems impossible only when thinking of applying it now, directly to the human body/brain. Instead, start with a much simpler species, so simple that whatever we envision of doing to a human, to be able to apply *now* to that species. Once we manage to extend that organism's life, improve the technology and move one level up.

For instance, human's brain has in the order of billions of neurons (and ten times more synapses), while the model organism with the simplest known nervous system, the worm *C. Elegans*, has 302 neurons (and about 5000 synapses). Scientists have already mapped all these neurons and their connections, and several are working on getting the electrical properties of them. Automated methods for scanning and for measuring of electrophysiological parameters of neurons are

[2]Or mostly.

being developed. Once the necessary data are available, this worm's nervous system is first modelled mathematically on the computer, first isolated, then together with his sensors and muscles. His behaviour on the screen is compared to the real life behaviour, then the model is improved, better data are incorporated, and the steps repeated. Once the simulation is satisfactory, we can start replacing his neurons, and then the entire net, with artificial ones, connecting to the biological sensors and muscles. We should note that this is in principle possible, just as it is possible to get readings of the electrical functioning of one single neuron (using microelectrodes or other means) and in turn force a neuron to fire. Moreover, the idea is also already supported by the experience of making artificial eyes/cohlears, neural prosthetics and robotic limbs connected directly to nerves. Add to this all the advancements in miniaturization of device manufacturing down to micro levels and below. After succesfully replacing the neural net of the worm, we should with replacing at least one sensor and all or some of his muscles with artificial ones, and study the behaviour of the new body. Overall, with the current level of technology existent in the word, we believe it is realistic to achieve all this on the worm, nowadays.

This will mark stage one complete, and together with improving and automating the techniques, we could move to a next stage/level: an organism with an order or two higher number of neurons; perhaps a Pond snail with 11 thousands of neurons. And improve the model, the method, the tools. Then move to a fruit fly, with one hundred thousands neurons; a cockroach or a bee - a million neurons; a frog 16 million. Then the clever guys: a bird, the mouse (75 millions). The octopus 300 millions, the cat 1 billion, the cimpanzee 6.7 billions. This way, in several steps, we can get to the human: about 100 billion.

The overall idea is that once something is doable in principle, and once it is proven on a simplest case, then with a bit of improvement it should be possible to apply it to a more complex case[3], given that the complex one is organized based on similar principles as the simple one. [4]. And once something is doable in practice, and the problem is in time and energy, then *with enough people working on it, the time can be reduced to even our life time*.

We perfectly understand that this, as a whole, is a huge undertaking; it is not the project for one scientist, or even a team of scientists. It is a project that needs to involve many, many teams of researchers around the world, that will communicate their results and move towards a high, common goal. How can it be organized? We would like a model that would include all of the traditional ones (business, academic, government-directed, open source...), one that will not put any restrictions on the agents involved, on sources of funding, and on the motivation (for profit or not, for the achievement of the project's final goal or just for a specific stage) of those working on specific steps. This model is probably the *open-collaborative* one: a framework that will take advantege of the so-called collective inteligence, open for contribution for *anyone* interested, be it accomplished researcher, or a smart high-schooler (take for example Wikipedia) that can support his arguments with verifiable facts.

So imagine a big, openly editable[5] website, that will present the project from motivation to accomplishment. A place that will list the big stages of the project, and each stage directing to another page listing, maybe in a tree-like fashion, sub-stages, and so on , down to "small" research steps that can be undertaken by one or several researchers in up to a several years' time. Each step would be accompanied by thorough study of what what has been done, and what remains to

[3]Pretty much like an argument by induction in mathematics.

[4]For instance, there is a striking similarity in neuron functioning across species

[5]For protection against vandalisms, there can be added different layers of how much one can edit based on his registering and past contributions on the website, recognition by peers (take as an example the stackexchange-like websites), or perhaps even the proven real-life specialization of the person).

be done: all editable by online volunteers in their free time[6]. At the same time, each page, each step would have discussion space where users can discuss live and vote on different proposals.

As such, almost *anyone* seriously interested would be able to participate, either in the research itself, or in the organization and maintaing of the website.

The research itself is evidently highly interdisciplinary, and it will involve people with background in neuroscience, math (modelling the networks), computer science, electrical and mechanical engineering, biology, biomedical and neuro- engineering and other.

Let us end this introduction with a "worst"-case scenario remark: what if due to insufficient progress, the main goal – life extension – will not be achieved during our lives? Then we must point out to the huge importance the kind research involved will have anyway. For medicine, suffice it to get to the stage of replacing individual neurons, and small neural nets: think of millions of people suffering from spinal cord, and region of brain's injuries. Same goes for the accelerated progress in artificial sensors and limbs. For robotics and artificial inteligence, suffice it to simulate on a chip the brain of simplest species and think about how many robots are there which don't really have a "brain" to behave autonomously.

However, if enough people will join the project, and will make their best effort, we believe we are *ABLE* to achieve Artificial Body Life Extension, *during our lives.*

[6]Think about how many of us spend hours and hours every week playing computer games, and about the goal of this project. Also think about the progress Wikipedia has made for becomming the biggest repository of free information for everyone.