Life as a Raw Material: Illusions of Control

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Introduction

> 'We overlook only too often the fact that a living being may also be regarded as raw material, as something plastic, something that may be shaped and altered.'[1]
>
> H. G. Wells, 'The Limits of Individual Plasticity', 1895

More than a hundred years since H. G. Wells wrote his essay 'The Limits of Individual Plasticity', it seems that we can no longer overlook the fact that life has become raw matter for our engineering dreams. Life is increasingly seen as the new frontier for exploitation; from industrial farming through in-vitro meat and bio-prospecting to synthetic biology, life is extracted from its natural context and transformed into something to be manufactured. This is all part of a larger human project that can be called the 'single engineering paradigm'. The concept of the 'single engineering paradigm' refers to a future in which the control of matter and life, and life as matter, will be achieved through various applications of engineering principles, including uses of nanotechnology, synthetic biology and, some suggest, geo-engineering, cognitive engineering and neuro-engineering. Following the logic of the 'single engineering paradigm', there has emerged a New Biology, whose major 'claim' is to represents the biological application of the logic underlying engineering. This is particularly true in the case of synthetic biology. That is, synthetic biology's rhetoric proclaims that it is not merely rebranding of existing forms of manipulation of life, but rather represents a far-reaching shift

Somatechnics 2.2 (2012): 250–262
DOI: 10.3366/soma.2012.0060

www.eupjournals.com/soma

in ways life is being perceived and used. These claims are not new, but in recent years, we have witnessed a resurgence of the application of engineering logic in the fields of the life sciences, coupled with the treatment of life as a raw material for manufacturing products. Synthetic Biology's proponents claim that it will 'revolutionise the technology of the future'. As it has been argued:

> Engineers are interested in synthetic biology [or in biology in general] because the living world provides a seemingly rich yet largely unexplored medium for controlling and processing information, materials, and energy. Learning how to effectively harness the power of the living world will be a major engineering undertaking. ('Synthetic Biology: FAQ')

Synthetic Biology can also be seen as a 'catch phrase' of contemporary attempts to apply engineering logic to life, and as such, it covers a wide range of approaches ranging from re-branding of genetic engineering to the creation of synthetic life forms (i.e. Syntia and/or protocells[2]).

Driven mainly by engineers, Synthetic Biology in Europe and North America is going through an image construction exercise that it is instructive to consider. A worrying trend is that engineers, who are used to a system of certifications and approvals, tend to favour restrictive approaches in regard to access to these new techniques. Mechanical engineer turned synthetic biologist Alistair Elfick likes to quote comedian Simon Munnery's gag about molecular biologists: 'The engineering equivalent of Genetic Engineering is to get a bunch of concrete and steel, throw it into a river, and if you can walk across it, call it a bridge.' According to Elfick, now that engineers are moving in the construction of 'bridge' will finally be done the right way. However, as Pollack writes:

> 'If we think of a cell as a computer, it's much more complex than the computers we're used to.' For this reason, some scientists say, it might be difficult ever to make biological engineering as predictable as bridge construction. 'There is no such thing as a standard component, because even a standard component works differently depending on the environment,' Professor Arnold of Caltech said. 'The expectation that you can type in a sequence and can predict what a circuit will do is far from reality and always will be.' (Pollack 2006)

Having control over life and its processes may have always been an ambitious human endeavour. What is changing in the contemporary period are the public attitudes towards life resulting from the accumulation of scientific knowledge and technological capabilities, which are constantly intensifying in proportion with the increasing speed and scale of manipulation. A choreographed interplay between hype and actuality is impressed upon a public that is bombarded with information about developments on genetic and biological engineering. As the public perception that we are now witnessing an historically unprecedented level of control over the matter of life steadily grows, it seems that whereas previously biologists were employing their understanding of engineering to the life sciences, now it is the engineers who force-fit engineering methodologies to living systems. Life is becoming bio-matter, waiting to be engineered.

One important aspect of applying this new engineering mindset to the manipulation of life is the notion that it would make bio-matter easier to engineer; and consequently enable the manipulation and creation of new life by the uninitiated. As a result, life is also becoming raw material for artists, designers, hobbyists, and amateurs. Artists and designers are already engaging with bio-matter in ways that only a few years ago would have been hard to imagine.

The narratives of Synthetic Biology oscillate between openness and control – global standards and restriction of use – while emphasising that the unparalleled power to engineer life is waiting for us just around the corner. The term 'bioterror' has been tossed around frequently in regard to the power, ease of use, and availability of new biological technologies. The idea that the engineering approach will yield full control over life and it will do so with unmatched ease seems to be of major concern to safety experts and government agencies who subscribe to the hype of contemporary biological engineering. Controlling access and monitoring developers and users seems to increase at the time when DIY and artistic use of bio-matter surges.

Historical Reflections

As mentioned above, the application of engineering logic to life has historical precedents. Already in 1895, H. G. Wells reflected on a body as a malleable entity in his essay 'The Limits of Individual Plasticity', writing that '[t]he generalisation of heredity may be pushed to extreme, to an almost fanatical fatalism' (36). A year later Wells demonstrated some of these ideas and their possible consequences in his novel *The Island of Doctor Moreau*. The plasticity of life processes was demonstrated quite spectacularly only three years later, in 1899, when Jacob Loeb developed what he called 'artificial parthenogenesis . . . the artificial production of normal larvae (plutei) from the unfertilized eggs of the sea urchin' (Loeb 1899). In other words, Loeb demonstrated the capacity for fertilisation (in a sea

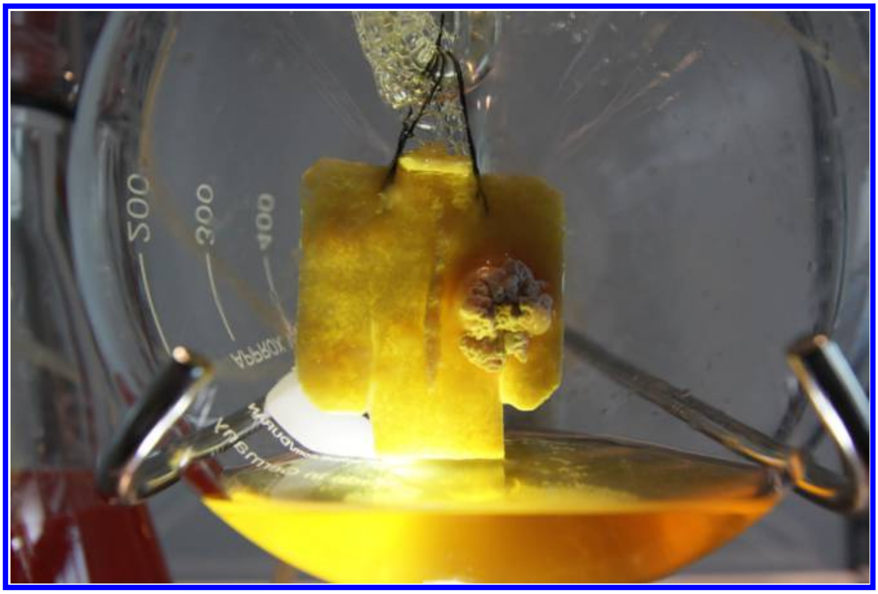

Fig. 1. 'Victimless Leather: A Prototype of Stitch-less Jacket grown in a Technoscientific "Body",' The Tissue Culture & Art Project, 2004. Image courtesy of the Tissue Culture & Art Project (Oron Catts and Ionat Zurr).

urchin) without the use of sperm. Loeb wrote, following his discovery: 'it is in the end still possible that I find my dream realized, to see a constructive or engineering biology in place of a biology that is merely analytical'.[3]

Loeb symbolised a change in the field of the biological sciences from descriptive to prescriptive, from the realm of knowledge gathering to the realm of technological application. He was one of the first to discuss life as bio-matter that could be synthetically engineered or remade, and suggested that biology should shift focus from mere observation to manipulation. He also, as a thought experiment, suggested making a living system from dead matter as a way to debunk the vitalists' ideas and claimed to have demonstrated 'abiogenesis' (Loeb 1906).[4] Loeb adopted in his experimentation and biological research what he described as an 'engineering standpoint' (Pauly 47). Loeb's strong belief in control over life and his mechanistic approach to life led him to argue that 'instinct' and 'will' were 'metaphysical concepts . . . upon the same plane as the supernatural powers of theologians' (Pauly 47).

The belief that life is a by-product of matter that can be engineered has led to innovative applications and interesting interpretations. Ten years later after Loeb's work cited above, Alexis Carrel, a surgeon, demonstrated the plasticity of the body, through the development of the technique of tissue culture – the growth of living tissue/cells in-vitro – in an artificial environment. Carrel was a well-known and respected scientist who advanced the medical field in new techniques of suturing arteries and transplantation as well as tissue culture, and won the Nobel Prize for Medicine in 1912. He was also a complex and controversial figure – a person who pushed the ontological implications of his discoveries to some extreme and morally questionable places, far from its strictly bio-medical or even scientific realms into ontological and socio-political issues.

In the 1930s, the surgeon Carrel joined forces with a mechanic, the famous aviator Charles Lindbergh, to devise the Organ Perfusion Pump, a mechanical pump for circulating nutrient fluid to feed large organs that could, by this means, be kept alive outside a host body. Carrel's affiliation with Lindbergh, the great American aviation hero, extended to a shared ideology of eugenics, which Carrel outlined in his 1938 publication *Man, the Unknown:*

> Those who have murdered, robbed, . . . kidnapped children, despoiled the poor of their savings, misled the public in important matters, should be humanely and economically disposed of in small euthanasic institutions supplied with proper gases. A similar treatment could be advantageously applied to the insane, guilty of criminal acts. (296)

It can be argued that the application of mechanical/engineering logic to the living body followed along the same line of thinking that led Carrel to treat human societies as objects to be engineered. These engineered objects would be able to be fixed by the removal of any faulty parts. 'Eugenics,' Carrel wrote in the last chapter of *Man, the Unknown,* 'is indispensable for the perpetuation of the strong. A great race must propagate its best elements' (299). This book was a worldwide best-seller, and was translated into nineteen languages.

Following Loeb's fantasy of engineered life, in 1952 Miller and Urey managed to create amino acids in a test tube as they were simulating early earth conditions. In 1955 Heinz Fraenkel-Conrat and Robley C. Williams showed that a functional virus could be created out of purified RNA and a protein coat. At the time it was described as 'life created in the test tube'. In 1965 Professor Sol Spiegelman and his team at the University of Illinois 'succeeded in putting together the non-living nucleic acid message which produced a virus', creating what was nicked named Spiegelman's monster, and in 1967 'Arthur Kornberg at Stanford University and colleagues announced that they had copied the DNA of the Phi X174 virus, producing an entity with the same infectivity as the wild virus' (Taylor 1968).

In 2010, Craig Venter declared that he had created the first life form of which it could be said that its 'parent is a computer' (Venter 2010). Even though what Venter achieved is indeed a great technological feat – being able to synthesise the longest chain of DNA and replace a genome of a simple bacteria with a synthesised version – here the raw matter of engineering, that is, the cell and its contents, are still of biological origin. The role the computer played in synthesising the genome was actually only that of a glorified copier – copying a genome without fully 'understanding' its meaning. The only novel part that was introduced to the genome was a 'watermark' – a hidden message that contained the names of the researchers, a URL and quotes relating to creation of life – something that the artist Joe Davis had done back in the mid 1980s (Davis 1996) showing once again that artists can precede scientists in conceptual breakthroughs.

Cultural Reflections

The concept of synthetic life (life engineered from raw materials) presents one of the most challenging, deeply philosophical, ethical and cultural areas that require artistic scrutiny. Promising to fulfil Loeb's dream to debunk the vitalists' ideas, and alternatively used by proponents of 'intelligent design', Synthetic Life is ready to assault cultural sensitivities about life. However, Synthetic Life is only one of the areas that are now labelled Synthetic Biology. The area where most genetic engineering currently occurs is that of the standardisation of biological parts.

One of the most famous events associated with this ambition is iGEM. iGEM was set up as an international competition in Synthetic Biology for undergraduate students, where the teams use and develop 'biobricks' – that are 'standard biological parts'. iGEM has grown quite dramatically – from only five teams in its first year (2004) to over 110 in 2009. What is relevant here is that one of the iGEM judges is an artist: Rich Pell. Furthermore, in 2009 a team from Srishti School of Art, Design and Technology (Bangalore, India), won a bronze medal and a special mention.[5] This team comprised design and art students; none of them is a scientist or engineer. Their project involved the (poetic) creation of bacteria that produces the smell of earth after rain. In 2009 some of the other teams, including the winners of the grand prize- the Cambridge team,[6] worked with designers that acted as project advisors. By a strange coincidence 2009 also saw, for the first

Fig. 2. 'Disembodied Cuisine', The Tissue Culture & Art Project, 2003. Image courtesy of the Tissue Culture & Art Project (Oron Catts & Ionat Zurr). Photographer: Axel Heise.

time, a very public presence of the FBI. At iGEM; FBI agents engaged with the teams and urged them to work closely with government agencies and safety officials.[7] In 2010 iGEM saw even more teams working with designers as advisors as well as at least two artistic teams that entered the competition, including a new Srishti team with a project that demonstrated how the engineering of one organism influences the phenotypic behaviour of another.

Another initiative which began in 2010 and links art, design and synthetic biology is Synthetic Aesthetics – a research project conducted by the University of Edinburgh and Stanford University and jointly funded by the National Science Foundation (USA) and the Engineering and Physical Sciences Research Council (UK). In this project six artists/designers and six synthetic biologists are paired to develop projects ranging from architecture, bioart, and industrial design to smell and music. One of the stated aims of Synthetic Aesthetics is to 'construct the groundwork that could inform new schools of engineering and research, new schools of art and design, innovative approaches to the study of synthetic biology in society, and new approaches to societal engagement with synthetic biology.'[8]

Synthetic Biology reinforces the pervasive influence of the engineering mindset within the life science laboratories, at the very same historical moment that the artistic mindset has also entered into these spaces. The scientific laboratory, in which artists (as well as engineers) are located thus cannot be viewed in isolation but are positioned within a larger cultural networks that are organised around the maximisation of utility, efficiency and profit.

Engineering Mindset

In a recent paper which received relatively wide coverage, scholars Diego Gambetta and Steffen Hertog demonstrated that 'among violent Islamists, engineers with a degree, individuals with an engineering education are three to four times more frequent than we would expect given the share of engineers among university students in Islamic countries' (Gambetta and Hertog 2009). After eliminating other plausible possibilities such as network links and/or technical skills, they conclude that an 'engineering mindset' as well as current social conditions in Islamic countries as the most plausible explanation of their findings (Gambetta and Hertog 2009).

Firstly, we should highlight that, as emphasised by the authors of the paper cited above, this 'engineering mindset' is not at all unique to Muslim extremists. On the contrary, it is a mindset which characterises extremist thinking in general, engulfing all religions as well as secularism. It might, more generally, be understood as a mindset that is determined by binarised thinking, in which things can be neatly categorised as either right or wrong, positive or negative. Secondly, this 'engineering mindset' reflects:

> an assumption, which has been raised in psychological research, that engineering as a field of study and a profession tends to attract people who seek certainty, and their approach to the world is largely mechanistic. So they are characterized by a greater intolerance of uncertainty – a quality that is evident among extremists, both religious and secular. (Sivan 2010)

A Case Study

On a level above the molecular, living cells and tissues removed from the original context of the body and are being used as raw material. An interesting case study is that of the development of in-vitro meat. Humans' relationships with meat tend to reflect the broader cultural attitudes towards complex living systems. Where once eating animals had cultural and symbolic significance—as evident, for example, in the notion that a person would gain the attributes of the animal consumed—now 'factory farming considers nature as an obstacle to be overcome' (Foer 2009: 34). Factory farming represents an industrial scale application of engineering logic onto full animals, to maximise production and yield of animal products. However, this approach is starting to be seen as archaic and problematic, not so much on ethical grounds as for its perceived inefficiency and environmental cost: 'alternatives can be produced under controlled conditions impossible to maintain in traditional animal farms, they can be safer, more nutritious, less polluting, and more humane than conventional meat'.[9]

The idea of growing meat without the animal has been around for some time, as a science fiction idea (for example as described in *The Space Merchants* (1952) by Frederik Pohl and C. M. Kornbluth) and even Winston Churchill wrote in 1932: 'We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under suitable medium.' However, it was only in the late 1990s that this idea started to be seriously considered and followed technologically. Developed alongside the new approach to the body as manifested through the concept of regenerative medicine, in-vitro meat represented a non-medical application of tissue engineering principals.

As part of The Tissue Culture & Art Project (TC&A), the authors of this paper developed a series of pseudo-utilitarian works under the banner of 'Technological Meditated Victimless Utopia' that included the first ever growth and consumption of in-vitro meat. Starting in the year 2000 TC&A have grown muscle tissue as meat. In 2003 TC&A presented a performance/installation titled Disembodied Cuisine.

In Disembodied Cuisine frog skeletal muscle cells were grown over biopolymer while the healthy frogs lived alongside as part of the installation. In the last day of the show, two 'steaks' were cooked and eaten in a Nouvelle Cuisine style dinner, and four frogs, rescued from the frog-farm, were released to a beautiful pond at the local botanical gardens.

Even though our artistic project was set up to highlight the irony of transforming meat into the ultimate engineered matter, in-vitro meat is now considered seriously as a potential alternative for the production of animal proteins for human consumption. One complication arising from the victimless meat endeavour as a manifestation of the techno-scientific project is that it may create an illusion of a victimless existence. First, in order to grow in-vitro meat,

Fig. 3. 'Odd Neolifism', The Tissue Culture & Art Project, 2010. Image courtesy of the Queensland Gallery of Modern Art. Photographer: Natasha Harth.

there is still the need for a serum created using animals' blood plasma. Although some research to find alternatives is underway there are no immediate solutions and animals (mainly calves or fetal bovine) are killed for it. Second, all the 'costs' concerned with the running of a laboratory, i.e. fossil fuels burned, green house gases produces, water and trees consumed, miles travelled and the waste created mean that the ecological footprint of in-vitro meat is significant. Third, there is a shift from 'the red in tooth and claw' of nature to a mediated nature. The victims are pushed farther away; they still exist, but are much more implicit. It should be remembered that animal cells cannot manufacture nutrients from nothing; in-vitro meat is merely an engineering exercise in translating/synthesising nutrients from other sources. In other words, parts of the living are fragmented and taken away from the context of the host body (and this act of fragmentation is a violent act) and are introduced to a technological mediation that further 'abstracts' their liveliness. By creating a new class of semi-being, which is dependent on us for survival, we are also creating a new class for exploitation, as it further abstracts life and blurs the boundaries between the living and the non-living, the subjects versus objects (tools).

A future project we are experimenting with involves the use of muscle tissue as the semi-living labor; skeletal muscle cells that are grown and coerced to become actuators. This project further problematise the distinctions between the living (whether human or other animal) and the machine (whether living i.e. woman, slave or animal, or non-living) and emphasises some absurdities concerned with ideal notions of technological solutions and technological efficiencies.

Conclusion

If in recent years the engineering mindset is being introduced into the life science laboratories, so too is the artistic mindset, such as in the case of SymbioticA – the Centre of Excellence in Biological Arts in the School of Anatomy and Human Biology at The University of Western Australia.[10]

Critiquing Synthetic Biology and refusing to take part in its developments may seem to suggest a call to halt the research and its implementation, and return to an unattainable romantic past in which humans and nature lived in harmony. This is an unhelpful reactionary perspective. Entering the places where Synthetic Biology is being developed and using it to create artworks that have the potential (even against the artist's will) to become cogs in the future propaganda machine is also problematic. Yet we want to believe that artistic expressions that are more subtle and complex will be able to offer glimpses of the possible and the contestable; works that are neither utopic or dystopic but rather ambiguous and messy; acting to counter the engineering hubris of control. We also hope that artists will be able to present/empower those outside the hegemony and give them the voice they deserve.

A future dominated by the single engineering paradigm might be upon us; bio matter is increasingly used as raw material. If this is the case, the engineering approach should not be allowed to monopolise life. One way to emphasise and attract attention to alternative frames of thought is to open up the very same tools and spaces that serve this future to other disciplines, including artistic.

Notes

1. H. G. Wells, 'The limits of individual plasticity,' in *H. G. Wells: Early Writing in Science and Science Fiction*, ed. Robert Philmus and David Y. Hughes (Berkeley: University of California Press, 1975), p. 36.

2. See Gibson et al.
3. Jacques Loeb to Ernst Mach, 28 December 1899. Quoted in Scott F. Gilbert, *Developmental Biology*, (New York: University Press, 2000), pp. 93–117.
4. Jacques Loeb *The Dynamics of Living Matter* (1906), p. 223. Abiogenesis is also known as autogenesis, or spontaneous generation of living organisms from non-living matter.
5. See http://2009.igem.org/Team:ArtScienceBangalore for information about the Srishti team project in iGEM.
6. The Cambridge team had Daisy Ginsburg and James King, both graduates from the Design Interaction Department at RCA as their advisors.
7. For example, http://www.the-scientist.com/article/display/57355/;jsessionid=F02FF2700916567D38F99196FA11BEBA.
8. See http://www.syntheticaesthetics.org/about.
9. For more information, see http://www.new-harvest.org/default.php.
10. SymbioticA – Centre of Excellence in Biological Arts, http://www.symbiotica.uwa.edu.au.

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