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GLIMPSES OF THE FUTURE

In which we look forward, with some trepidation, to an imagined world in which today's discoveries have been put into practice, and consider the impact that today's social media might have upon human connectedness!

Humanity still evolves. Natural selection is part of our destiny but another layer of evolution, social evolution, seems destined to play a more immediate part. Our environment is changing rapidly; in one long lifetime we have moved from pen and ink to interactive social media. Computer intelligence and scientific discovery are shaping our future. Science fiction gives us a glimpse of what it could be like.

How will we evolve, with a world population of 8 billion individuals busily mixing genes and a generation time of 20 years? If we think solely in Darwinian terms, the answer is: slowly. The mathematics of Darwinian evolution is such that it tends to stabilise large populations, by weeding out mutations, and proceeds most quickly in marginal or isolated groups.

As a part of Gaia, humanity and its affairs is not exempt from the fate of this collective whole. Recently, we have perceived that we are having a measurable impact on Gaia. Whether for good or ill, our future depends on the continued existence of Gaia. It is therefore worrying that our impact has been brought about by tampering with one of the fundamental components of energy flow through the biosphere – that is, letting loose our stored energy, fossil fuel, all at once, in geological terms.

Already, in only 250 years since the Industrial Revolution, we have exploited fossil fuels to the extent that a carbon dioxide greenhouse effect is warming the planet and disrupting the climate. This is creating a new scenario because Gaia's regulatory systems, one of which is evolution itself, are adjusting to 'down-regulate' the effect of such changes and achieve a new steady state. Part of that down-regulation could be to curtail the activities of the causative agent – ourselves. Gaia will survive but we may not.

In the face of finite resources, the phrase 'sustainable development' is an oxymoron. The idea of evolution going on forever to greater and greater complexity cannot be sustained. As complexity increases, the amount of energy required to maintain complexity also increases. And, as we have seen in other walks of life, highly complex things are inherently less stable. Things have a tendency to fall apart and, according to the mythical Murphy, anything that can go wrong will go wrong, given enough time. Even the *Titanic* was sinkable; so was the 'invincible' HMS *Hood*, which exploded and sank in three minutes when German shells penetrated her armoury. Evolution, however, will continue to rearrange the DNA Lego bricks with not *necessarily* any net increase in complexity and anyway, what could be more complex than the human brain, with its trillions of connections? Perhaps it marks the end of our line of evolution.

We do, however, have another string in our bow, and it is social evolution. Perhaps if we can bring this to bear on our existential dilemma, we may win ourselves a reprieve. Historians are long used to thinking about human social structures as if they, the structures, were organisms. The concept of civilisations as super-organisms with limited and predictable lifespans is explored in Oswald Spengler's *Decline of the West* (1932). Indeed, by making comparisons with previous civilisations he concluded that, by the beginning of the twenty-first century, Western civilisation would be in decline as established religions lost their grip on the majority of people, and national boundaries would blur to provide overarching empires, possibly even commercial ones.

The idea that towns and cities, those that are not architect-designed like Canberra and Brasilia, arise naturally in association with natural resources and organise themselves along general principles is due to Lewis Mumford (1961). Arnold Toynbee (1972) thought in terms of the life of the city, during which it faced continual cycles of challenge by external influences, followed by response. Eventually, the senescent city is unable to meet

the challenge and it falls. The three consequences of energy flow are here displayed: increased worldwide connection (Spengler), self-organisation (Mumford) and cycles (Toynbee). During these changes, humanity is continually challenged by social as well as natural evolution. Social evolution is the quicker of the two; 12,000 years ago people had to be able to live in a stone age culture and today, with more or less the same genetic make-up, they must live in a world changing under the impact of computer-assisted intelligence.

Most recently there has been interest in the organisation of human societies from researchers such as Peter Turchin (2007). Turchin was originally a population biologist who studied the way that prey and predator relationships changed. He was interested in why they cycled through boom periods of rapid prey increase followed by busts as the predator population soared then crashed as the abundance of prey decreased and food became scarce, and so on. He then realised that his mathematical description of this process could also be applied to describe the rise and fall of civilisations.

Turchin identified two sorts of cycles of civilisation. The first is a growth cycle that typically lasts two or three centuries. It starts off well enough. In the early stages, the foundation period, everyone is more or less equal but, benefitting from the improved living conditions as people cooperate in building the city, the population begins to grow. Society begins to stratify and wealthy elites form. The elites control resources and employ the less wealthy as a workforce. As the population continues to grow, the number of potential workers outstrips demand and their wages and standards of living fall.

Social unrest follows, and a destructive cycle begins. There may be revolution as social structures break down and a greater equality among the population is established. This period characteristically lasts for about two generations, when regrowth and rebuilding start. Destructive cycles may be repeated before final collapse or regeneration. From this simplified account it is clear that even human social systems are, in Darwin's words (from *Origin*),

> elaborately constructed forms, so different from each other and dependent upon each other in so complex a manner, [they] have all been produced by laws acting around us.

As well as this inherent cycling, however, there is still another tiger lurking in the evolutionary underbrush, one that Malthus and Darwin thought they had flushed out nearly 200 years ago. It is the problem of exponential growth. The human race has grown exponentially with the result that by 2030, if unchecked, it will take two planets' worth of resources to sustain us. Happily, there are signs that the rate of population growth is beginning to slow.

But the exponential tiger has other prey in sight. Just as the Victorians in the middle of the last century had failed to see the implications of exponential growth for living things until Malthus and Darwin pointed it out, so Kodak, the company that had been a household word for 100 years, fell foul of the exponential growth of information technology. Kodak failed to understand that exponential doubling affects other things than populations. In spite of having developed a digital camera as early as 1975, the company decided not to pursue the technology, concentrating instead on their stock-in-trade of now largely obsolete photographic paper. Kodak filed for bankruptcy in 2012. In 2014, after selling off assets in the form of patents it had held, they were again trading profitably but with a vastly different strategy. Kodak had fallen, one more victim to the tiger of exponential growth, this time not of living organisms but of the increase of miniaturisation of computer circuits. There will be other casualties.

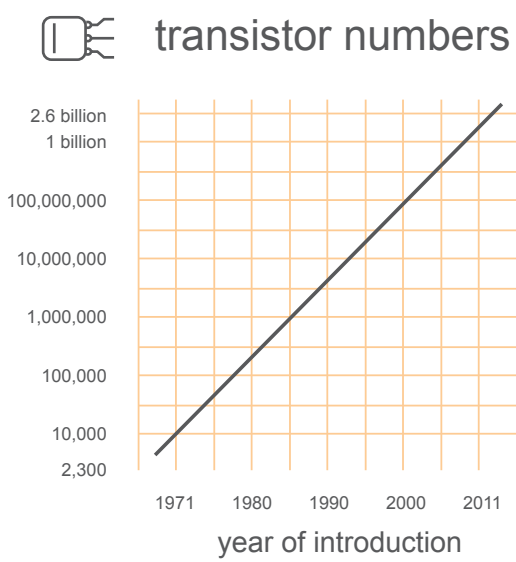

Figure 20. Transistor production.

Moore's Law, shown pictorially in Figure 20, states that 'the number of transistors in a dense integrated circuit doubles approximately every two years'. The period is now often quoted as 18 months, because modern transistors are faster. The evidence suggests that Moore's Law will continue to apply for at least another 10 or more years, as quantum computers and, more distantly, 'wetware' computers, made of neurons, already exist in rudimentary form. By that time, Ray Kurzweil (2016), Google's director of engineering, expects a computer intelligence will have passed the Turing test and achieved human levels of intelligence.

Should we be afraid? Our societies will certainly change under the impact of increasingly able computers. Do we have anything to fear physically, from attack by robots? Science fiction writers for more than 100 years have been anticipating societies in which this has happened. In particular, Isaac Asimov (1954), with his stories of dystopias in which robots play an important part, has been very influential. His three Laws of Robotics, built into robots by humans, to eliminate threat to humans, are frequently quoted. They are:

> A robot may not injure a human being or, through inaction, allow a human being to come to harm.
>
> A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
>
> A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Later, Asimov added another law, one that took priority.

> A robot may not harm humanity or, through inaction, allow humanity to be harmed.

Asimov was a writer of science fiction. His Laws of Robotics were carefully thought out, but they were literary devices, developed so he could write stories about the ways that his characters, robots or people, circumvented them. They are too vague, lacking precise definitions of 'harm', 'benefit' and 'human'. Asimov's imagined worlds consist of people not too dissimilar from you and me, with robots that are apparently at the top of the artificial intelligence tree. Louie Helm, of the Machine Intelligence Research Institute, has blogged that even if Asimov's vision came about, it would be transient as humans begin to deal with the ethical problems of a machine super-intelligence that transcends the robot era.

But suppose a robot decided that it was in humanity's best interest in the long run to reduce the population. It is already conflicted by the first and the fourth Laws. If it decides against killing the 'surplus' population it must resort to other means and disregard the Laws. Indeed, one new scenario has recently been reported in which the Laws may be circumvented. Apparently, self-driving cars can be fitted with an 'ethical knob' to override the Laws which, if pressed by the passenger, allows the robotic 'driver' a choice when about to be involved in an unavoidable accident. It may seek the least harmful alternative, and allow its the passenger to be killed if it will bring about fewer deaths than taking evasive action.

Our capacity to read the future depends, in part, on how well we can understand the past. In the *Phenomenon of Man* (1959), Teilhard de Chardin saw a trend in the increasing evolutionary complexity of nervous systems and brains and conceived a future when all humans were connected in a planetary hook-up that he called the noosphere. His idea of a noosphere was compounded of his religious beliefs and a sort of telepathy. Writing 70 years ago, he had completely failed to see the rise of computer intelligence and the technology that permits the construction of a 'mechanical noosphere' that is embodied in modern social media. He was, however, certainly correct in his view that increased connectedness between individuals would change the world, but not in a way that he expected. Isaac Asimov, however, could conceive of such a future, where robotic intelligence was commonplace. In *Caves of Steel*, written about the same time, Asimov describes a society so enamoured of its capacity for computer communication that its individuals have come to live in splendid and sterile isolation, communicating by the equivalent of Facebook. It is the extreme of the tendency towards personal physical privacy that has been developing in the West since the eighteenth century.

If we want to look into the future in the relatively short term – say, 200 or 300 years from now – it may be good, first, to look back the same distance to take note of trends. The present book is written by a couple of dinosaurs, children of the 1930s, so we have had the opportunity to notice more than most. At school, we were all taught about the Industrial Revolution and how a set of technologies based on advances in iron smelting and metallurgy, made possible by the availability of abundant coal, changed the face of Britain. The industrial future was, and still is, embodied in the Iron Bridge that crosses the River Severn. It was made

of cast iron and opened in 1781. This was the first triumph of a modern disruptive technology, a term used by Clayton Christensen (2003) in his book *The Innovator's Dilemma.*

A disruptive technology is a game changer. It can be large, like the Iron Bridge, or the Model T Ford that did away with carriage horses. It can be the accumulation of small discoveries. One of us, growing up in Australia in the 1930s, remembers the iceman. His job was to patrol the streets with a horse-drawn cart that had an insulated compartment containing large blocks of ice. These he sold in chunks to the local householders, while small children clamoured for the ice chips. This was a livelihood that was doomed when the first powered domestic refrigerator appeared. It was also one less task for a carthorse. There are many, many other examples. Indoor flush toilets did away with the night-soil collector and his poor old horse. The streets used to be loud with the calls of the rag and bone man and his horse-drawn cart. In England, the Italian ice-cream vendor on his modified tricycle, the itinerant Spanish onion seller on his bicycle, his strings of onions draped over his shoulders, the dustmen collecting dustbins, the coalmen, also with horse-drawn carts, delivering coal and coke, in hundredweight sacks poured straight into the cellar, are gone. When the word processor came on the scene, the typewriter was doomed. Who now remembers logarithm books, slide rules or mechanical calculators? Who now remembers typing on wax sheets for the Gestetner duplicator to make copies? Who remembers what the world was like before computers and Twitter? We have been inundated by a deluge of new technologies for the last quarter of a century and have adapted to them. But new technologies make new societies. The discovery of fire, the knapping of flint, the smelting of metals, the first labour-saving machines, the first motor cars all changed the societies in which they first appeared. Here are some new technologies that may have profound effects in the future. Most of them are discussed in more detail by Fagan (2017).

1. Social media. There will be a higher level of computer-driven connectivity but reduced physical interpersonal communication. Already it seems that dating websites are liberalising humanity by increasing the number and type of people available outside the usually local group of potential mates.
2. 3D printing is becoming better and cheaper. It says much about the human race that one of the first 'printed' things to receive public attention was a ceramic handgun. As 3D printers become even

more common and accessible, only the easily transported printing programs, and access to a local machine, will be needed to build a wide range of products. (Since this paragraph was written several months ago it is already out of date. Personal 3D printers are now available for a few hundred dollars.)

3. Electric self-driving cars will lead to far fewer cars on the road: fewer on-road parking spaces and fewer household garages will be needed, as cars will be effectively 'parked' while travelling. Cities will be revolutionised by the freed-up space. Insurance companies will lose an important part of their business. The carnage on the roads will be vastly reduced, if not eliminated, freeing up many beds in hospitals.
4. Agriculture and animal husbandry will either be further automated, or, as promoted by the regenerative agriculture movement, natural systems will be allowed back into the equation. In developing countries, a surge in education levels will allow the continuation and improvement of appropriate local agricultural systems.
5. The first 'meat' grown artificially from stem cells has already been produced. It requires much less water per gram to produce than a real steak and far less space, and results in much less methane production so is less harmful to the planet. Previous attempts at artificial diets have, however, failed, due to the inability of humans of the time to identify the myriad contributions to a 'healthy diet' that needed to be included. It remains to be seen whether this ignorance can be overcome.
6. There are apps that can read facial expressions. If one can be made that can tell, with even an 80 per cent level of accuracy, that someone is lying, imagine political debates and interviews in the future where it is being used! Think about the effect it might have on personal relationships where one partner can be *shown* to be lying!
7. Uber is a car hire organisation that owns no cars; Airbnb is a hospitality organisation that owns no hotels. Their businesses are all about connectivity; putting people in touch with suppliers. There are concerns for the futures of the automotive and hotel industries, already complaining that these new collaborative arrangements evade taxes and hard-won health and safety legislation.
8. Medical diagnostics and surgical operations by robots are on the increase. Machines already perform many of the simpler procedures. The doctor's role will become largely one of reassurance and

direction to the appropriate service, the provision of counselling and perhaps providing first aid. There will be important implications for welfare systems.

9. Law is a recorded accumulation of previous human decisions that create legal precedents and address most of the ethics encased in the Bible and the Koran. In a world dominated by digital communications, it is expected to become fully programmable – and infallible!
10. Pattern recognition software will enable instant identification of faces in crowds and permit constant supervision. It will allow the identification of perpetrators of antisocial behaviour and permit constant supervision of everyday events. There have already been attempts to introduce an identity card into to Australia, so far, heartily rejected. Now, given the activities of data miners, it may be unnecessary!
11. Power will be cheap and clean. Solar energy production has been on a rising exponential curve for years. In 2017, more solar energy systems were installed worldwide than fossil fuel power stations. With cheap power comes cheap and abundant freshwater by desalination of seawater. Electrolysis of seawater will provide unlimited hydrogen as a power source and return oxygen to the atmosphere.
12. CRISPR (recall: 'clustered regularly interspaced short palindromic repeats'). We have already discussed CRISPR in Chapter 4. In short, it is a simple way to edit the genetic make-up of an organism. Small lengths of DNA are removed from, or inserted into, a pre-existing DNA molecule. The first CRISPR-edited baby has been born.

This list, which is certainly not exhaustive, concerns things that are happening now. At the very least, they will bring about a restructuring of the human workforce. How they will interact, and what that will bring in the medium term, is far from clear. There will no doubt be unforeseen, emergent consequences as a product of all this new connectivity.

It is thus at least a 12-horse race. Were we to bet on a couple of winners, they would be numbers 1 and 12, the impact of social media, and CRISPR.

Already there is evidence to show that the connectivity of social media is creating worrying consequences. Twitter, apart from being the preferred mode of communication of a former President of the United States, has had a major impact on young people. Things can be said on Twitter

that former social conventions would have prevented in face-to-face conversations. This loss of reticence, combined with the power of images on Facebook, can have a devastating effect on undeveloped minds, driving some to suicide. Recent reports in the conventional communication media describe the concern that schoolteachers have for children, to the extent that, in some schools, phones are confiscated during school hours. One result of this, according to some teachers, is that breaks and lunchtimes are once again ringing with laughter and buzzing with conversation. It seems healthier than sitting around in groups, communicating with thumbs. One surprise, though, is that parents feel uncomfortable with the embargo on phones. In these days of close parenting for fear of bullies and paedophiles, parents feel intense discomfort in being cut off from their children and 'not being there' for them, even during school hours.

The full impact of CRISPR has yet to be revealed. It provides unlimited opportunities for altering the genetic composition of any organism on Earth, from the single cell to the blue whale. Food crops and domestic animals are obvious targets, with the desirable objective of improving yields and increasing resistance to disease. Once the genome is known, the strategy is to make the necessary changes in the fertilised egg, allow it to grow to maturity and to breed from it. It is possible to do this in humans, weeding out the sections of DNA that may lead to unfortunate genetic disease in the adult. In humans, it is a dangerous strategy, as so much of human DNA is silent. However, in time these problems will be overcome and the technology may move from deletion of the deleterious to the attempt to make positive changes that will be expressed in the adult.

Will we learn from the eugenics disasters of the twentieth century? Or will we attempt to make super-humans, a race of beautiful geniuses who will take over the world? Is it all a dream? Or a nightmare …?

The remainder of this chapter describes a future imagined by the authors, based on current science and inspired by the works of Fagan (2017), Asimov (1954), Aldous Huxley (1932) and Winchester (2004).

Days in the lives of …

Part 1

Mary woke up with an intense feeling of relief. She lay still for a while, reliving a nightmare in which she had been walking along a huge indoor shopping mall in the middle of a large crowd. She cringed at the thought of the press of people. Ever since she was a little girl she had been scared of crowds. She supposed it was the fear that had been passed on to her by her parents, of contracting the Disease. Her parents, who had lived through the worst of the Great Infection years, were forever traumatised. They had impressed on her the lethal danger of crowded spaces. She gave a little shudder and came more fully awake, wondering what the time was. On cue, her implant displayed 25.31.07.2.2.08.2218. Second of August, it was her birthday and she was 50 years old.

Time to check on everyone, she thought, calling up ChatterBox in her implant. She quickly ran through her friends' previous night's exploits, sent them a Happy Tuesday message, and a private message to her life partner. Ever vigilant, her implant sensed her mood and her heightened emotion and obligingly provided 10 minutes of erotic sensation.

Totally relaxed now, Mary started to contemplate the future. She was, after all, only 50. With reasonable luck, and regular halting of the ageing process through replacement of the DNA lost from the telomeres at her chromosome ends, she could look forward to another 100 years in perfect health. Her mind turned to her eggs and the families that she had always planned. Perhaps it was time to start the first one.

By the time Mary had been born, in 2168, they were just about over, those terrible decades of haemorrhagic virus disease. The Great Infection had finally run its course. GI was a variant of Ebola virus that first emerged in West Africa in 1976. The only good thing about it was that if you survived infection you were immune. After about 75 years in which it had been confined to the African continent, it had finally entered the global population in 2050 through the worldwide Stratospheric Travelnet. Some said it was the ultimate act of terrorism, the Disease being carried by a man who, while himself immune, had been infectious to others. He had travelled widely around the globe, spreading the Disease, before being killed in a freak accident. He had an asymmetric encounter with

an 80-tonne *Argentinosaurus*, regenerated from fossil DNA, in a South American game park. He was reduced to a smear on the road by one sweep of the giant tail. Once the wandering source had been eliminated, the Great Infection was gradually brought under control but not until it had done away with about half of the human race. The human race took a deep breath and counted up the dead and found it to be about 4 billion. Fortunately, the Disease had never spread to the colonies on the Moon and Mars. They were newly self-sufficient and they had quarantined themselves.

Machine intelligence had reached the stage of self-maintenance by the time the crisis came. Western society, China and Japan had each been held together by the efforts of the world of computers and robots. In the USA, the easy availability of 3D-printed firearms had led first to the collapse of central government, then to the emergence of pseudostates permanently at war, as the more populated ones strove to consume the poorer ones.

Along the way, men as sperm carriers had become collateral damage. It had been known as early as 1950s that sperm quality was declining. The cause was unknown, although the rising concentration of endocrine disruptors used in human and animal population control, and now to be found as pollutants in drinking water, were suspects.

A remedy for sterility only emerged with the growth of stem cell technology. Stem cells were harvested from bone marrow and maintained in special nutrient culture medium. Tweaking them, by careful adjustment of the composition of the nutrient medium, encouraged them to develop along different pathways, becoming blood cells, muscle cells and those of other types, including sperm.

Stem cells from the healthiest males were therefore stockpiled in special sterile centres that had been established and staffed by medibots. As the cells matured, the DNA of the sperm was checked and those conforming to the best genetic standard, after CRISPRing, were frozen for future use. On the presentation of a CRISPR certificate, any woman could make a withdrawal, submit her eggs for fertilisation and bank them in suspended animation until required. They would be released to her on production of an Approval to Reproduce.

Mary had had her Approval Form for several years. Now she got it out to check the date and, with satisfaction, saw it still had a year to run before expiry. Theresa, her special friend and lover, had got hers at the same time,

and they had always planned to hatch a pair of eggs together. Each month they spent a week at one or the other's house. They were both professional women so they could afford a fully self-driving vehicle and docking facilities at their homes. This allowed them to visit one another without exposing themselves to the outdoors, for Theresa, too was agoraphobic, having also learned to be terrified of people during the Great Infection.

Mary was a gifted ceramicist. Her workroom still had a potter's wheel as she liked to feel the clays and the pastes she worked with changing shape under her fingers. She made pieces of all sorts, household utensils, cups, ornaments, artworks. This laborious, repetitious but strangely satisfying side of the creative art had remained, although duplication was automatic. All she had to do now was to think of the original idea and make the item. Her implant would record the movements of her fingers, convert it to a manufacturing program and send the record to a 3D printer that would store it in its capacious memory. The item would be printed while she could continue enjoy the stimulation of the creative thought. Buyers could order any item except for those commissioned by people who had paid a healthy fee to keep their purchases unique to themselves. She also did occasional commercial work that she sent off to industrial printers for reproduction in bulk.

Theresa was also an artist, and perhaps it was this that was the foundation of the friendship. She was, with the help of her implant, a 'visualiser'. She imagined stories about the future, mainly for children, and her implant captured the images and relayed them to a storage computer. On request, the computer would transfer them to the implants of specially assigned critics for approval and editing. She too was very successful, and her imaginings were very popular and appeared on a variety of social and communication media. Her eggs had also been passed by CRISPR and stored to await future activation.

Mary's enthusiasm for parenting increased as she opened the private section of her implant and ChatterBoxed Theresa to explain her decision. Theresa was delighted, for she, too, had thought it was the right time for the first parenting episode of their lives. They agreed to meet at once.

Mary went to the docking pod to wait for the transporter. Her excitement and happiness grew on the short journey and she barely noticed the creeper-covered ruins, where once had been terraced housing, nor the abundance

of bird life and flowers and the absence of livestock on the short journey. Theresa was at the dock to welcome her and they immediately went into the studio to discuss plans.

First, they checked Theresa's reproduction permits and all was in order. Both women had decided on employing exo-uterine technology, as neither wanted the bodily distortions caused by a biological pregnancy. There followed the delicious decision of choosing the model. In the end, as they were both well-off, they picked the most expensive: Bokanovsky Multi-Ectogro, the Rolls Royce of its type.

Theresa had opted for the 'full pregnancy hormone experience' because, she said, she thought it would make her a better visualiser. The health robots that already monitored Theresa's immune system could easily take care of this. Mary elected to take only the 'lactation' package both for convenience and so as not to forgo the opportunity for intimacy it would provide with the newly decanted babies.

Together, they decided to create a special menu for a celebration dinner and it was a fine banquet. The centrepiece was a roast made out of compacted muscle cells derived from the stem cells of an Aberdeen Angus (who was still grazing happily in a paddock in Scotland), assorted vegetables, followed by blue-green sweet cakes made from a flour of ancient algal cells. The main dish was accompanied by a surprising number of fermented foods to placate their intestinal biomes. There was yogurt, kefir and kimchi, fermented green beans and sauerkraut, with kombucha and cultured buttermilk to wash it down. There were different varieties of cheese to go with the cakes. All this food was accompanied by a magnificent red wine, which they had ordered for the occasion. It was quite fresh, having been formulated only that morning, but the winemaker was a genius and had crafted into it 20 years of simulated age that would please the palate of the most fastidious connoisseur. Needless to say, it wasn't cheap.

The next morning, Mary and Theresa completed the applications and submitted them for approval. In the usual computer efficient way, acknowledgement was instantaneous and the two approvals arrived two minutes later. One hour after that, two containers that looked rather like the small plastic butter containers you get in restaurants were delivered by courier. They arrived together with holographs that showed the fertilised ova from all angles for their records.

They inserted the pods into the Multi-Ectogro. Disdaining growth rate adjustment function, they set the dial at an old-fashioned nine months and pressed the button. The incubator hummed into life. In their excitement, they failed to notice the occasional flicker on one of the thermostat indicators. Nine months later they were delivered of two baby boys.

Part 2

The following is a copy of what remains of an address that was apparently mindcast in the early years of the twenty-fourth century. It was found in a time capsule buried under the body of a well-preserved cyborg, in the Cybermorgue of a Euthanasia Centre at the South Pole.

Our name is Charlie – Charles or Charlotte depending on your preference. We were born into a world where gender was considered to be a trivial attribute, compared with one's intelligence. This is reflected in the fact that we are a person who was born as an amalgam of both genders and brought up accordingly.

At the time we were born, in 2219, life expectancy was about 150 years. Since the new outbreak of GI, whose rapid spread was assisted by the deficiencies of a largely synthetic diet, much research has been devoted to providing an optimal diet for citizens. We now eat food that has been grown and created according to the prescriptions of a balanced hunter-gatherer diet. One of the effects of this has been to bring about a further significant increase in life expectancy. This has stimulated even more research, especially on an effect of stem cells that was first observed centuries before we were born. It was found that regular transfusions of stem cells into mice considerably lengthened their lives. What worked with mice also worked with humans.

When we were small, some of our stem cells were harvested and then grown in perpetual culture. Now, they are continually used to replace the ageing cells whose damaged DNA contributes to the ageing process. We could expect to live to 400 but we suspect that few will have the stamina – or be allowed – to last the course. We are now, in 2419, 200 years old, currently the socially permitted limit of our life, if one is not a double-alpha. We are therefore keen to complete this record before the Euthanasia Team arrives.

We are what used to be called a cyborg. That is to say, many of our natural functions have been replaced by prostheses. Our implant is an obvious case, as it gives us enhanced hearing and vision. Because of a malfunction with the thermal setting of the Bokanovsky Ectowomb purchased by our parents, our limbs did not develop properly after birth. As a result, we were early enthusiastic supporters of the prosthetic movement and without much misgiving we volunteered to test new prosthetic limbs that had been and were being developed. Any misgivings we might have had were solely about the discomfort that surgery might involve. We knew that the stem cell technology would, in any case, allow us to grow new limbs, at the cost of about a year's worth of time and effort. Our misgivings were baseless, however; and equipping us with artificial limbs was an enormous success, as they greatly outperform natural ones. The mini-computers in each of our prosthetic limbs amount to what is effectively a dispersed brain – somewhat analogous to the eightfold octopus brain – that communicates, via our implant, with our natural brain, so our mental acuity is much enhanced.

We won't describe the tribulations of living through the period of the evolutionary accommodation that occurred between Gaia and humans. The mean atmospheric temperature, due to the elevated carbon dioxide levels, rose about five degrees. Suffice to say that, even though burning of fossil fuel was outlawed quite early, and replaced with solar energy, there was a considerable overshoot. Temperatures continued to rise as greenhouse gases were released from the melting ice, the warming tundra and the sea and from the millions of fermentation chambers that were wild animals. The sea level rose 30 metres. Humanity, which once considered itself apart from, rather than a part of, Gaia, learned a bitter lesson. In was in this period that stem cell technology blossomed, and 'meat' was created in closed systems that recycled resources, including carbon dioxide. The only greenhouse gases are those produced by humans as they eat the product.

The change went from the turmoil of transformation to a new steady state in a century, from about 2250 to 2350. It is fortunate that we now have ways for us to send our story mind-to-mind, via our implants, so you can have the full experience of the years we are remembering.

At the beginning of the change, communication had gone not much further than wireless connection between technical machines. Human beings were just beginning to struggle with the disruption of their social

and natural environments. The changes in the summer of 2300 seemed abrupt, even though they had been predicted since the mid-twentieth century. At that time technology was at its height. Shuttle planes were, like Shakespeare's Robin Goodfellow, putting a girdle round the Earth in very nearly 40 minutes. The timetable was generous. You could be picked up and put down at a thousand different places around the planet, although that didn't stop people complaining.

They should have been happy with what they had. Technology has had to be reinvented to fit our new environment, and now the supersonic people carriers that were once everywhere have had to be mothballed as the stratosphere is too turbulent. A hundred years ago, in 2319, a shield of reflective dust was injected into the stratosphere to increase the Earth's reflectivity, in the fond hope that it would save the planet from the planetary warming. This was done rather than address the problem at its root, the overuse of fossil fuels. Sadly, the shield has done its job too well. Plants have been dying and biodiversity is diminishing as the number of plant species is too rapidly being reduced. There is ice formation at the poles once again and it is probable the Earth has been tipped prematurely into another ice age. Food is becoming scarce and expensive. People once again are beginning to have recourse to the synthetic foods that have already proved disastrous during the Great Infection. There seems to be no will to tackle the problem of removing the reflective dust in the atmosphere …

(The narrative breaks off here, as apparently the Euthanasia Team arrived a couple of days earlier than scheduled.)

Well, we had fun dreaming up a couple of science fiction scenarios to accommodate many of the issues to which humans will have to adapt themselves in the future. Ignoring the cries of 'don't give up your day jobs', here is the list.

1. Stratospheric Travelnet. Space travel.
2. Pandemics (this was written well before the appearance of COVID-19). Global terrorism and the collapse of the USA.
3. Failed climate manipulation; disastrous global cooling.
4. Abolition of animal farming; unsuccessful chemical nutrient diets.
5. Cranial implants connecting directly to brain and the development of ChatterBox, a social medium that talks directly to implants, also allowing direct communication between people via implants; prostheses connected to the brain by implants.

6. Very advanced stem cell technology. Limb regeneration achieved, permitting voluntary limb amputation to take advantage of superior prostheses. Appearance of cyborgs, part human and part machine.
7. Self-maintaining artificial intelligence. Advanced medibots. Self-driving vehicles and other robots.
8. 3D printers commonplace. When we started this book they cost tens of thousands of dollars. The other day a home unit was on sale for $256.
9. Cryogenic gamete storage perfected, allowing bureaucratic control of reproduction and population, leading to the abolition of reproductive sex. Recreational sex only permitted; orgasmic centres in the brain directly stimulated by implants. Hormone levels manipulated via implants creating an intersexual humanity. Total exo-uterine technology for embryonic development and gene editing by CRISPR.
10. Anti-ageing DNA technology; girlish women at 50 years of age.
11. DNA resurrection technology – e.g. *Argentinosaurus.*
12. Four-hundred-year life expectancy and social control of euthanasia.

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