The potential for future life

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Introduction

Life technology has been progressing rapidly since the early 90s. The human genome project uncovered an important part of the information we need to understand what it takes to make up a human. The proteomics projects now well under way seek to build a fuller picture of the interactions among the many proteins constructed and used within our cells and their interactions with our DNA. With the rapid progress in these and other studies, it seems certain that within a few decades, we will be able both to customise existing life forms and to design new life forms from scratch. More exciting still, we will also learn how intelligence and consciousness work, and eventually be able to design artificially intelligent entities.

Much of this progress will be enabled by progress in nanotechnology, which will not only accelerate progress in biotechnology and information technology, but also help to merge them, with dramatic consequences. The term 'NBIC convergence' is often used (nano-bio-info-cogno) to describe this very broad convergence of technology, though it could be argued that the real convergence is simply bio and info, since nanotech is really an enabling technology, and progress in cognition technology one of the obvious consequences of converging bio and info.

With all of the impressive tinkering with the genomes of existing life forms, we have yet to see the first bacterium assembled totally from scratch by humans. However, this is now very likely to be announced in the next couple of years. The development of a wide range of synthetic biology and synthetic life forms is inevitable. Life will just become another form of human technology.

The IT domain is in some ways more interesting. There is still ongoing debate as to when some particular electronic activity would qualify as a life form, and further debate as to when it would qualify as conscious. Indeed, some participants in the artificial life and artificial intelligence debates insist that these will never be achievable. If they are right, then the rest of this article is no more than science fiction.

However, I am confident that not only is it possible to create conscious and highly intelligent entities base entirely on electronic processes, but that this could be achieved by 2020, and furthermore, that we will be able to link biological and electronic processes to make hybrid life forms that exists partially in the biological domain and partly in cyberspace.

Upgrading rain forests

But let's start with the most obvious use of life technology. At the moment, humans are having a devastating effect on their ecosystem, especially by clearing forests, over-fishing, polluting and of course changing the climate. Many species are disappearing. On the good side, gene banks are being constructed to index as many life forms as possible, and conservationists try hard to protect as many species as they can. It is likely that species will soon be brought back from extinction by recovering their DNA and using cloning technology. But why limit this to previously extinct species? Why not create entirely new ones once we understand how to mix and match genes off the shelf, or to design and assemble DNA from scratch? Surely it will be possible in principle to design and build a whole new ecosystem, and in the not very far future. Indeed, we might have to do so if environmental problems continue to escalate.

It is a long way from simple genetic modification to creating a Mk 2 rainforest. However, although first thoughts might indicate that this will necessitate a slow, gradual development path and result in very conventional life forms, further thought suggests that it will not be like that in practice. Progress can become alarmingly fast once our knowledge reaches critical mass.

Convergence of technology creates a positive feedback loop, with advances in one field helping to accelerate advances in another. Better IT means faster development in biotech, and better understanding of techniques used in nature leads to better IT. In a decade or so, chip manufacture will be moving from lithography to nanotech component assembly. It is likely that custom design proteins will play a big part in this component assembly, bringing the biotechs into IT manufacturing. And of course at the same time, medical demands will mean much greater use of IT in medicine, such as nervous system interfacing, medical monitoring and smart drugs. So companies from both sectors will be competing head on in the same markets.

But convergence also means that boundaries blur at much more fundamental level. Implanted IT can be used to greatly enhance the capabilities of organisms, both by directly enhancing biological properties and by transparently linking them to externally provided capability. So, an organism might be given better internal senses or faster response. Or it might have external sensors or actuators networked under its own direct control. Or it might even be networked with other organisms into higher level organisms, or have access to the sensory capability of another organism. Linking AI to genetically modified or wholly

synthetic organisms would allow hybrid life forms that exist partly within discreet physical bodies and partly unconstrained within the network.

So convergence of IT with biotech will have very considerable consequences for the whole nature of life, greatly increasing the scope of what is possible for a life form. Our Mkii rainforest could be populated by genetically enhanced organisms, some of which are networked via the internet, leading to amusing possibilities such as animals using dating sites and GPS navigation to find mates. Abundant sensors and feedback mechanisms could ensure ecosystem stability in a kind of electronic Gaia.

AI & AL

Understanding life in the biological world will help the creation of life on-line too. Or at least sentience and intelligence. At the very least, these could be accomplished using networked biology, or synthetic biology, taking a platform that we know works and networking it. But probably, we will be able to make wholly electronic entities that indisputably exhibit consciousness and intelligence. They will not be like us though, any more than other species, or aliens, are like us.

Intelligence is useful. So is consciousness. Once we understand how to make them, we will do so extensively. Smarter weapons will inevitably be some of the first uses, then banking, invention, and other commercial exploitation. Eventually, we will consider using artificially intelligent entities in computer games and entertainment. But we must be very careful here. Ethical issues are abundant once we start down this road. For example, we should ask what rights conscious and intelligent machines should have. Should we give them freedom, independence, the right to own property, run companies, make money, and start their own empires? Should we still be allowed to treat them as just machines, and switch them off at the end of the day, or use them in battles like future versions of Robot Wars? Wouldn't this reduce humanity to the level of the Roman Coliseum again? Should we allow them to earn money, then spend it on robots so that they can emigrate into the 'real world'. Our foreign office has no means of dealing with immigration from cyberspace. It might soon have to.

Smart bacteria

Hybrid life forms are likely to start with smart bacteria. Future electronic manufacturing will require bottom-up assembly processes, with proteins assembling components into circuits. Since bacteria are likely to provide an easy way of manufacturing the appropriate proteins, we may well see them being used in electronic manufacturing processes, being dissolved away once they have accomplished their job, to leave the circuits.

Later, it would perhaps become possible to modify the DNA of bacteria so that they can manufacture circuits within their own cells without affecting their own viability, and then to power the circuits like any other cellular component. These 'smart' bacteria would be able

to reproduce, with all of their descendants containing circuits too. Since self-organisation technology is also developing quickly today, millions of smart bacteria would be able to cluster and organise into very sophisticated, scalable computing resources. A standard sized pot of 'smart yoghurt' could contain many orders of magnitude more intelligence than a human brain.

Science fiction has often explored dystopian futures where smart machines try to take over. Smart yoghurt might not seem much of a threat compared to Terminator style robots, until you realise that bacteria would not be confined within yoghurt. We breathe bacteria in all the time. Some bacteria can make us very ill, some can even affect our thoughts. Certainly they exist on almost every surface, such as computer keyboards. Smart bacteria could easily intercept our thoughts and passwords even before they get anywhere near encryption tools. If they could enter our brains and interface to our brain cells, controlling us directly, they start to look very much like serious threats. What is especially worrying about such a scenario is how difficult it would be to police such technology. The temptation to use such technology for weaponry is likely to be irresistible to both governments and terrorists. And yet a design fault or accident is a potential extinction level event.

Migration

AIs might be given the right to earn money, buy robots and move into the real world 'when they grow up' just as human kids become independent and leave home.

More interesting is that the opposite might also be possible (although certainly much later), with humans having such transparent links between their brains and the IT world that they can essentially download into cyberspace. This has some initial attraction just as a form of electronic immortality, with death ceasing to be the end of our minds at least. But it might not be just when we die that this is attractive. Migration or commuting between the real world and cyberspace might become commonplace. As a means of rapid travel it would be hard to beat. The 'Total recall' virtual holiday might become feasible. Again, many interesting issues come to mind. As a means of limiting environmental impact of a large population, perhaps 'time-share bodies' would offer a contribution. We could live in cyberspace with minimal resource consumption, coming into the real world only when we need to. In cyberspace, we might have many parallel existences. Instead of making life decisions and only have one life to live, we might have many, with a whole population of 'us'.

Global consciousness

And of course, another major advantage of linking or transferring our minds into cyberspace is that it would then be a relatively trivial technology development to allow telepathic communication between people. Or indeed, among all organisms, and all the AI population too.

The consequences of shared, and even global, consciousness are hard to imagine. Loss of individuality, shared and customisable personalities, multiple existences, and a highly variable and dynamic concept of self are just a few that spring to mind but there must be very many more. Immediate concerns about the religious implications spring to mind, given how much people care about such matters. It is highly unlikely that people would all accept such developments without objection.

But the fact remains that whatever objections exist, and there would be many, it is also obvious that some people would relish the opportunities afforded in such a future, so there would certainly be a market demand. Immortality and almost limitless scope for personal upgrade, along with the ability to live in an extremely compelling world, would certainly attract many people.

However, the cost might simply be too high. Exciting though these possibilities are, the technology required to enable them can also be used for weapons. The commoditisation that would be needed would make the technology available to many to whom it simply must never become available. To give every dictator and terrorist, and lunatic, and even suicidal students access to technologies that could ultimately destroy all life on earth is to invite extinction. Will this be enough to prevent us proceeding down this path? Personally I doubt it, and the technology timeline coupled with the associated risk, suggests a default date of 2085 for human extinction, give or take a decade or so.