Revisiting digital technologies: envisioning biodigital bodies

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Abstract

In this paper the contemporary practices of human genomics in the 21st century are placed alongside the digital bodies of the 1990s. The primary aim is to provide a trajectory of the biodigital as follows: First, digital bodies and biodigital bodies were both part of the spectacular imaginaries of early cybercultures. Second, these spectacular digital bodies were supplemented in the mid-1990s by digital bodywork practices that have become an important dimension of everyday communication. Third, the spectacle of biodigital bodies is in the process of being supplemented by biodigital bodywork practices, through personal or direct-to-consumer genomics. This shift moves a form of biodigital communication into the everyday. Finally, what can be learned from putting the trajectories of digital and biodigital bodies together is that the degree of this communicative shift may be obscured through the doubled attachment of personal genomics to everyday digital culture and high-tech spectacle.

Keywords: genomics, biodigital, bodies, spectacle, everyday

Introduction

In this paper the contemporary practices of human genomics in the 21st century are placed alongside the digital bodies of the 1990s. The primary aim is to provide a trajectory of the biodigital. This includes an outline and critique of a set of discussions around digital culture and biomedical technoscience. The central motif of the paper, envisioning biodigital bodies, is, on the one hand, approached through the perspective of human genomics and its digital practices and the film *Tron Legacy* (2011) on the other. The argument pursued has multiple parts: first, that digital bodies and biodigital bodies were both part of the spectacular imaginaries of early cybercultures. Second, these spectacular digital bodies were supple-

mented in the mid-1990s by digital bodywork practices that have become an important dimension of everyday communication. Third, the spectacle of biodigital bodies is in the process of being supplemented by biodigital bodywork practices, through personal or direct-to-consumer genomics. This shift moves a form of biodigital communication into the everyday. Finally, what can be learned from putting the trajectories of digital and biodigital bodies together is that the *degree* of this communicative shift may be obscured through the doubled attachment of personal genomics to everyday digital culture and high-tech spectacle.

"Digital bodies" have operated in the discourses of digital culture to refer to those avatars and images that represent, simulate, and warrant the humans off-screen. Figures as diverse as Lara Croft and the Visible Human have been crafted as three-dimensional avatars from digital graphics or rendered from technologies that scan human tissues. Such virtual embodiments and the coupling of computer-body relations have been core dimensions of communication in digital cultures (e. g. digital art, HCI) since the 1980s. At the same time they have been the figures of fictive imaginaries in cyberpunk, science fiction, and Hollywood film. In these fictions digital bodies also extend to biodigital fusions of data and flesh or to emergent bodies immanent from the digital, such as the characters in William Gibson's early novels and in films such as *Tron, Lawnmower Man*, and *The Matrix*.

The spectacular imaginary of digital and biodigital bodies was supplemented by what can be thought of as digital bodywork entered into by people in their adoption of the web in the mid-1990s. People had worked on online profiles and avatars during the 1980s when internet protocols were established, but it was only after the commercialization of internet service provision in the mid-1990s and the advent of the web that this kind of activity became widespread. Internet use has always involved communicating an online presence of some kind and the work of creating these dimensions of communication can be thought of as bodywork. The creation of online profiles, user names, homepages, graphic avatars and the use of photos and web cameras are all part of this bodywork. The allure of the cyberculture, as promoted by *Wired* and other sources, helped encourage the consumer interface with the web. At the same time, the high-tech production values of film, print, and graphic design far outstripped user experience of digital interfaces in the 1990s. In other words, being online in the 1990s was not as seductive an experience as it looked when envisioned in other media forms. People's engagement in these bodywork practices contrasted with and supplemented the spectacular imaginary of digital bodies signalled through popular cybercultures, gaming, digital art, and graphic design.

Biodigital bodies remained in the domain of fiction during the 1990s. There were no corresponding user practices that fused biological tissues and digital circuits. By the 21st century, however, something like biodigital bodywork has started to appear with the emergence of a consumer interface for human genomics: the biodigital points to digital bodies in their representational and simulated senses, together with bioscientific digitizations of dimensions of identity such as genomes (O'Riordan, 2010). This can be understood as the intersection of biotechnology and digital culture. Luciana Parisi (2004) takes up this term in her formulation "abstract sex", in which she argues that a biodigital mode of life is characterized by cloning and cybersex. While her use of the term has some bearing on this analysis, and cloning is also central to digital culture, in this article I am interested in challenging the theorization of the biodigital as a possible cultural form. In its spirit of challenge, this paper has alignments with Jackie Stacey's (2010) analysis of the genetic imaginary as well as Eugene Thacker's (2004) documentation of biomedia. Here I make the argument that revisiting digital communication technologies in relation to these actualizations of the "biodigital" (O'Riordan, 2010; Parisi, 2004; Parikka, 2010) allows for the production of a more critical evaluation of the entanglement of human bodies and digital and computational machines.

The expansion of computational methods in the biological sciences (Thacker, 2004; Hine, 2008; Waldby, 2000; Cooper, 2008) as well as the explosion of genome sequencing since the 1990s has ushered in digital bodywork practices of a biomedicalized kind (Clarke et al., 2003). These biomedical entanglements of human bodies and computational signs have already been analyzed under the imprimatur of a number of formulations including the posthuman (Hayles, 1999), data made flesh (Mitchell and Thurtle, 2003), and biomedia (Thacker, 2004). As I will however demonstrate in this article, the emergence of personal genomes as digital media artifacts raises new questions about how biological bodies are accounted for in digital forms.

The article proceeds by outlining a much more detailed spectrum of digital and biodigital bodies in the 1990s. This spectrum operates to clarify the distinctions between digital and biodigital bodies and to set up a working distinction between fictive and actualized bodies. I use the film *Tron Legacy* to more clearly refine this spectrum and some of its contradictions as well as to demonstrate how the fictive/actual and digital/biodigital dynamics play out in visual digital culture. The article then details the emergence of online consumer genomics through the example of the genome scanning company *23andMe.* I argue in the last three sections on biodigital forms, communication, and participation that this is a practice that elicits work on a new kind of biodigital profile and

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thus actualizes biodigital bodywork, as genome scanning requires a tissue sample as part of the construction of digital presence. These sections are also used to develop the argument that because these biodigital practices signal a shift in what communication means for participants in digital culture, further investigation of these practices is needed.

Digital bodies and biodigital epistemologies

In the 1990s, in tandem with the emergence of the web, digital bodies proliferated as communication practices in the form of text-based and graphic avatars for computer games, online and virtual environment interfaces, and user profiles. The emergence of the commercial internet as the consumer interface for networked computing in the mid-1990s transformed the imaginary of cyborg and digital bodies into a set of practices. Simulating digital bodies became a central design challenge for interface, gaming, and graphic designers in this period. Taschen, the vanguard of visual design publishing houses, compiled the glossy coffee table book *Digital Beauties* in 2001, as an ode to this sexualized imaginary (O'Riordan, 2007). Lara Croft, the iconic digital body avatar for game play in the popular *Tomb Raider* series, was proposed as an ambassador for British innovation (until the parent company was bought by the French). Annanova, a virtual newscaster, was the flagship avatar for the anticipated new generation of mobile devices in the 1990s and was sold to the telecommunications company Orange in 2000 (O'Riordan, 2006). Textual and graphic avatars that allowed a doubling of the body and machine were the central motif of both cybercultures and cybercultural studies in the 1990s.

This proliferation of avatars was also matched in popular culture in cyberpunk novels, graphic novels, and film. The earliest "dipped in digital" bodies were featured in the Disney film *Tron* in 1982, and saw further iterations in *Lawnmower Man* in 1992. This aesthetic was transformed through the noir-realism of *The Matrix* (1999) at the end of the 1990s (Gillis, 2005). Cyborgs like those in the *Alien Quadrilogy* (1979–1997) represented the anticipation of compassionate humanism in computer systems, as well as the anxiety that humans were losing something of their own humanity in the move to digital life.

In the same period digital bodies were also central in the critical registers of the digital arts (Vesna, 1997) as well as in critical and cultural theory (Haraway, 1991; Hayles, 1999). The relationship between digital forms and human bodies continues to be both a central concern of digital media theory and a tropic motif of digital art. Taking three recent publications in the field as examples, Mark Hansen's (2006) *Bodies in Code: Interfaces with New Media*, Anna Munster's (2006) *Materialising*

New Media: Embodiment in New Media Art, and Jennifer Gonzales' (2008) *Subject to Display: Reframing Race in Contemporary Installation Art* illustrates the point that this critical concern continues. All of these theorists demonstrate ongoing preoccupations with different kinds of digital bodies grounded in digital art practices and elaborated in their theory-making. The centrality of the body to digital culture continues to be pertinent to questions about the nature of contemporary life. Much digital art practice continues to focus on critiques of this relation. Experimental projects like Victoria Vesna's early 1990s *Bodies INCorporated* (1996) reflected this concern over the emergence of the consumer interface with the web. The use of the metaphor of skin and the term digital bodies in the titles of exhibitions, projects, and collections of essays throughout the last two decades attests to a long-term and critical fascination with digital bodywork.

In the period from the late 1980s to the start of the 21st century, digital bodies in the forms outlined above (communication practices, popular culture, digital art, and critical registers) were imagined as interfaces between digital media and the biological body. During this same period they saw a shift from the imaginary into practice. These interfaces took very different forms in these different contexts: on the one hand, as arenas of design and celebration and as objects of critical, ironic, and skeptical interrogation, on the other, and sometimes as both. In each case, however, digital bodies were imagined as communicative interfaces, the meeting point of body and computer. Avatars, for example, were understood as the contact point or bridge between the human body outside of the computer and the interiority of computing networks or cyberspace. Digital bodies as they had been imagined in cyberpunk became practiced as simulated human identities and profiles or as representational interfaces for acting with the computer.

However, digital culture continued to dream of a body-computer circuit that was much more integrated than the one provided by the practices of communicating with the computer in the 1990s. In *The Age of Spiritual Machines*, Ray Kurzweil (1998) dreamed of uploading human consciousness to computer systems. In a similar milieu, many cyberpunk writers, transhumanists, and artificial life (alife) researchers speculated about life emerging from complex computing systems or the transubstantiation of bodies into computers. Alongside transhuman discourses, critical posthumanisms also explored a decentering of the human as the central point of agency and pointed to mechanic, augmented, and distributed agency (Hayles, 1999; Miah, 2007). However, these imaginaries of biodigital convergence had very little in the way of material corollaries or actual world practices until the Human Genome Project reached its apotheosis in 2000. Unlike the digital bodywork of engagement with the

web, biodigital bodies did not have a consumer interface around which user practices could coalesce until the emergence of personal genomics in the early 21st century.

In fact, despite enthusiastic predictions and the establishment of transhumanist orientated research clusters at leading international institutions like Oxford University, the shift from biodigital imaginary to materiality and practice has been much slower than the move from imaginaries of digital bodies to practices of avatars and profiles. The Visible Human Project was perhaps the closest material instantiation of a biodigital body in the 1990s (Waldby, 2000; Doyle and O'Riordan, 2002). For this biomedical project, two human cadavers were frozen and thinly sliced across the horizontal axis, the slices were then digitally scanned and recombined to create a kind of 3D fly-through of the human body that existed both in a digitized form and was derived from the materiality of the biological body. However, this project, which seemed like the exemplary form of the time, was exceptional. As Catherine Waldby persuasively argues, its lack of human life also erased the biological and made a revenant of it, that is, a real ghost in the machine, an apparition, an example of the "digital uncanny" (Waldby, 2000)[1]. It was also representational, despite destroying the bodies it consumed, it did not translate them into informational forms so much as reconstruct them as digital representations.

The Human Genome Project was a more ambitious attempt to constitute human biological identity as digital, although this was not its primary intention. This project mapped a singular human genome, known now as the reference genome. It took 15 years and the participation of hundreds of scientists[2]. The project generated an unprecedented amount of information in mapping the three billion base pairs of the human haploid genome. The human reference genome is a digital entity, in effect a 3.5 gigabyte database, that can be interrogated for information about the genetic sequence of human nuclear DNA. This is not the only kind of DNA in the human body, but it has become understood as the reference DNA for the human. Rather like Ray Kurzweil's transhumanist idea that consciousness could be uploaded to a computer, the high profile geneticist Walter Gilbert claimed in the wake of the Human Genome Project that a human being could now be stored on a compact disk (Gilbert, 1992, p. 96). Like the Visible Human, the Human Genome Project involved the biodigital bodywork of taking (living) human tissues — blood — but in this case transforming and translating it into machine-readable code represented as the human reference genome.

In the 1990s digital bodies proliferated as communication practices across a variety of forms as outlined above. They appeared in both the fictions and practices of digital culture as text-based and graphic avatars,

online personas, second selves, artificial and other lives on the computer screen. Although biodigital bodies were also imagined in the same period, they rarely saw instances of practice. Clearly, biological models and processes have strongly influenced and guided computer science and informatics (and this influence works both ways), and thus digital culture. Such influences can be followed throughout the areas of Alife, emergence, digital biology, creative evolution, fractals, swarms, simulation, and flocking in the 1990s (Bentley, 2002; Haraway, 1997; Kember, 2003). However, at the time computational practices had yet to have an impact on much of the practice of the biological sciences. Models of the body and mind as machine and as computer provided determining epistemic directions in biology, resulting in a wave of debates on the significance of the model of the body as code and the code metaphor's influence on biological thinking (Haraway, 1997; Kaye, 2000; Roof, 2007). However, the practices in many of the life sciences remained relatively analogue and computational coding as a practice of biology did not become integral until the late 1990s and early 21st century (Hine, 2008). As such, former biologist turned social scientist, Christine Hine, could claim as late as 2008 that biology remained so un-computational that even the use of e-mail was a less dominant work practice in biology than in other areas of the sciences (Hine, 2008, p. 10). The convergence of informatics and biology in the form of bioinformatics has only really seen an influential disciplinary arc that establishes practices such as post-doctoral training in the early 21st century.

N. Katherine Hayles (1997) points to an earlier cyborg ontology in her influential account of how "we became posthuman" in the late 1990s. The "we" of her text is the philosophical subject position of the reader. The posthuman figures in her study are new fictional protagonists, subjectivities, and legal protocols that deconstruct the unitary self (Miah, 2007), and not corporeal bodies or practices as such. Although the influence of cybernetics was far-reaching, computational practices did not reach that far into the body. Cyborg theorists (Hables Gray, 2002; Stone, 1996; Zylinska, 2002) and artists (especially Orlan and Stelarc) demonstrated that pacemakers, speech synthesizers, and surgical body modifications were proof of a machine-human condition. However, these were all examples of prosthetic additions to the biological body and the biological did not flow back through the circuits of the machine.

Of all the features of the 1990s technoculture, the Human Genome Project (1989−2003) comes closest to a practice of biodigital communication. The project was a long-term and large-scale international research effort, one of the largest of its kind. Dimensions of the politics of human genomics have been communicated to policy and political science audiences via the writings of Cook-Deegan (1995) and to science studies

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and sociologists via multiple authors including Haraway (1997), Kevles (1992), and Reardon (2005). The project was communicated to global media publics throughout the 1990s in news coverage and documentaries, largely initiated by press releases from scientific journals that updated the world on the fragments of the map as it was developed. At the start of the 21st century the completion of the draft was announced in an international press release by the then Prime Minister and President of the UK and USA, respectively. The project was communicated through this kind of staging in very powerful terms as the book of life (Nerlich, Dingwall and Clark, 2002). The aim of the project was to sequence the human genome via the transfer of blood samples into a digitized genome map. Rather than taking images of tissues with the goal of representing anatomy, or providing imaging of hitherto unseen dimensions of the body, it aimed to translate the samples into a biotechnological tool that could provide new understandings of human biology. On completion the genome data was made accessible through the online browsers UCSC Genome Browser in the USA and Ensembl in the UK. It was strongly promoted throughout government science policy and press framings as a public resource. At the same time, the requirement for high-level processing power to produce the genome and for computational architecture to query it made it one of the most influential projects to usher in the computational turn to biology (Hine, 2008; Ratto and Beaulieu, 2007; Thacker, 2005). I would suggest that the rise of bioinformatics has come out of this move to genomics and the demands to manage and interpret genomic information. Bioinformatics has very quickly reached out to a consumer interface through the circulation of genomes in digital culture. It is at this new consumer interface that biodigital bodywork has shifted from fiction to practice.

In summary, although biodigital forms haunted the technocultural and cyber imaginaries of the late 1980s and early 1990s, they did not emerge as material practices until the late 1990s and early 21st century. While biodigital epistemologies were influential in both the information and life sciences and biodigital figures have populated media cultures, biodigital ontologies have been less visible. In coupling cybernetics and biological systems, the cyborg was the iconic technocultural body figure of the 1980s and early 1990s (Featherstone and Burrows, 1996; Hables Gray, 1995; Haraway, 1991; Hayles, 1999; Woolmark, 2000). Digital bodies remained a central trope of the technoculture as it opened into a mass market via the vectors of the internet, gaming, and mobile telephony. As such, the biodigital body can be thought of as a 21st century form with its precursors in the 1980s figuration of the cyborg and 1990s digital bodies, ushered in by the emergence of bioinformatics and its reach to a consumer interface through direct-to-consumer genomics.

"It's biodigital jazz"

To help illustrate this story about shifting digital and biodigital communication, I enlist the bodies of the film *Tron Legacy* (2010). This recently released Disney film owes much to the cybercultural imaginaries of the 1980s. It is a sequel to the 1982 film *Tron*, which provided the first take on cyberspace and cyberbodies in mainstream film. The 1980s film helped to edge computing subcultures toward the media exposure that would come in the following decades.

The *Tron Legacy's* homage to the original *Tron* release eschews the mundane reality of everyday digital culture experienced in the 21st century. Rejecting social and networked media such as *Facebook* and *Google*, it returns to the otherworldly spectacle of graphic digital bodies in computer space. The computer world in the film is not the networked social media platforms of today's digital landscape, but an enclosed virtual world. In this world and in its relation to an outside, *Tron Legacy* sustains two versions of the biodigital. The first is where the body of the user is digitized through the use of an advanced laser technology that translates the body of the user into an in silico version of itself. The main character lives inside computer space after being digitized and translated from the outside world into this space. The second version is in the ISOs (Isomorphic Algorithms), a form of artificial life that simply emerges inside computer space when the conditions are right. Humanoid in form, these are a synthesis of silicon and carbon life. The only surviving ISO in the film takes the form of a beautiful woman called Quorra whose body also proves translatable when she leaves the computer world for the outside at the end of the film. *Tron* and *Tron Legacy* constitute a key dimension of digital culture and encapsulate many of its central themes and figures, including digital and biodigital bodies. Although *Tron Legacy* is a film of its own moment, it is also about nostalgia and revisits visions of digital biology and a pre-networked imaginary in which computers could stand alone.

Inside the *Tron Legacy* story world digital bodies are part of the textures of everyday life, the digital avatars have lives and the biological lives have avatars. However, the biodigital convergence of biological and computer life in the ISOs is the miracle. The ISOs represent a kind of magical being within the virtual world fantasy. They come directly from the artificial life hypothesis that life emerges from conditions of complexity and that these conditions could be generated by computers. The step from digital to biodigital is the magical thinking or fantasy attached to today's digital bodies. They are fictional figures that cannot be reduced to explanation. They are evoked as emergent "biodigital jazz", a phrase used in the on-screen dialogue to describe the ISOs in the film in terms of beauty, reverence, and awe.

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In the 1980s and 90s digital and biodigital bodies were imagined as dystopic, utopic, and ironic entities that would provide the entry points and interfaces between virtual and actual. As the virtual and actual have come together in the mundane everyday life that is digital culture, these spectacular bodies have become less salient for thinking about the interface. Although there has been an increased use of graphic avatars to represent online engagement, the digital bodies that augment people's lives as they use digital technologies everyday are less about these forms than they are about profiles. The digital bodies of everyday life are aggregations of information, data doubles, or data selves that do not materialize as graphic entities, but rather as drop-down menus, profiles, passwords, and other distributed systems of recognition and interaction.

Despite the mundane reality of digital life, biodigital bodies continue to hold a kind of magical place in many areas, as evidenced by *Tron Legacy*. Technocultural elites still fantasize about biodigital bodies and popular culture is populated with figurations of the biodigital. Spectacular characters like Quorra remain a salient feature of the contemporary digital imaginary. Digital bodies remain attached to the attendant spectacle of the biodigital body, althrough digital bodywork has long moved from fiction to practice.

My argument in this article is that biodigital bodies are at the point of moving into the domain of practice through the proliferation of individual genomes and their attachment to online profiles and other dimensions of digital bodywork. These new avatars of genomic information open up into biodigital practices. These include the reckoning of self-identity in relation to genomic profiles, the production of techno-cultural capital via genomic knowledge production, and the extraction of biomedical labor in the form of samples. This biodigital bodywork is a site in which biotechnology and digital culture come together in new practices that extend the disciplinary compulsion to upload everything. They extend this disciplinary form from one that has an attachment to information about the body to one which also has an attachment to the corporeality of the body. This extends the reach of information as an episteme so that the body only truly becomes knowable when it is mediated through digital forms. The biological body as a site of knowledge, authority, and truth is supplemented by digitization so that the biodigital body, or the body as knowable through informational and digital practices, becomes the relocated political center of a biomedicalized digital economy. In other words, the upload regime has extended from digital to biodigital and despite controversy about direct-to-consumer genomics, this has happened rather quietly.

Biodigital bodywork has become a practice that is far-removed, in some ways, from the seductive imaginaries of digital culture. The current

practices of the biodigital body are quite mundane. Genomes circulate through browser interfaces with genomic information and these have high-end and graphically appealing production values in commercial domains like *23andMe*. Genomic information looks good, it is interesting and engaging, but it is not the spectacular departure from the real that is evoked by the ISOs of *Tron Legacy* or any other of the seductive digital beauties or deities rendered in the imaginary of digital culture.

The allure or the horror of these fictions obscures the move to the biodigital that has already happened. The gap between imaginary and practice never comes together such that the realization of digital culture or its instantiation never looks like the imaginary extrapolated in the past. Gibson's cyberspace imagined in the 1980s therefore does not match the practices of the 21st century; we have nonetheless entered into a society augmented and structured by digital infrastructures. In this way, the allure of fictive biodigital bodies disguises the biodigital bodywork of practice.

Current biodigital bodywork brings together human tissues and digital infrastructure, but the spectacle, horror, or uncanny is not attached to these practices; instead, they are naturalized as common sense practices of genomic knowledge production and digital culture through the discourse of participatory empowerment. *23andMe*, for example, opened its services under the banner of democratization and a statement from the list of company core values reads as follows: "Because we believe 23andMe's mission extends to the advancement of science, we intend to give you the opportunity to participate in research that could improve understanding of how genetics influences our lives" (23andMe, n. d. unpaginated). In this convergence, however, something is lost. The actuality of the biodigital is not registered as a turning point − it looks like just another upload. The distinction between digital media and biodigital media is obscured by the mundanity of the practice of browsing genomic information and the idea that this is just more data, or simply more network power.

After the Human Genome Project: biodigital forms

It has been ten years since the completion of the Human Genome Project and its single reference genome. In the last five years there has been a proliferation of digital genomes generated by direct-to-consumer genomics and the research focus on personal genomics in the field. The developments in computational power that occurred during and after the project make it possible to sequence a human genome in a matter of weeks, with a single human genome able to be stored on a data stick. Personal genomics, which has emerged in the early 21st century, has led to the

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generation and circulation of increasing numbers of digital genomes. These can be thought of as biodigital forms, because they involve an exchange of bodily materials and digital information. The person sends a saliva or blood sample to the providing company or research team and receives information about the body, returned in the form of sequence data, and its annotation via a browser. This convergence of bodily materials and digital media promises new ways of participating in and knowing about the world.

Personal genomes as media artifacts circulate in the context of the digital media culture of the 21st century. This is characterized in part by the promissory rhetoric of convergence, participation, and emancipation. Digital culture promises a convergence of production and consumption and offers creative and emancipated subjectivities as the reward for participation (Jenkins, 2006). Personal genomes circulate as a form of biodigital bodywork in this context.

Like the digital bodies of the 1990s, much of the discursive context is utopian. Consumers consent to the mapping of personal genomes through the promise of a return of self-knowledge and democratized genomics (Reardon, 2011). In some ways these forms are far removed from the transhumanist imaginaries of earlier decades, such as in the work of Ray Kurzweil (1998), mentioned above. They are more closely linked to mundane practices of ancestry and medical testing and may have implications for health care. They involve the collection of samples from research subjects, patients, consumers, celebrity elites, and scientists.

The biodigital body in its dominant form, as personal genome, is in some ways very similar to other avatars of digital culture. While it links the body of the user of digital culture with the interface, the transaction that constitutes this link is differently demanding. The imaginative and emotional investment offered in online profiles, games, and virtual world avatars and other mediations of the self is supplemented in this case by a biodigital materialism. In the case of personal genomes, the digital aspect of self is derived from the extraction of tissues from the consumer's body and this appears to promise the addition of a biological dimension. This adds to the psychic, emotional, and temporal connections already elicited through participation in digital culture.

Previous attempts to incorporate bodies into the folds of biodigital life have been cast in the dark shadow of the uncanny or vampire projects (Haraway, 1997; Waldby, 2000); however, personal genomics companies, like *23andMe*, have been promoted by themselves and others as offering opportunities for a different incorporation. This incorporation promises pro-active participation, empowerment, and material benefits. *23andMe* offers its genome scanning service in the terms of promises of personal-

ization and democratization, promising better futures and proffering the opportunity to join the vanguard of a 2.0 research revolution in biomedical research (Reardon, 2011).

23andMe is one of a cluster of companies generating personal genome scans and sequences (e. g. *Knome, Pathway, DeCodeMe, Navigenics*). This cluster is part of a wider attempt to make genomics meaningful in both biomedical and market terms as well as to generate tangible outcomes from genomic information. The creation of multiple human genomes to fill up databases and provide large-scale data sets that can be subject to analysis and computation is perceived by researchers in this area as one route to such an imagined future.

This circulation of personal genomes creates new forms of biodigital bodywork. As such, this area has attracted controversy and some legislative struggles in both the UK and the USA (Prainsack et al., 2008). These controversies have been characterized by an attention to the question of medical relevance. Medical relevance invokes biomedical regulation and an association with genetic counseling. However, one concern is that genomic information does not have enough relevance to be worth the promises that are attached. Taken in this light, consumers who anticipate medical relevance are perhaps being duped. A further concern in policy reports such as *More Genes Direct* (2007, UK) is that if medical relevance is inferred, people may act on inaccuracies or little understood information in ways that might place a burden of cost on health care provision or have a harmful impact on the health of individuals.

These legislative concerns about medical relevance have also been a focus in the sociology of medicine for some time (Hedgecoe, 2008; Tutton, 2009). In addition to these perspectives, personal genomes can be additionally understood as part of new biomedical repertoires of biography and autobiography (O'Riordan, 2011). As a consumer interface they provide a means through which biotechnology is incorporated into everyday life (O'Riordan, 2010). Using the frame of digital media theory, communication scholar Marina Levina (2010) argues that personal genomes are part of a network subjectivity or network consumerism. Levina engages with Tiziana Terranova's (2004) thesis on network politics and argues that *23andMe* extract "free-labor" (Levina, 2010, p. 5) through an appeal to biocitizenship, hence "citizen bioscience functions to grow and expand network power" (2010, p. 7). Here, the engagement with Terranova implies a network organized unevenly in favor of those doing the extracting.

Networked modes characterize the contemporary media ecology, and free labor as it is conceptualized in debates about digital culture is a dimension of the kind of biodigital bodywork that is conducted here. However, free labor operates differently across media sites. How it is

mobilized in the moral economies of software production (Berry, 2008; Kelty, 2008), for example, is different from the free labor extracted from participants in personal genomics. Free labor in software production involves working on software and can be understood as either a craft entailed or piece work. The extraction of tissue samples in order to generate genomic information is a different kind of bodywork. It can still be understood in terms of the creation of forms of production, but the extraction of bodily samples places it closer to the work of "biocapital" as conceptualized by Kaushik Sunder Rajan (2009), who argues that genomics and the dot com economies are co-constitutive parts of the same political formation. The links go beyond political economy however, and the biodigital bodywork of personal genomics also bears close similarities with the affective digital bodywork of online porn cultures (Mowlabocus, 2010). Mowlabocus writes of online amateur porn production on a site called XTube:

> "Amateurs transform their real bodies into (immaterial) digital bodies that can enter the XTube economy and earn capital. In doing so they simultaneously enter into a parallel economy, one that legitimates them through ratings, comments and tagging, and increases their subcultural capital and standing within the social network."
>
> (Mowlabocus, 2010, p. 82)

This model, and the suggestion of a parallel economy, has strong similarities with online genomics, where consumers increase the biological value of personal genomes by attention, subscription, annotation, discussion, and the formation of groups around genetic interest. Free labor is thus part of the equation, albeit not the whole story. Biodigital bodies ineluctably draw on the biological materials of the body and it is this quickened media dimension, that of biomediation, which is elided by the rhetoric of digital culture and by some academic critique in this area. At the same time, the level of attention and commitment seen across the very different kinds of investment in gaming (Taylor, 2006), software cultures (Kelty, 2008), pornography (Mowlabocus, 2010), fan cultures (Jenkins, 2006), and cultural work more generally (Gregg, 2011) is much higher than that seen in personal genomics so far (Levina, 2010; O'Riordan, 2010). Biodigital bodywork is not simply another form of digital interfacing, it asks for new kinds of reconciliation (Bassett, 2007). Although genome companies are in pursuit of the same kind of assiduous attention that people give to digital bodies, the parallel economy that Mowlabocus refers to might turn out to be different.

Biodigital communications

In her discussions of communicative capitalism, Jodi Dean (2002, 2009) argues that much communication in digital culture has lost its message value. She examines the dimensions of a world in which contributions to the media ecology can be understood as passive contributions to a media that does not connect to a material politics. Arguing against the celebratory tone of "convergence culture" as it is characterized by Henry Jenkins (2006), she draws from Zizek's reformulation of interactivity as "interpassivity" to make a distinction between contribution and message. A message, argues Dean, requires a communicative act of understanding and she attaches a message to a use value. Conversely, contribution to digital culture may not have the use value of a message; in other words, it may not say anything to anyone. Dean explains that in communicative capitalism "a contribution need not be understood, it need only be repeated, reproduced and forwarded" (2009, p. 27). Therefore, according to Dean, much production in digital culture may not have the message value of meaning; it is not communication, but contribution. This offers one way of framing the current circulation of genomes. It is tempting to think that there is a lot of noise circulating, but that there is not really anything *there*.

Digital media is however a vector through which people understand themselves as well as communicate with others. Personal genomics demands that people understand themselves through the digitization of bodily samples. In contradistinction to Dean, this contribution needs to be understood. The "there" in personal genomics is in the project of making biodigital contributions productive of meaning and value. Following Stuart Hall (1973) in concert with Dean, biodigital communication demands attention through its tie to a person's life. In Hall's terms, this can be linked to the argument that the context of production and that of consumption constantly inform each other. The value of a personal genome is not only in its contribution to digital culture, it also has two kinds of message value. One kind of value is offered to the audience, and in the case of the individual address of personal genomics, the audience and source of information are the same. The second kind of message is the value offered to the producers. In terms of personal genomes, it seems that this value is much higher than that returned to the consumer-audience. *23andMe* as a biotechnology start-up is more invested in genomic information than an individual user of the site. There is a hierarchy of consumers, too, and those users who are already participating in technological or media elites are better able to use their genomic information through, for example, writing books or newspaper articles on the basis of the experience (O'Riordan, 2011). This kind of value is

not connected to the biomedical value of the scan information, but to the technocultural value of participation in the process. Thus, paradoxically, people who get into genome scanning because they are looking for a return in biomedically useful information get less value than those who are not.

Although Stuart Hall's communications model of encoding and decoding (1973) is formulated in relation to the broadcast medium of television, it usefully emphasizes the way in which media is a vector through which people understand themselves. Hall's model also has the value of emphasizing the way in which contexts of production and of consumption are similar. He illustrates that technical infrastructure, relations of production, and frameworks of knowledge are shared at the point of encoding (production) and decoding (consumption) (Hall, 1973, p. 165). Although ideology might operate to disguise these shared structures, media is made and consumed in the same cultural context, with production and consumption feeding into each other. This model of circulation illustrates the integration of media in society, culture, and identity. This makes it harder to imagine a dislocated zone of circulation in which media contributions can be made, but, at the same time, fail to touch real lives, as Dean suggests. Following Hall's model, the distinction between contribution and communication that Dean makes could only be sustained if people decoded their genomes as meaningless. In the case of personal genomes, which could be taken as the messages, and the biodigital form of these messages, both are communicative contributions. The scene of circulation demands that identity become knowable through this register. Genomic information demands that tissues pass through the vector of digital media in order to become a meaningful and a productive site of power. In this move from digital to biodigital, there is a shift from an earlier demand that all bodies be reconciled to a data double in order to have structural intelligibility (Bassett, 2007) to a demand (at least in genomics) that digital media becomes the vector through which bodies must pass in order to have biomedical intelligibility.

Demands that consumers engage in new forms of biodigital reconciliation are unevenly distributed. While digital reconciliation per se is widespread with the near-universal demand that people be attached to identity card or passport databases, genomes have not become an absolute pre-requisite for communicating identity. However, biometrical forms of regulation are on the rise and the use of genomics in border regulation has been suggested in the UK[3]. It seems possible that genomics will be a route through which biodigital bodywork will continue to proceed. It is nevertheless difficult to predict the shape that this will take. The biomedical value of genomic information is debatable and there is only

uneven evidence that genomics can become a determining technology in the ways that have been anticipated in dystopian imaginaries. There is, however, much evidence to suggest that media technologies shape social life and identity and that the addition of a biodigital dimension to the communications technology-identity relation augers change as well as continuity. One communicative dimension that does seem possible is that the imperative to upload and share biodigital identities may, like digital profiles, become socially normative in technocultural work cultures (Gregg, 2011). Certainly the people currently engaging in such an activity are limited to journalists, entrepreneurs, research and development agents and investors for info and biotech companies, employees of the genome companies, and academic researchers.

So what kind of communicative shift is entailed? I would suggest that the digital bodywork of making a media presence in the form of profiles, images, and information has been representational. People have used a digital media presence as a communicative node to represent themselves to others, to act as a communicative extension, which primarily can be in the hands of the producer. While profiles are always constrained by the architecture of participation, the media uploaded derives from the contributing person. People may not always be aware of the implications of the information they contribute, and it is impossible to know what one's own media presence communicates to others. The audiences for an online profile may be friends and family, but they are also and always Internet Service Providers, platform providers, advertisers, and un-known audiences beyond a known sphere of circulation. However, this representational media presence is a communicative node, which is over-whelmingly used to communicate with others and one in which people have some control and oversight. Biodigital communication further dis-locates some of this control and oversight. To have a biodigital presence is to give something up, to take a substance from the body and put it into the circuit of production. Genome sequencing is not like making a web page, it is a biotechnological process at some radical remove from participation. The meaning of genomic information is also at some re-move. Giving up a tissue sample and having it returned as genomic data and annotated through a browser as part of an online presence reinserts a form of production that decouples participation. People do not have much control or oversight about what their genome communicates, what it means, or how it is communicated to them. The biodigital quality of this communication means that the online presence as a mode of communication speaks back to the producer in ways that the producer cannot control or oversee. A biodigital profile communicates with its producer in ways in which the person doing the uploading does not have control or oversight. Biodigital bodywork opens up the body to a

differently weighted communication circuit, which intensifies the role of the media as a vector of self-knowledge so that the biodigital form communicates meaning back to the body of the audience. Genome sequencing communicates information about ancestry, health, and behavior in current instantiations. The meanings of these communications cannot be completely imposed, they will be always negotiated by their audiences. The biotechnological filter in this case, however, limits the power of the audience/producer to do the work of interpretation and to shape the meaning of genomic communications.

Conclusion: participating biodigitally

There are three things I would like to come back to: the first two are the shifts from fiction to practice, and from digital to biodigital, and the third is how this relates to communication. In the 1980s and 1990s, the digital imaginary was populated with the figure of the digital body, which shifted from cyborg to avatar and incorporated AI and Alife. These figures emerged from genre fictions, particularly science fiction, to inform popular culture in the same period that computing cultures shifted from a marginal position in terms of real politics to take center stage in Europe and the USA. In popular media cultures both digital and biodigital bodies emerged as key tropes of the technoculture, but only digital bodies emerged as practices. Avatars and online profiles are manifestations of digital bodywork and they have become attendant figures for many people's everyday life. In these practiced forms, digital bodies have become necessarily denuded of many of their dimensions of spectacle as they pass into a different kind of phase as cultural forms.

While digital bodies have become mundane practices, fictions about biodigital bodies continued to animate digital imaginaries in the 1990s and in the early 21st century. The turn of the century *Matrix* trilogy (1999−2003) rode on the popularity of the fantasy figures of cyberculture and continued to gesture toward a biodigital imaginary. A decade later, James Cameron's *Avatar* (2010) provided another epic foray into similar terrain. In this same period digital media has come to the fore in remediating other forms. A shift can be traced from biodigital fictions to biodigital practices. This has other axes that could be traced, but the circulation of personal genomes is one area in which biodigital bodywork appears to be operating. Personal genomes, like online profiles, supplement the spectacular imaginary of biodigital bodies with another relatively mundane engagement with digital media. Biodigital practices have arrived rather quietly − this, together with the rhetoric of convergence, obscures a dynamic move that could benefit from some disaggregation.

Communication has traditionally been understood as a process of making meaning through the passing of messages. This is a process in which meaning is made, rather than a transparent process through which pre-given meanings are exchanged. A constitutive dimension of media is a power to change the sites of production and consumption. Media, where bodies are represented and meanings are made about them, have an inscriptive power upon actual bodies. In the biodigital elites that are assembled around genome scanning and sequencing, the attempts to establish the circulation of individual genomic information as socially normative in these circles creates a new form of attention. This involves the extraction of free labor in the service of biomedicine, the empowerment of consumers in accessing their genomic information, and the creation of technocultural capital to enhance the power of an individual's career value. However, it also creates a milieu in which biological dimensions of life become subject to norms of digital sociality. The same regimes of openness about communication and information that structure contemporary digital cultures and their resulting problems (exacerbating inequality for example) become those to which geneticized identities are also subject. The technocultural elites already engaging in these practices of biodigital bodywork provide a supplement to the spectacle of biodigital bodies by advocating the relevance of personal genomes for everyday life.

Bionote

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Notes

1. These hauntings take many forms, not least of which are the ethics of consent in the case of Joseph Jernigan, of Waco, Texas from whose body the male data was constructed. For the Visible Human Project the biodigital bodywork consumed the dead body of the biomediated subject. In the case of personal genomics, the biodigital bodywork is a live transaction based on very minimally invasive tissue samples, such as saliva and blood, thereby constructing a relation with a living user. Such genomic avatars have so far attracted less emotional and subjective investment than

other online profiles, although it is this kind of attention to and investment in the interface that personal genomics companies seek.
2. See for example Robert Cook-Deegan's (1995) *Gene Wars: science, politics, and the human genome* for an account of the HGP.
3. See the *Nature* editorial "Genetics Without Borders" (2009) 461, 697 (8 October, 2009) for more details of this scheme and the CESAGen resource put together in response to the public debate: Human Provenance Pilot Project: Resource Page at http://www.genomicsnetwork.ac.uk/cesagen/events/genomicsandidentitypolitics workstream.

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