

THERE WILL BE NO CYBORGS, ONLY ARTELECTS

A Dialogue Between Hugo de Garis and Ben Goertzel

The two scientists Hugo de Garis, and Ben Goertzel have worked together on artificial brains, at Xiamen University in China. They are also good friends, and have discussed issues related to the future of AI, technology, humanity, intelligence and the universe many times. But they don't always see precisely eye to eye. This is one of their many conversations, centered on Hugo's notion that the future will be defined and dominated by artelects – vastly superhuman artificial intellects – rather than cyborgs.

Ben:

Hugo, what exactly do you mean when you say “there will be no cyborgs”?

Hugo:

My basic point is really simple: “there will be no cyborgs” in the sense that the computational capacity of a nanotched grain of sand is a quintillion times that of the human brain, making the distinction between a cyborg and a pure artelect pointless. Any human being wishing to convert himself into a cyborg will effectively be killing himself, unless he dramatically impairs and restricts the capability of his cyborg portion. He will no longer be “he” but an “artilect in human disguise.” This argument has implications for the species dominance debate.

Ben:

OK – so why do you say cyborgization equals death?

Hugo:

In my media appearances I often talk about a grain of nanotched sand being added to a newly born baby's brain to convert it into a cyborg. I finally got around to actually calculating just how much greater the computational capacity of that grain of sand would be compared to that of a human brain (assuming classical computing capacities – if one assumes quantum computing capacities, the quantum estimate is astronomically larger!)

Let's start with some basic assumptions. Let the grain of sand be a 1 mm cube (i.e. 10^{-3} m on a side). Assume the molecules in the sand have a cubic dimension of 1 nm on a side (i.e. 10^{-9} m). Let each molecule consist of 10 atoms (for the purposes of an “order of magnitude” calculation). Assume the grain of sand has been nanotched such that each atom can switch its state usefully in a femto-second (i.e. 10^{-15} of a second). Assume the computational capacity of the human brain is 10^{16} bits per second (i.e. 100 billion neurons in the human brain, times 10,000, the average number of connections between neurons, times 10, the maximum number of bits per second firing rate at each interneuronal (synaptic) connection = $10^{11} * 10^4 * 10^1 = 10^{16}$).

I will now show that the nanotech grain of sand has a total bit switching (computational) rate that is a factor of a *quintillion* (a million trillion) times larger than the brain's 10^{16} bits per second. How many sand molecules in the cubic mm? Answer :- a million cubed, i.e. 10^{18} , with each of the 10 atoms per molecule switching 10^{15} times per second, so a total switching (bits per second) rate of 10^{18} times 10^{15} times $10^1 = 10^{34}$. This is $10^{34}/10^{16} = 10^{18}$ times greater, i.e. a million trillion, or a *quintillion*.

Ben:

Yes, that's certainly a compelling point!

Now that I think about it, another interesting calculation is obtained by applying the Bekenstein bound from fundamental physics.

[http://en.wikipedia.org/wiki/Bekenstein_bound]. You're probably familiar with this, right? Related to black hole thermodynamics, this is a bound on the number of bits of information that can possibly be contained in a certain amount of matter, assuming current physics is correct.

According to the Bekenstein bound the number of bits possibly storable in the matter comprising a human brain is around 10^{42} . Factoring in the smaller diameter and mass of a grain of sand, one decreases this number by a few powers of ten, arriving at an estimate around 10^{35} or so for the sand grain. Compare this to estimates in the range $10^{13} - 10^{20}$ for the human brain, based on our current understanding of psychology and neuroscience [<http://www.merkle.com/humanMemory.html>]. Of course, a human brain cannot approach the Bekenstein bound without being restructured so as to constitute some very non-human-brain-like strange matter. A cyborg combining a human brain with a grain of "sand" composed of strange matter that approaches the Bekenstein bound, would potentially contain 10^{35} bits in the femtotech sand grain component, and 10^{21} bits or so bits in the legacy-human-brain component.

Hugo:

Right. And this has huge political consequences for the species dominance debate

People like Kurzweil, Warwick etc claim that there is a third ideological human group in the species dominance debate, besides the Cosmists (pro artelect building), and the Terrans (anti artelect building), namely the Cyborgists, who want to add artelectual components to themselves, thus converting themselves into artelect gods. They argue that by converting humans into artelects via the cyborg route, it will be possible to avoid a gigadeath "artilect war" between the Cosmists and the Terrans, for the simple reason that the human race will have converted itself into artelects, so there wont be any Cosmists or Terrans left (i.e. human beings) to wage the war. Everyone will have been upgraded into an artelect.

There's not much point is using the term cyborg, because as the above calculation shows, the human component in the cyborgian brain is only one part in a quintillion (a million trillion), so can effectively be totally ignored. So really, there is no third ideological group. There are only Cosmists, Terrans (and artelects.) Even in the very early days of

cyborgian conversion, the vastly superior computational capacities of nanotech matter will make itself felt. The first cyborgs will very quickly become artefacts. Since their bodies would still be human, the Terran paranoia against them would be great. The Terrans would be unable to distinguish a cyborg from a human just by looking at him, hence all human looking beings would be suspects.

A potential cyborg then needs to consider the fact of the above calculation and become fully conscious that a decision to “add the grain of sand (or more)” is a decision to commit suicide as a human being. The resulting cyborg is utterly dominated by the artefactual capacity of the sand grain which totally drowns out the human component (one part in a quintillion, and probably vastly more as quantum computing scales up).

This means that if a mother “cyborgs” her baby, she loses her baby. If adult children cyborg themselves, their elderly parents lose their adult children. Thus it is clear that cyborging will be *profoundly disruptive* to humanity. A large proportion (probably about half, and this needs to be researched more thoroughly, e.g. the BBC vote of 2006 and the Coast to Coast radio poll of 2005) of humanity is deeply, viscerally opposed to Cyborgism and Cosmism, and will go to war to stop both the Cosmists from building pure artefacts and the Cyborgists from converting themselves into (near) pure artefacts. They will simply *not tolerate* becoming an inferior species, with all the enormous risks to the survival of the human species that the rise of the artefact raises.

When I hear Cyborgists saying such things as “I want to become an artefact god myself, by converting myself into an artefact by adding artefactual components to my brain”, I become cynical, because I wonder if they realize how enormous the computational capacity of artefacted matter is. I sense that too often, these Cyborgists are ignorant of the “physcomp” (physics of computation) calculations applicable to nanotech matter. They need to be made aware that a decision to cyborg themselves is a major one – it means the end of their lives as humans. They would no longer be human, they would be artefacts, which from a human being’s point of view, is to say that they would be utterly, utterly alien, frightening, and to the Terrans, worthy of extermination.

I feel that 2011 will be the year that the “species dominance debate” goes mainstream (at least in the US, where this debate has been led.) Ray Kurzweil has recently been featured in a Times magazine article and I was featured in a History Channel program “Prophets of Doom”. There will be several movies in 2011 on the same theme, so the general public will become more exposed to the ideas. If one thinks back 5 years and asks oneself, “How conscious was I of the climate change issue?” Most people would say, “Only a little, if at all.” I would not be at all surprised that 5 years from now (2015), the issue of species dominance will be part of the educated person’s general knowledge, as much as is climate change today.

And after the issue heats up, the species dominance issue will not go away! Every month technical progress is taking humanity closer to being able to build artefacts. The issue will heat up, and tempers will flare. Political parties will be formed on the issue. The debate will later start raging, then the assassinations and sabotages will start. People will take

sides. The two ideologies (Cosmism and Terranism) are both very powerful (i.e. building gods vs. preserving the human species – “do we build gods or our potential exterminators?”) and so far have split humanity down the middle. Most individuals are ambivalent about the issue – feeling the awe of building artifact gods as well as feeling the horror of a prospective gigadeath artifact war.

Personally, I’m glad I’m alive now. I don’t want to see all this horror that is going to consume my grandchild and billions like him. I just don’t want to see it. If I live into my 90s, I will see the species dominance debate rage (it’s starting already amongst the AI specialists) but I won’t see the war. Thank god.

Ben:

There’s certainly a lot of truth to that, but it seems to me you’re overlooking one major point. Some people may want to become cyborgs with a more *limited* machine component than what is potentially possible, i.e. they might *choose* to be 50% human and 50% machine (in terms of computing power), even though it would technically be possible to become 99.99999% machine (computationally), and only .00001% human. This doesn’t affect your arguments about species dominance, but it does IMO mean there could really be three political groups – a) those wanting only legacy humanity (Terrans), b) those wanting only limited expansion of human capabilities, e.g. 50-50 human/machine hybrids (the Cyborgists), c) those wanting expansion without unnecessary limits (the Cosmists). From a Cosmist viewpoint, the Cyborgists and Terrans will be basically the same thing. From a Terran viewpoint, the Cyborgists and Cosmists will be basically the same thing. But to a Cyborgist, the Terrans and Cosmists will seem qualitatively different.

Or is your point mainly that, once we have the femtotech grains of sand available, they’re just going to achieve massive superintelligence so quickly that all the distinctions between inferior-intelligence human-scale beings are going to become totally irrelevant?

But don’t you think it’s possible that the superhuman artifacts may let pesky little humans and cyborgs keep on existing and minding their own business, just as we humans do with ants and bacteria?

Hugo:

If the “artificial factor” is only million times more, or a billion, or whatever, the qualitative conclusion is the same, i.e. the human component has been swamped. So there’s little point from the Terran viewpoint in distinguishing between an artifact and a cyborg. The so-called “third option” of Cyborgism is a phony one. There really are only 2 options – Terran or Cosmist. The last part of your question is critical in this whole species dominance debate, namely that of “risk”, i.e. the risk that if the artifacts come into being, that they may exterminate humans, for whatever reason. I just don’t see Globan (i.e. world state) Terran politicians around mid century, tolerating the Cosmists demands to build artifacts. To do so would be to accept that the fate of humanity lies with the artifacts. Humans would become the “No. 2” species. We would lose control of our own

fate. I see the Terran politicians drawing a line in the sand, i.e. pushing hard for a globally legislated maximum AIQ (artificial intelligence quotient) and anyone superseding it is to become a criminal and be prosecuted. This will force the Cosmists to organize and oppose such a ban. The rhetoric either way will heat up (the “species dominance debate”), and spill over into the “Artilect War”, which with 21st century weapons, will lead to “gigadeath”.