Chapter 14

Craig Venter and the Re-programming of Life: How Metaphors Shape and Perform Ethical Discourses in the Media Presentation of Synthetic Biology

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Introduction

Synthetic Biology[1] is a rapidly growing interdisciplinary science at the confluence of biology and engineering. It focuses on the design and fabrication of biological systems through the 'writing' of DNA. This newest field in the 'new' genetics is increasingly seen as a paradigmatic shift in our relationship with nature. In this chapter we will show that when scientists and the media try to convey its novel features and promises, they tend to use a language which, although rooted in the discourses used to frame older genetic advances such as genetic engineering and the decoding of the Human Genome Project (HGP), changes the focus of metaphorical framing from interpreting and altering to inventing and fabricating. This underlines both the field's continuity and similarity with what has gone before but also signals various discontinuities and differences.

We aim not only to investigate the rhetorical function of metaphors used by scientists and journalists when writing about synthetic biology, but to understand their inherent ethics and the implications this may have for public understanding of this field. With claims as bold as the creation of artificial life,[2] it is unsurprising that the emergence of the field and its early successes have caused a stir in the media. This stir was in part engineered through a concerted promotion campaign orchestrated by a major player in the field and one of the most 'visible' scientists

1 The dominant neologism for a field variously named 'intentional biology', 'biological engineering' and 'constructive biology' among others. We use 'synthetic biology' throughout.

2 A phrase used prolifically in the media with regard to the activities of Craig Venter. For example see: 'Scientists 'closer to creating life'' (*Daily Mail*, 29 June 2007), 'Creation of artificial life brought a step closer by DNA transplant' (*The Times*, 29 June 2007), and 'Playing God; The man who would create artificial life' (*The Independent*, 25 January 2008).

(Goodell 1977) of the last decade: Craig Venter, an American scientist heading the J. Craig Venter Institute, which was set up specifically 'to save the world' (see Shreeve 2004: 373). Former co-decoder of the human genome, one reporter notes, he 'has become the poster boy of synthetic biology' (Conner 2008).[3] This paper investigates the traces left by one of Venter's promotional campaigns in the media, namely that carried out in the UK. It examines the metaphorical framing used by Venter, his collaborators and the journalists they spoke to and treats this as a form of ethical discourse.

Some of the ethical issues are summarised in a report prepared by Balmer and Martin (2008). They include the need for scientists to engage with the public early in the development of synthetic biology to ensure that research does not get ahead of public attitudes; synthetic biology must not be over-hyped by its supporters and critics should not exaggerate the risks it poses; current regulations and guidelines should be reviewed to ensure that an appropriate governance framework is in place before synthetic biology applications are introduced. In many respects, Venter has done what this report asks of scientists. He has engaged widely with the public through lecture tours, debates and media appearances and he has openly expressed some of the ethical challenges faced by the field. This kind of direct engagement with the public and his expertise in working with journalists indicates that his framing of the issues may significantly influence the discourse generated in coverage of the field, which makes it even more interesting to delve into the language he used in his public engagements and its ethical implications.

Methods and corpus

In this study we focus on newspaper articles to explore discourses surrounding synthetic biology. We are interested in the tone and content of the messages rather than how this information is received and understood. We combine metaphor analysis with frame analysis, a combination of tools that has been used successfully in recent years in media studies and in science and technology studies (STS) to reveal hidden agendas, ideologies and beliefs about emerging technologies (e.g. Coveney et al. 2008). It is important to analyse media data to understand the way metaphors are used to draw parallels between seemingly unrelated concepts and to make the novel or unfamiliar appear familiar.

We used the newspaper database LexisNexis Professional to locate articles written since 2000 that mentioned the search term 'Craig Venter'. We collected a body of over 400 news articles. After reviewing these and rejecting irrelevant pieces or pieces that only referred to synthetic biology in passing, we eventually adopted a corpus of 50 UK articles that were written during, and with regards

3 Professor at Stanford University. His approach has drawn upon Web 2.0 and is thus much more interactive than Venter's. Future work could investigate if these divergent communication practices produce different understandings of the field.

to, Venter's work and had a substantial focus on synthetic biology. The selection process was debated between the co-authors who substantially agreed on which articles to include or exclude from the final corpus. Our inter-coder reliability was about 90 per cent.

Through an in-depth qualitative analysis of these news articles, certain themes began to emerge quite clearly, themes that clustered around a number of prominent conceptual metaphors. Some of these are long-standing new science metaphors that are already familiar from Human Genome discourse (see Kay 2000). Other metaphors begin to emerge, it seems, quite specifically in order to provide suitable analogies for the representation of the inner workings of synthetic biology, as well as for the promotion or critique of this new science.

According to the cognitive view of metaphor (Lakoff and Johnson 1980), metaphors help us understand an abstract or inherently unstructured subject matter in terms of a more concrete, more highly structured subject matter. Metaphors are not only linguistic but cognitive phenomena, they are necessary for our thinking, acting and speaking (Ortony 1979). They are conceptual devices, rather than rhetorical ones, and, we would add, they are also social devices. In cognitive linguistics, conceptual metaphors, such as ARGUMENTS ARE WAR (and their linguistic realisations, e.g. 'He spearheaded the debate') are seen as mappings across at least two conceptual domains: the conceptual source domain (e.g. war) and the conceptual target domain (e.g. arguments). We develop this position by treating the production of such mappings as an act of ethical discourse. In the example above, we would argue, that when one moves from a source (war) to the target (arguments) the ethical relationships are also transferred. To treat arguments as wars allows for and legitimises certain behaviours that might not otherwise be ethically acceptable, for example the attempt to 'destroy' an opponent. By following this position we are able to treat metaphors *as* ethical statements.

These mappings between source and target domains are not arbitrary. Rather, they are grounded in our everyday experience of the body and the world we live in. As we shall see in the following, many of the conceptual metaphors used to structure the promotion of and debate surrounding synthetic biology are derived from our knowledge of old and new types of technology, from books to computers and beyond. The kinds of metaphors *as* ethics that are used in the media discourse of synthetic biology will certainly be influenced by their context but, we contend, they may in turn influence that context and re-configure previous understandings of our selves and our environments.

Backdrop to the media staging of Venter and synthetic biology

Venter has a reputation for patenting his research and discovering new ways of generating personal capital through scientific research. Certainly Venter is pushing synthetic biology forward on the back of various altruistic aims, which we explore below, but this has not reduced the corporate dimension of his work. Venter is not

hiding his capital-oriented approach either; in an interview with *Newsweek* he asserted that the processes his teams were developing would be patented and that if they made an organism that could produce fuel they would patent that process also, since it could be 'the first billion- or trillion-dollar organism' (Sheridan 2007). Venter's private company and his not-for-profit institute are garnering funds from both public and private sources, as is the field of synthetic biology more generally, most evidently in the United States of America (Balmer and Martin 2008).

Although it is often viewed as a new and emerging field, synthetic biology and its relations with the media inevitably rest on past interactions: genetic engineering and the HGP. These precede Venter's current work and provide clear examples of how societal repulsion or endorsement of a branch of genetics can affect scientific endeavours (see CSEC 2001). Media coverage of Venter has been extensive. As a controversial, out-spoken and 'anti-establishment' figure with an interesting history, he makes for easy and pleasing articles in a range of news publications. His previous actions have resulted in a characterisation as the 'bad boy' of science – an epithet he doesn't mind, as long as he isn't called the 'evil' boy of science (Shreeve 2004: 238). He became the antidote to the softly-paced and communal effort of the HGP: a shot-gun wielding geneticist-cowboy.

Despite the potential ethical controversies surrounding synthetic biology, Venter's synthesis work is yet to encounter the same level of negative media coverage as did genetically-modified (GM) crops, or his financial ambitions with the HGP. How is Venter publicly and metaphorically managing the inherent antagonism of fear and hope? What stylistic changes have occurred in the presentation of his research to the media; in other words, how has Venter recreated himself and what can we learn about the potential for public-media ethical dialogue over the application of synthetic biology?

From the 'book of life' to 'building machines': Problems for regulation

Following from the central use of the 'book of life' metaphor, in discourses that relate to genomics, it is interesting to note that within the corpus there was very little reference to that dominating metaphorical frame, although it should be said that Venter rejected that metaphor after the completion of the genome project (see Nerlich and Hellsten 2004). Reference to a book was only found, with relation to synthetic biology directly, in the context of a recipe book in a *Times* comment piece. This was perhaps used with reference to the *Anarchist Cookbook* (Powell, 2003) since it is deployed alongside fears of bioterrorism: 'Could synthetic biology be used to build bioweapons? Yes. Once it's proven that we can cook up fully functioning bacteria and viruses, the recipe book can be used for good or ill.' (Ahuja 2007)

Although the metaphor still refers to a bank of knowledge that can be used by humans for our own devices, as with the HGP, the book itself has been domesticated. It is no longer the great and foreboding 'book of life' that resonates

with the biblical book of revelation but rather a recipe book for budding scientists or dangerous individuals to get their hands on. Certainly the idea of a recipe book connects more easily with the emerging fears over garage biology (see below). The metaphor of the recipe book is not new in genomics but assumes a different and more disturbing meaning in this context.

The reading (the book of life) metaphor is being displaced by its natural successor, writing, which is used to explain that synthetic biology has shifted towards control and creativity when compared to the interpretative and pedagogical notions heavily deployed in the HGP. Though there is metaphorical continuity from reading (a product of creativity) to writing (engaging in creativity and producing something), it is not a literary writing frame that we find ourselves within any longer, rather it is computational writing: instead of 'discovering' the 'book of life', the work of synthetic biology is more akin to the development of software, as one of Venter's co-workers states:

> I like the analogy with a computer. You have an operating system which, by itself, doesn't do anything, but when you install it on a computer, then you have a working computer system. It's the same with the genome. The genome is an operating system for a cell and the cytoplasm of the cell is the hardware that's required to run that genome. (Conner 2008)

Furthermore Venter describes the genome transplant his research team accomplished as being 'like changing a Macintosh computer into a PC by inserting a new piece of software' (Highfield 2007b). The metaphor that Venter and his colleagues are using is repeated in the coverage of their work, as a news report describes:

> The synthetic biology that Venter is pioneering springs from an attitude that scientists are building machines, not living things. These are seen as computers capable of replicating themselves, with genes as software controlling hardware cells – a view that dates from Watson's and Crick's discoveries in 1953. But Venter is taking the process to a new level by creating new hardware and software where none existed. (Anon 2007b)

The computing metaphor has completely permeated the press; the *Daily Mail* writes: 'They managed to swop the entire genome – the genetic software containing information for life – of a bacterial cell with one from a different, but related, bug.' (Ballinger and MacRae 2007) Talk of 'programming' microbes is also used: 'Now the inventor [Venter] plans to design new codes on computers to programme synthetic microbes to produce fuel from sunlight' (Anon 2007b), and elsewhere: 'This will create a life form with biological instructions written entirely by humans.' (Henderson 2008) Again, the code metaphor is old, as old in fact as modern genetics (Kay 2000), but what was once a metaphor used to construct genetic theories about the workings of DNA or to explain these workings to pupils in textbooks or to the public in newspapers, has turned literal and practical in this

context. Griffiths (2001) argues the 'information talk' surrounding the link from genes to amino-acids is not a true account of how genetics relates to behaviour but rather a reflection of the present dominance of information technology in contemporary culture. This metaphorical writing of software extends what Griffith's finds in genetics: a will to see genes as intentional information.

What implications should we draw from this metaphorical shift? Treating these metaphors *as* ethics we find that a highly instrumentalist approach to the ethics of synthetic life is being embedded in the media discourse. This computational metaphor, made up of phrases like 'the genome is an operating system', 'a life form with biological instructions written entirely by humans' and 'the genetic software containing information for life' is a conceptual mapping from programming to genetics. Such a conflation of types of code and the direction in which the metaphor is formulated, from software to cells, implies that as with the programming language of a computer, the genetic language is the entirety of the organism's system. This signifies total mastery over the operations, i.e. the behaviour, of an organism and produces a concept of life that is entirely mechanistic. The ethical implications of such a metaphorical mapping relate to how we position the organism on the boundaries of living/inanimate and synthetic/natural. Interestingly this metaphor draws on the synthetic, programmatic aspect of the organism whilst maintaining its living, natural status. This ostensibly contradictory construction allows Venter's microorganisms to fit comfortably into various other motifs deployed within the discourse, each of which has a particular rhetorical power. The immediate effect of this instrumental, computational metaphorical positioning of the organisms as programmed is that ethical attention is no longer concentrated on the form but the process.

These analogies move us away from interpretation of the existing genetic code and towards creation of new codes, away from literature and towards computation; they perform a reframing of the ethical discourse from one of biological monstrosity, as in the case of Frankenstein foods, towards a more sedentary role for the organism. The upshot of this is that the inventor becomes the source of ethical trouble. It seems that in synthetic biology our fears centre on the possibility of human error or maleficence. Within the computational frame the designed/synthetic aspect of the organism is highlighted, which reduces the life-like quality of its behaviours and, in coordination with this instrumentalist discourse, the stage is reoriented. The spotlight moves from the monstrous creation to Dr Victor Frankenstein himself, the scientist who is doing the creating. Whether or not Venter intends to situate the scientist at centre-stage matters little for the performance. But perhaps *our* metaphor goes too far: the media is not a stage and the metaphorical frame is not a spotlight; the audience of a newspaper may choose what they read, they may still make the connections to Frankenstein's monster if the journalist does not. There is a gap between our analysis of how metaphors are deployed in media discourse and their effects on public opinion.

During the GM debate, crops and food were the focus of public anxiety and fears. The plant geneticists that might be involved in producing them were almost

invisible. When the deciphering of the human genome was announced, to some degree the focus shifted onto the scientists, some of whom, like Venter, became very visible indeed, almost celebrities. So, whilst there is some incongruity between framings of GM and SB, we find a degree of continuity between the ethical shaping of the HGP (see discussion on corporatism below) and the shaping of synthetic biology. However, none of these previous scientists had claimed to 'create life'.

Whereas in the real or fictional past, the creation of life may have been in the hands of exceptional individuals (Dr. Frankenstein), this may no longer be the case in synthetic biology. Although this field has its visible scientists, such as Venter and Endy, it is also open to anybody who wants to give it a try. This opens up yet other ethical issues, this time not related to personalities but to the wider scientific public, not only in terms of fearing or admiring its end-products but in terms of producing them itself.

This human-centric approach to ethical issues is evident within emerging talk of 'garage biology', a term that refers to the use of microbiology and DNA synthesis tools at home – a form of 'bricolage' that the biologist François Jacob could only have dreamed of (Jacob 1977). The decreasing costs of those tools may be starting a biological equivalent of the programming era, as Rob Carlson (2005), a prominent synthetic biologist writes: 'The advent of garage biology is at hand. Skills and technology are proliferating, and the synthesis and manipulation of genomes are no longer confined to ivory towers.' Or as Markus Schmidt (2008) writes: 'it is likely that in the future more and more people without a traditional education in biology or genetics (and probably even without higher education) will be able to manufacture biological systems.'

The programming metaphor underlies this fear of garage biology. Schmidt fears that 'The more successful the attempts to program DNA as a 2 bit language for engineering biology … the more likely will be the appearance of ''bio-spam, biospyware, bio-adware'' and other bio-nuisances.' Of course it isn't just the trifles of what we might call Life 2.0 that one would have to contend with, but the worry that '[a]n unrestricted biohackery scenario could put the health of a biohacker, the community around him or her and the environment under unprecedented risk.' (Schmidt 2008) And in the media coverage, journalists ask: 'what happens if a DNA hacker with evil intentions finds a way to isolate the nastier bits of the smallpox or Aids viruses, then splices them into another, to unleash on the world?' (Rowan 2006) There is a metaphorical continuity here from the computational metaphor that sees scientists as writing software for cells, through the garage biologist who hacks DNA, through to the dispersal of the results into the environment as 'viruses', which brings the metaphor full circle back to its origins in biology.

It isn't solely garage biologists (or 'biopunks') that are seen as potential threats but scientists also, those who might allow a synthetic organism to escape from the lab and those who might release it intentionally. Researchers at Stonybrook University synthesised polio virus (Cello et al. 2002) and others developed the pandemic Spanish Flu virus of 1918 (Tumpey et al. 2005). Both of these

experiments caused a stir in the media, prompting discussion about the ethics of scientific practice and feeding into the then hyperactive fear about terrorism.

This scientist-centric ethics is also evident in the discourse developed by various colleagues of Venter's in a recent report (Garfinkel et al. 2007) on ethical issues in synthetic biology. It emphasises the need for scientific practice and regulation. Perhaps this serves to move the debate somewhat from a form of deontological ethics, meddling in the natural world, to a far more utilitarian one, in which we must take into consideration the risks posed by scientists rather than science. However, this connection to computation still lends itself to claims of scientists 'tinkering' with life, and altering the natural world. Described as ominous by a *Times* journalist, an MIT scientist is quoted as saying, 'The genetic code is 3.6 billion years old. It's time for a rewrite.' (Anon 2007b) This rewriting, this creation of 'new hardware and software where none existed' (ibid.) is what underlines much of the ethical dimension of synthetic biology. As the field is increasingly seen through this metaphor, the ethical issues to be debated are likely to move towards regulation of scientific practice and proper laboratory and purchasing procedures and away from discourses of the un/natural or even artificial, a word still used in discourses around synthetic biology.

In the following we will first outline some of the more negative coverage that the computational metaphor provoked, stoked in part by a critique from an NGO working prominently in this field. We shall then outline some of the more positive images also discussed in the British press coverage, which link synthetic biology not to capitalist landgrabs (see below), but to saving the planet from the ravages of climate change – a discourse of hope that, like so many discourses of hope in biotechnology, remains unfulfilled, but which counterbalances any fears that memories of genetically engineered plants or animals may still provoke in the public sphere.

Industrial rhetoric, the patenting problem and Venter the evil genius

Having suggested that the metaphorical framing of synthetic biology through the computational frame performs a re-focusing of ethical trouble from the organism to the scientist, which had begun in the HGP, we argue that the second effect of this programming language is that it may support claims to novelty regarding the patentability of such things as the minimal genome.[4] By emphasising the 'design' of organisms and seeing the scientists as engineering the software we are encouraged to conceptualise their outputs as products. This programming metaphor, therefore, may also be embedded within a parallel ethico-legal discourse on the intellectual property

4 Minimal genomes are the output of Venter's Institute. They are bacteria that have had all the non-essential genes removed from their genomes, so that they can have particular genetic sequences put into them. This is the process through which Venter intends to produce bacteria that can synthesise biofuels or clean up the environment.

status of the output of synthetic biology. Rai and Boyle (2007) suggest that synthetic biology might bring together the ways that the U.S. separately handles patenting and copyright and that this could represent the 'perfect storm' for intellectual property law. Much of such bad weather reporting was prompted by Venter's attempts to patent the minimal genome, which he attempted in the U.S. and at the international level through the World Intellectual Property Organisation, number WO2007047148. More recently Venter filed patent applications for making synthetic genomes (UPSTO no. 20070264688) and putting them into cells (20070269862). This computational metaphorical work may serve to highlight the non-natural, formed, 'created' dimension of synthetic organisms, not simply as an explanatory frame, but as a tool in *constructing* synbio products as designed and novel, thereby facilitating their patentability. By conceptualising the organism as hardware and the synthetic genome as software the ethical contestations surrounding the patenting of life, which has previously been highly controversial, are potentially undermined.

Further to the theme of computer engineering, the language used by newspapers frequently deploys what can be interpreted as a rather industrial metaphor. Due to the inter-disciplinary nature of synthetic biology, vis-à-vis its ties to engineering, this metaphor sits easily with both computer analogies and those of capitalist industry. We read in *The Times* that 'microbes can become bespoke factories' (Ahuja 2007), likening the process intended for manipulation of microbes to a sophisticated production line. That Venter has 'constructed a synthetic chromosome' (Randerson 2007a) alongside mention of an 'assembly process' (ibid.) suggests nuances of modern industry. By describing the organism as 'off- the-shelf,' in terms of the microbe itself or its genes, the media strengthens the image of industry, of pre-made products fabricated en masse and readily available. The products of synthetic biology, we are encouraged to think, will be as commonplace to everyday life as a pre-packaged shirt and tie combination.

Within the corpus of UK newspapers, it is really only the Canadian pressure group ETC – or the Action Group on Erosion, Technology and Concentration – that reaches newspaper articles as outspoken critics of Venter's work. They have, for example, used the term 'Microbesoft' to describe Venter's move: 'A suite of patent applications lodged by J. Craig Venter and his colleagues claims exclusive monopoly on a wide swath of synthetic biology and demonstrates a not-so-subtle move to position Venter's company, Synthetic Genomics, Inc., as the 'microbesoft' of synthetic life.' (ETC 2007b)

By using the phrase 'microbesoft' the pressure group encourages the industrial/computational metaphorical frame. This is rhetorically successful since the frame already highlights the patenting claims that Venter has made. However, by implicating global capitalism, they challenge the ethical erasure. Highlighting the profit motive may serve to undermine the public acceptance of the patentability of these hardware organisms and their software genomes. The ETC connect this programming language to patents, industry and monopolisation of a market to re-characterise Venter as a corporate villain; a narrative is developed around the character, both personal and professional, of Venter.

Journalists in the UK media report that Venter is 'dubbed Darth Venter for wanting to charge the human race a fortune to read its own genetic code' (Anon 2007b). This is used to describe him in the context of the HGP. The description continues: 'Now the balding Vietnam veteran has another *cunning plan*: to get exclusive rights to the *bare essentials of life* and create green fuels that will make him a dollar trillionaire. (Anon 2007b, our emphasis)' More dramatically, Venter has also been named, 'the bogeyman of modern science…pilloried as the unacceptable face of science for profit, the man who wanted to turn the essentials of human existence into patents to enrich himself' (Pilkington, 2007).

Taken directly from the ETC press release, *The Daily Telegraph* (Highfield 2007a) quotes ETC affiliate Pat Mooney as saying, 'for the first time, God has competition. Venter and his colleagues have breached a societal boundary, and the public hasn't even had a chance to debate the far-reaching social, ethical and environmental implications of synthetic life.' This anchors a critique of Venter's enterprise clearly in past discourses of scientists playing God, especially in the context of genetic engineering. This is intended, one can assume, to stir discomfort in readers, due to its heretical angle. The quote 'God has competition' (originally from: ETC, 2007c) was used on several occasions within the corpus and again, by use of a kind of essentialist argument this highlights the scientist as the source of ethical concern.

By playing in the same field, by mobilising their discourse around the computational and patenting metaphors, and linking this, via 'microbesoft', to a negative conceptualisation of capitalism, the ETC is able to advance an argument against Venter, the representative of synthetic biology more generally. These rhetorical moves allow them to play into a super villain narrative that, superficially, appears as comic book rhetoric: Venter, the scheming 'mad scientist' is 'playing God' and collecting the riches of the seas and lands to use these 'essentials of life' to 'enrich himself' and his pocket. Certainly this makes for exciting reading since Venter's evil plans provide a perfect hook on which to hang the ethical dilemmas. However, the discourse as a whole functions not only as a form of entertainment but as a frame through which one might view the emerging field and its associated hopes and fears.

However, much of Venter's rhetoric promotes a much more positive image of him and synthetic biology that helps to tame the monsters of capitalism and genetic modification. He is here not to exploit the planet but to save it from the dangers of climate change. Through his own comic book narrative Venter characterises himself as a super hero, a Captain Planet of the 21st century.

The greening of genetic modification and Venter the saviour of humanity

Climate change is a concern that has dominated the media's attention over the past few years, so much so that perhaps such level of attention represents an obsession. The Institute for Public Policy Research released findings by Ereaut and Segrit

(2006) suggesting that alarmist language used in the media to discuss the issue was tantamount to 'climate porn', offering a thrilling spectacle of impending disaster but ultimately distancing the public from the problem . This research revealed the use of various linguistic repertoires, or systems of language, that are routinely used for describing and evaluating actions, events and people in the context of climate change. One of these repertoires, pragmatic 'techno optimism' is arguably apparent within Venter's discourse and its reporting in the press. This techno optimism relies on technological solutions to planetary problems and utopian visions of the future, from geoengineering to synthetic biology.

The Sunday Times, when discussing different technical means of combating climate change, describes Venter's work as more natural than many: 'Other researchers [i.e. Venter] are seeking more natural solutions. Most of these focus on exploiting the tiny marine algae that fill the upper layers of the world's oceans.' (Leake 2007) This seems more organic, than say solar panels and wind turbines. The way that Venter's venture seems to offer solutions to the environment alters the frame of discussion to a more altruistic one, distant from suggestions of corporatism. Use of the metaphor of 'lungs' compares the microbes Venter is working on with breathing apparatus for the earth and encourages a natural, harmless framing of microbe synthesis. It suggests a healthy symbiotic relationship between microbe and planet, and thus between Venter and planet:

> American scientists are studying ways to give the Earth a new set of 'lungs'', vast colonies of bacteria and other microbes that are able to scrub the atmosphere of greenhouse gases such as carbon dioxide and methane and perhaps even convert the pollutants to ethanol, which can be used as a fuel. (Highfield, 2007e)

Personifying microbes as agents 'scrub[bing]' the earth highlights a cleansing process which adds positive connotation to ideas of synthetic biology: we might be able to clean up our act if we can just get the technology right. Purification of the earth might also purify our thinking of the 'stains' left by Frankensteinian monsters on public perception of genetics.

The connection between synthetic biology and green-ness is often deployed in a single breath, as with *The Daily Telegraph*'s discussion of Venter's work: 'Synthetic Genomics, a US company run by Dr Venter, recently submitted worldwide patents on methods it has developed to create synthetic microbes to create greener kinds of biofuel' (Highfield 2007d). The familiar metaphor, 'environmentally friendly' is used prolifically in the discourse with regard to the fuel that may potentially be produced by Venter's microbes: 'The team, led by Craig Venter…wants to build new microbes to produce environmentally friendly fuels.' (Sample 2007a) This ties-in with further language implying assistance and help provided directly by the microbes: '…bacteria which could help mop up excessive carbon dioxide and help combat global warming or provide biofuel or remove carbon' (Randerson 2007a).

This is again apparent, for example, in *The Independent* when it states, 'Dr Venter said that the aim of the research is to make new, artificial life forms that

can help to solve the world's most pressing environmental problems, for instance by producing green biofuels, breaking down toxic waste or even absorbing carbon dioxide from the atmosphere.' (Conner 2008) This language suggests helpful bacteria that provide solutions to the planet's problems and characterises the science as value-led. The bacteria may be artificial, but they are also green.

In this context Venter becomes an eco-hero, rather than, as the ETC suggested an 'extreme genetic engineer'. This positive image is connected to the naturalisation of the organisms Venter is working on and is fostered through attribution of a life-or-death scenario to the research, as repeated in several articles: 'It is important to understand the role and function of these organisms to ensure the survival of the planet and human life on it' (Highfield 2007e). If Venter can't do his research, if we don't work with the environment and give it a new set of lungs we might all be doomed. This emphasis on the heroic importance of his mission leads to him being likened with adventurers and pioneers, most notably, Darwin: 'The modern answer to Charles Darwin's 19th century voyage upon HMS beagle' (Highfield 2007c).

This comparison, it can be argued, directly contradicts ideas of science-for-profit and corporatism. One finds in this metaphorical framing an adventurer who might lead us, in collaboration with the friendly environmental organisms, into a greener more natural relationship with our planet.

There are two opposing discourses then that both utilise the same rhetorical strategy: to set-up a battle between the fate of humanity and an enemy: in one instance Venter, the representative of industrial capitalism, is the enemy; in the other, it is we ourselves and our lack of knowledge that is the enemy. By framing the debate about synthetic biofuels in this manner, an all-or-nothing fight for the future, various ethical issues are highlighted (who makes money? who owns nature? who should be trusted?) and others implied (is capitalism evil? is science out of control?). The positions developed through the use of metaphors as ethics are a stark contrast. In the former deployment of the narrative we find 'profiteering industrialists are tinkering' with natural entities thereby implying an ethical standpoint that essentialises the organism and to some degree the category of 'life' and reduces the practices of scientists that have been the focus of the ethical debate to the level of childish play. Treating the metaphor as ethics it is obvious that the ETC is strongly anti-capitalist. In Venter's counter-narrative we find microbes are 'natural' solutions, a frame that highlights the 'organic' nature of the hardware and re-characterises Venter as in tune with the environment. This is an ethical standpoint that supports research into synthetic biology, appeals to notions of working with nature rather than against it such that our global problems can be solved via green technological determinacy.

Conclusions

The broad frames discovered in the corpus play across the binaries living/inanimate and synthetic/natural whilst highlighting the good or evil action of human

scientists. This is accomplished through the development of a computational metaphor that builds upon but significantly alters previous literary metaphors such as the 'book of life', and has two ethical consequences: 1) life is seen in a highly instrumental way which encourages us to focus on the producer of the product and not the product itself; and 2) the products are seen as designed and part of industrial processes which facilitates claims to patentability. The ETC and the media coverage of their reports and comments plays into this metaphorical framing by implicating profiteering motives in the construction of these software/hardware products. They fuse the computational discourse with the second broad framing, a comic book narrative of tyranny, which poses Venter against mankind. Venter, though we wouldn't imply intentionally, counters this conceptualisation with his own comic book heroism. Whereas in the context of the programmatic metaphor the designed aspect of the organism was highlighted, it is the natural aspect that comes into play when the metaphorical frame turns ecological. Neither of these framings exists independently but they are not entirely compatible since they highlight particular features of the organisms for particular purposes, whether those be to close-off fears or to highlight hopes.

A metaphorical struggle is taking place between various conceptualisations of synthetic biology and Craig Venter himself. We have shown, as others have, that certain ethical concerns are highlighted and others erased by the actors, e.g. the ETC, in their metaphorical framings. However, by treating these metaphors as ethical statements in themselves we have been able to show that they not only shape ethical spaces but also make normative pronouncements on ethical issues. This is important for analysis of how scientists and other actors communicate science to the public. Perhaps more significantly it demonstrates that when journalists reproduce the metaphorical frames that their interviewees use, e.g. the programming metaphor, they themselves are making ethical pronouncements on the content of their articles. When they invent or play into metaphors of villainous capitalists and ecological heroes they aren't presenting objectively, rather they are actively engaging in ethical debate with scientists and the public. How and why science communicators choose metaphors may have less to do with enabling understanding and more to do with a political and ethical disposition.

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