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Google Warming: Google Earth as eco-machinima

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Abstract

This article argues that the computer automation of perspective and rendering in Google Earth has far-reaching consequences for the relationships between representations of the earth, its ecology and cultural responses to climate change. Theorists Erwin Panofsky (1991) and William Ivins (1975) to Lev Manovich (1993) and Don Ihde (2009) have argued that the emergence of Renaissance perspective structured a new relationship between the image and the object: contributing to the initiation of industrialisation and science. Whilst Manovich describes the impacts of Renaissance perspective in terms of its effect upon scientific and industrial structures, Jean Louis Comolli has argued that its advent was both a cause and a consequence of a shift to a humanist social regime. This article argues that Google Earth and its corollaries now complicate the visual and discursive constitution of the cultural and ecological environment. The contemporary computer-generated ‘visual nominalism’ of Google Earth results in a photomapped representation of the earth that can elevate environmental awareness through visualised data sets at the same time as it reduces the earth to a product design–engineered object. As Comolli’s *Machines of the Visible* becomes *Machinima of the Visible*, this article asks whether public and scientific calls for a turn towards geoengineering can be viewed through a product design–engineered interface that reconstitutes the social machine as an engineer of the earth object itself.

Keywords

Blue marble, cartography, climate change, digital earth, earth photography, geoengineering, global warming, Google Earth, machinima, new media, panopticon, perspective

In 1525, Albrecht Dürer rendered a series of now famous images (Figure 1) in a treatise on measurement. These images all illustrated draftsmen in the process of using drawing grids to render various three-dimensional (3D) objects in perspective. Dürer’s representations of representation (as it were) now form the mainstay of illustrations deployed in textbooks and blogs on the

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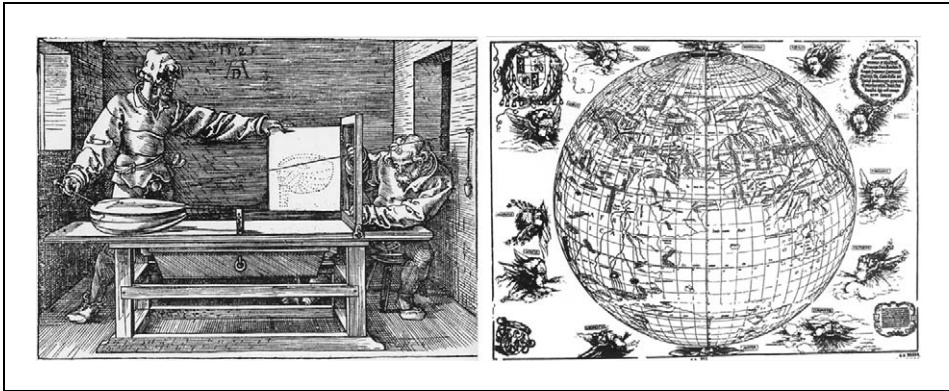


Figure 1. Dürer's 'perspective machine' and his perspectively simulated earth.

historical development of perspective. What these images show is the attempt by Dürer at the time to develop a means of automating the process by which objects could be rendered perspectively. Whilst these images are now ubiquitous with the discussion of perspectival historiography, another, equally significant image by Dürer is less commonly cited.

Ten years earlier in 1513, Dürer had also worked with the cartographer and mathematician Johannes Stabius to render a perspectival representation of the earth. Although these two sets of images are not discussed in relation to each other, their juxtaposition reveals a suggestive historical insight when considered in relation to contemporary computer-generated imaging (CGI). Whilst we can see in Dürer's 'perspective machine' the desire to find a means of automating the perspectival rendering of physical objects, in his earth image this process was reversed. Denied a physical object to easily render with one of his devices (the earth being somewhat too large to fit), Dürer instead relied upon mathematical cartographic simulation. Projecting a line-drawn map of continents onto a spherical object, Dürer and Stabius' work can be seen as a Renaissance precursor to contemporary computer-generated models such as Google Earth. In both cases, we have visual documents of the attempt to automate and simulate perspectival imaging. In both cases, Dürer was striving for something only made possible many hundreds of years later. As Lev Manovich has pointed out in his work on the mapping of space:

By automating perspectival imaging digital computers completed the process begun in the Renaissance. The automation became possible because perspectival drawing has always been a step by step procedure, an algorithm involving a series of steps required to project coordinates of points in 3-D space onto a plane. Before computers the steps of the algorithm were executed by human draftsmen and artists. The use of a computer allowed to execute them automatically and therefore, much more efficiently. (Manovich, 1993)

With such automation, the perspectival fabrication of an object such as the earth, which Dürer and Stabius had to painstakingly map by hand, can now be instantaneously simulated. However, the significance of this development can only be fully appreciated when it is considered in relation to the functional consequences that the development of perspective had in the first place. Relating the fabrication of space through 3D computer-generated imaging back to the Renaissance, Manovich has described a process whereby 'visual nominalism' came into existence during the 15th century. Citing William Ivins' 1939 research on perspective, Manovich argues that the invention of

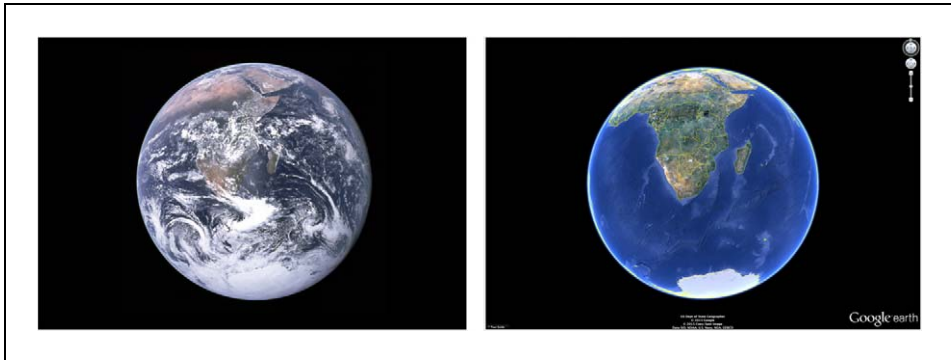


Figure 2. The *Blue Marble* photograph compared with Google Earth's default setting.

Renaissance perspective changed the relationship between material objects and representation with profound effects. Pointing out that other art historians only considered the significance and consequence of perspective for art history, Manovich notes that Ivins was concerned with visual nominalism ('the use of vision to capture the identity of individual objects and spaces by recording distances and shapes') as it impacted culture and society more broadly. The most significant impact of visual nominalism, Manovich argues, was its capacity to represent accurate and mathematically defined objects and spaces with the result that it propelled empirical science and contributed to the rise of modern engineering and manufacturing. More recently a similar argument has been made by Don Ihde (2009) in his work on what he calls 'technoscience's visualism' and the line that can be traced from Da Vinci to CAD (computer aided design).

Analysing Google Earth as a descendent of Dürer's original globe, I shall argue in this article that the contemporary rise of computer-automated visual nominalism has particular implications that are strikingly reminiscent of the historical precedent described above. If, as Manovich and others have argued, visual nominalism marked the industrialisation of visual and material culture, demonstrated as it was in the mathematically accurate rendering and distribution of object plans across Europe, then it also marked the rationalisation of the earth as one of these mathematically rendered objects. In this sense, it is no coincidence that Dürer was instrumental in trying to find a means of *both* automating perspective *and* rendering the first whole earth image with its continents mapped perspectively onto a spherical surface. Dürer's actions amounted to more than the rendering of our earth in a new manner; they marked the first time that a representation of the earth was brought within the auspices of the emergent processes of industrialisation. Dürer's image suggests that the seeds for understanding the earth as a mathematically articulated virtual construct of perspectival rendering techniques originated from the same historical root as that which Manovich identifies to be a source of industrial culture. Against this backdrop, I will address Google Earth.

My approach in this article contrasts sharply with the myriad accounts of whole earth photography that have characterised academic discourse over the past four decades. Such accounts have tended to focus upon the paradigm shifting effects of indexical, analogue whole earth representation such as the famous *Blue Marble* photograph (Figure 2) that inadvertently emerged from the space race. These accounts argue that the effect of whole earth observation, embodied in such photography, was to rewrite the relationship between humanity's social and ecological

understanding of its environment and its place in it. This relationship, described by Frank White (1998) as the 'overview effect', has been reiterated many times and a mass of popular and academic comment now exists on the social (Poole, 2008: 158), cultural (Franklin et al., 2000: 30), political (Cosgrove, 1994: 281), scientific (Lovell, 1995: 192), economic (Poole, 2008, 97–115; Redfern, 2003) and ecological (Castels, 2010: 177) effects of whole earth observation and representation.¹ Unifying almost all of these appraisals and commentaries has been the underlying narrative – generally reinforced with relevant quotes from the astronauts who took such images (Poole, 2008; White, 1998) – that seeing the earth for the first time, stripped of its cultural and political borders, allowed the image of a fragile, interconnected ecosphere to come to the fore.

However, Google Earth poses a complex set of contradictions to these narratives, not least because its existence resituates whole earth representation firmly back amongst representational forms that existed before the supposed paradigm shift of indexical photography. Considering Google Earth in light of Dürer's work, for instance, suggests that the predominant representation of the earth, both before the whole earth photograph genre and since, *has been a simulated model*. To paraphrase Manovich, indexical representation in this dynamic proves to be an anomaly in the face of generations of non-indexical rendering (Manovich, 2001: 195) and in such a context, space-based indexical photographs were a brief exception in our representations of the earth, rather than the rule. Neither entirely virtual nor entirely indexical, Google Earth operates as a machinic hybrid in which the panoptical power of satellite imaging² is combined with the simulative capacities of the product design–engineered object. It is through this combination that computer automation of perspective and the visual nominalism of Google Earth's simulated model changes the relationship between earth image and environmental imagination. Representing both the environmental feedback of satellite surveillance and the computer-automated construction of a virtual environment the machinic panopticism of Google Earth reflects a new representational politics in which the earth's ecosystems are rationalised as always already industrialised (or industrialisable). Crucially, however, it is not simply the industrialisation of data collection and data visualisation that marks this new representational politics. Rather, it is the capacity of code in contemporary computer culture to reconfigure the relationship between visualisation and action or between what Wendy Chun describes as code and its executability (Chun, 2011: 27).

In both the executability of code and the automation of visual nominalism that computer culture brings, we find the uniquely different role that Google Earth plays in representing our planet's ecology. If, as theorists of Cartesian perspective have argued,³ the shift from Byzantine iconography to Renaissance perspective marked a shift in which our visual culture transitioned from a theistically motivated order to that of a secular humanist order, with computer-generated aesthetics our visual culture is characterised by a similar transition. The claim made by theorists of the emergence of Cartesian perspective asserts that the iconographic imaging that preceded the perspectival revolution propagated a theistic world view; the logics of iconographic space communicated God's primacy to the viewer by emphasising the fact that such imagery was made for 'the greater glory of God'. By contrast, the emergence of perspectival images both provoked (and were provoked by) a social, cultural and political reorientation in Europe towards humanism; by replicating the binocular vision of the human subject, Renaissance perspective affirmed the individual (rather than God) as the centre of both the universe and the project to empirically understand the laws governing it. Renaissance perspective demonstrated to the viewer that the universe was subject to laws of physics (in this case the optics of light) that could be investigated and understood. In the contemporary context, however, the automated rendering of perspective, and the visual automobility it affords, turns the programme user from secular humanist to deified

consumer (Gurevitch, 2012). As the indexical camera of celluloid cinema has become the virtual camera of digital game space (Jones, 2007), the user has inherited control over an interface that conjures semi-simulated objects and spaces into being for their consumption alone. Hand in hand with these new circumstances, the transition to computer visualisation shaped by the ‘sorcery of source code’ (Chun, 2011) has furnished the user with seemingly omnipotent scopic capacities.

I shall argue in this article, then, that such a transition sees Google Earth and its virtual corollaries operating as ‘machinima of the visible’; representational forms that rationalise the planets eco/mineral systems and humanity’s eco/social interactions within the logic of the computer-generated simulated model. These developments have considerable implications for the way in which we approach, interact with and construe the earth as both a ‘virtual’ object and simultaneously a complex ‘physical’ entity. Notably, notions of the ‘virtual’ earth are not separate and distinct in this account from a ‘physical’ counterpart but instead are increasingly inseparable. As the simulation of the earth’s ecology continues to emerge as a central tenet of modern geosciences, and in turn, as calls for physical intervention in the environment (based upon such simulations) grow, the line between the ‘virtual’ and the ‘physical’ becomes increasingly less determinate with consequent cultural, political, philosophical and ethical implications. Such implications, alongside Google Earth’s machinic interface, are now setting the scene for both scientific discourse on the implications of geoengineering and artistic intervention into the philosophical possibilities on the horizon. This leads us, finally, to the notion of Google Earth as a machinima of the visible.

From machines to Machinima: Cartesian perspective and scopic divinity in the age of dynamic imaging

In 1971, Jean Louis Comolli wrote a seminal film essay *The Machines of the Visible*. In this work, he updated for film theory the above-mentioned claim that the development of Cartesian perspective was both a cause and a consequence of significant social and cultural change. For Comolli, this thesis could be transposed onto the cinematic apparatus. On the one hand, he argued, cinema functioned with, and in, the apparatus of representation at work in contemporary society. On the other hand, society was driven and shaped by these representations (Comolli, 1985: 121). Crucially, Comolli’s assertion was that there was a feedback loop between representation on the one hand, and social, cultural and political constitution on the other, or, as he argued, ‘if the social machine manufactures representation, it also manufactures itself from representations – the latter operative at once as means, matter and condition of sociality’ (my emphasis) (Comolli, 1985: 121).

With Comolli’s appeal to the conception of mutually constitutive representation in mind, we can turn to the idea of Google Earth as a machinima of the visible. The machinima of the visible allows us to account for the way in which the program’s interface amounts to more than a computerised renovation of either Dürer’s hand-rendered images or the whole earth genre’s indexical photography. Instead, the machinic logic of the Google Earth interface (and most other digital globe software for that matter) has implications not only for the way in which – to borrow Comolli’s now seemingly rather crude terminology – the social machine manufactures representation and manufactures itself from such representation. We might instead say that we are addressing the way in which the social machine *manufactures representations of the planet and manufactures the planet itself from such representations*.

With the concept of an industrial ecosystem already emerging as a key paradigm within a scientific community discussing geoengineering as a potential response to climate change, the Earth itself becomes both manufactured and remediated media. This is not to say that Google Earth

is the cause or the consequence of the changing ecosystemic conditions currently taking place. Rather, Google Earth is a scopic symptom of converging sets of scientific, industrial, ecological and visual cultural conditions. Through these convergent conditions, we reach the concept of Google Warming: the idea that global warming, whilst a very real physical process, is increasingly incorporated into the social and technological capacities of our culture to simulate, represent and direct the path of its future course. Notably, much of this simulation takes place within computers, research programmes and scientific discourse that itself rarely filters down to the level of public dissemination. Nevertheless, the fraction of material that Google Earth does visualise is symptomatic of Google Warming: the industrial data collection, interpretation, visualisation and representation of climate change within the auspices of an exponentially expanding computer culture.⁴ If global environmental policy is increasingly based upon scientific models dependent on the algorithmic simulations that likewise underpin new media culture, one might say that we are not only seeing the rise of media ecology but also of *ecology as media*. These conditions mark the culmination of a process started in the Renaissance and continuing to the present day where the earth's complex biological and ecological systems are rationalised under the logic of industrial vision. This is the machinima of the visible.

The conception of Google Earth's 'Google Warming' as a machinima of the visible leads us quickly to the consideration of Google Earth as a form of machinima. Defining the parameters of 'machinima', – and therefore Google Earth as machinima – is a task easier said than done, partly because the definition of machinima is itself still contested and somewhat indeterminate. Whilst the term was originally coined to describe the amalgam of 'machine cinema' content that gamers and film-makers made using virtual game spaces as sets for dramatic action, it has since been theorised as a more broadly based new medium. Henry Lowood (2007: 60) has described machinima's origins in the gaming community as a means by which players could demonstrate their skills by recording 'speed runs' through first-person shooter levels. For commentators like Jun Falkenstein, this historical origin and the deep-rooted cultural foundation that has come with it has meant that machinima as a medium is 'naturally tied hand and foot to the gaming industry' (Falkenstein, 2011: 87). For others such as Michael Nitsche, the defining characteristic of machinima is its foundation in the principle of the procedural; 'the main difference between machinima and any other CGI technique is its origin in the playable real-time image' (Nitsche, 2011: 13). Indeed, as Hugh Hancock has pointed out, the Academy of Machinima Arts and Sciences has similarly defined the medium in relation to its real-time function ('film-making within a real-time, 3D virtual environment') for half a decade. For others still, it is less the content that defines machinima than the platform through which it is made (Ito, 2011: 53). This last characterisation goes some way towards accommodating both the speed runs of machinima's origins and the narrative forms that have emerged since. All of this has led Hancock to rightly suggest that scholarship approaches machinima with an open-minded lack of determinism. In support of such a point, Hancock has compared the medium's current phase of development to the early stages of cinema (Hancock, 2011: 32).

With such varying claims for machinima's defining characteristics in mind, it might be more useful to ask *what kind of machinima Google Earth represents* rather than whether it can be considered machinima in the first place. For whilst Google Earth is not predominantly a game, its platform (to which the Google company fittingly applies the industrial-sounding moniker⁵ 'earth engine') bears enough similarities with a game engine (including a built in flight simulator) to allow it to be deployed in a machinic manner.⁶ Indeed, Google Earth now has a 'play-tour' mode that allows the user to create markers with which 'tours' can be procedurally regenerated later,⁷

whilst Google Pro has long had a moviemaker/video capture function. Regardless of in-program video capture capacities, the Google Earth interface functions according to the logic of the virtual camera common to other machinic forms and as such has been used in conjunction with third-party screen capture programmes for precisely this end.⁸

As computer culture has developed and the rendering of the 3D spaces opened up by it progressed, a wide range of film-makers and visual artists have emerged who use such computer-generated space as the locations for their virtual sets. Whilst machinima makers quickly learned the technicalities of how to use game software to make virtual movies, they also underwent a transition in their subjective positioning, beginning as players before discovering that they could operate as actor, director or even as a camera itself.

In his analysis of the virtual camera, Mike Jones argues that the virtual camera changes our relationship to simulated space and our conception of ourselves as spectatorial subjects. Digital cinematic forms, he argues, 'no longer stage for the camera but stage and compose the camera itself as a form of specific purpose scenic content' (Jones, 2007: 227). Jones goes on to argue that digital simulation no longer entertains a traditional relationship with object space, and instead the camera becomes a thing that is composed for the space rather than the other way round. This is crucial to our understanding of Google Earth and its functional construction of the user and marks a considerably changed image form from the indexically based whole earth genre. For where the whole earth genre represented the ultimate 'composing of space' in the capture of the earth image, the digital globe 'composes the camera' and therefore the viewer. The difference is that in the former the earth existed independently of the composition and capture of its image, in the latter the simulated earth exists as a by-product of the parameters dictated by the spatial specifics of the camera. This brings us to the heart of the shift; with Google Earth, the earth has been fabricated as a digital object purely for the viewer. This is a profound philosophical development in which the viewer does not simply inhabit a seemingly omniscient power of scopic automobility, they also become the reason that the simulated earth exists at all. In booting up the program and commanding the visualised data into being, the contemporary user exists in a new dynamic to the visualised earth. For Jones, this development can be traced back to the change in user expectations gained through gaming and is aptly described by him as a shift 'from "eye" to "I"':

The physical camera has long been associated with the 'eye', as a simulation of the 'eye' in an alternate world (either anthropomorphically or otherwise) and in doing so is rooted to a physical and tangible exploration and depiction of space that obeys rules of physics The virtual camera, by contrast, moves beyond this into new conceptualisations of space and the viewer's connection to, or immersion in, it. Through intangibility beyond the depicted space, the virtual camera becomes a simulation of 'I' rather than 'eye'; a simulation of viewer-derived presence in space rather than an anthropomorphically based viewing apparatus. (Jones, 2007: 228)

We might summarise this dynamic as follows: For Comolli, the film camera marked the culmination of a historical desire to put 'the eye in a strictly divine place' (1985: 126), whilst for Jones, under the logic of the virtual camera, the 'eye' recedes in favour of an emphasis on place willed into being by the 'I'.⁹ Where Comolli's spectator is invited to identify with the film camera and the structure of perspectival optics that it uses to recreate the sense of human vision, the user of a machinic interface literally *becomes* the camera in the act of interfacing with a form based upon the primacy of first-person perspective. Where Comolli argued the machinic representation of perspectival space in cinema created a mutually reinforcing feedback loop in which representation

was both cause and consequence of the social structure, as we shall see, with Google Earth as machinima this relationship becomes more immediate.

In common with its new media tendency towards tailored individuation (Manovich, 2001: 51) and composite remediation (Bolter and Grusin, 2000), the newly emergent virtual earth presents the user and the scholar alike with a new audiovisual and philosophical node of interaction. However, where the virtual camera that Jones describes is wholly constituted from computer-generated space and objects, Google Earth's 'virtual' camera is not so straightforward. Instead it is an amalgam of both the computer-generated simulation and the representation of data that originated in observation of the physical realm. Consequently the images, textures and geographic models of Google Earth are constructed from physically derived data. Here then, the *Machines of the Visible* becomes the *Machinima of the Visible* and changes the user's relationship to the earth as an entity that exists in the space between the virtual and the actual; subject to change and observation at both the physical and digital level with unexpected effects.

Through this function we see a key feature of Google Warming and its capacity to hand the power of scopic and informational control over to the user. Google Earth presents an environment quite different to that of the whole earth photograph (which represented an instant captured in time). Instead Google Earth presents time and space (and therefore all subsequent temporal functions such as ecology) as dynamic; that is to say that they are not just constantly changing and moving forward *in time* but endlessly reversible and reconfigurable *across space and time*. This is Google Warming; the presentation of the earth's environment as the construction of both an industrial data collection/simulation process in which scopic regimes of the Renaissance are combined with the simulative capacities of contemporary digital media. Google Earth brings a new cut and paste logic to the representation of earth's environment; nothing is irredeemable and nothing is permanent. Instead Google Earth presents the environment as a set of constantly changing and changeable variables visualised according to parameters forever in the process of being updated according to developments in measurement and simulation. In this sense, Google Warming is the visual representation of a turning point in our culture where both science and art begin to reconfigure the planet's ecosystem functions within the logic of the computer simulation.

Machinima, mapping impulses and satellite art: The work of Google in the age of ionospheric exchange

For Comolli, the link between representation on screen and its impact upon the world was both long term and general. With Google's machinic interface, this link can be immediate and specific. Bizarrely, the best example of this immediacy has been provided in recent years by high school children and college pranksters. In 2007, a group of schoolchildren kick-started a global phenomenon after creating graffiti on their school sports field using weedkiller to make a giant phallus. What was interesting about this act was the degree to which it was reminiscent of a thought process more commonly expected of conceptual artists such as Tom Van Sant or Pierre Comte (Wilson, 2002: 264–265). Childish symbol aside, these students deployed a disarming level of conceptual sophistication in their act; rather than seeing their school sports field as the canvas for their graffiti they saw it as a means to an end. Like a scratch film animator who carves their images onto celluloid rather than the cinema screen itself, the schoolchildren graffitied their sports pitch in order to see its projection emerge on Google Earth and broadcast to the world. With this act, the schoolchildren utilized Google Earth as a truly machinic form, collapsing the boundaries between real-world geographic actuality and cartographic representation.

With their graffiti, the students offer a response to the problem posed by Lisa Parks when she considers barriers to making satellite art. Parks rightly calls for an understanding of the potential of satellite art that operates beyond the work of art in the age of mechanical reproduction. She suggests we understand such work as art ‘in the age of ionospheric exchange’ (Parks, 2007), explaining the reasons why creative output in this manner has been limited up to now:

Often imagined as distant relay towers in outer space or as top-secret mechanisms of national security, satellites lie beyond the horizon of everyday visibility. Since they are seemingly so out of reach (both physically and financially) we scarcely imagine them as part of everyday life. In part because of this, publics around the world have both been excluded from and/or remained silent within important discussions about their ongoing development and use Since the uses of satellites have historically been so heavily militarized and corporatized, we need critical and artistic strategies that imagine and suggest ways of struggling over their meanings and uses. (Parks, 2007: 207–208)

The peculiarity of the school sports ground graffiti is that it utilizes the full spectrum of military industrial technology (at once both a symbolic and a concrete form of power and authority) to broadcast such a long-standing symbol of playground puerility to fellow pupils, school authority and the global public alike. It is an act of rebellion because it utilizes the ultimate form of panoptical surveillance (the ‘panoptical lens of space photography’) that extends and restricts ‘the possibilities of what it is to be human’ (Franklin et al., 2000: 28) to the most puerile ends.

The school sports ground cases (there are now many) recall the aerial artwork created for the Gods by the Nazca people (in what is now Southern Peru) that could not be seen from ground level. In these instances, however, the scopic capacities of Google Earth allow the viewer to become the very gods that look down on their own creations. Here are the machines of the visible literalised in the machinima of the visible; the representations constitute a literal action performed upon the world for the specific reason that it will then appear behind the screen and within the computer-generated composite model. Here action is driven by representation at the same time as representation is the result of action. Here Google Earth as machinima of the visible recalls Baudrillard’s assertion that:

The territory no longer precedes the map, nor does it survive it. It is nevertheless the map that precedes the territory – precession of simulacra – that engenders the territory . . . today it is the territory whose shreds slowly rot across the extent of the map. (Baudrillard, 1995: 2)

In the case of Google Earth’s Google Warming, the shreds of the earth’s actual territory rot and subsequently emerge on the map itself (Figure 3). From schoolchildren carving graffiti with weedkiller to polar time lapses of melting icecaps, Google Earth operates as an index of social, cultural, political and environmental rot visited upon the earth’s ecosystems. In many ways, the school prankster’s weedkiller graffiti is reminiscent of far more ominous processes of ecological vandalism now taking place. If the high school graffiti was made with the intention of appearing on Google Earth, however, the ecosystem destruction now visible through virtual earth interfaces is an unexpected by-product of the program. Whilst the cancerous destruction of the planet’s lungs is most stark when hovering over the Brazilian rainforest, it was the Haiti Earthquake (2010), the Mexican Gulf Oil Spill (2010) and the Japanese Tsunami (2011) that brought the panoptical environmental capacities of Google Earth into sharp a global media focus. In the case of the Haiti Earthquake, the promotional blurb on Google’s own website proudly (and somewhat distastefully) proclaims that within ‘36 hours of the Haiti earthquake in January 2010, Google compiled, prepared, and distributed satellite imagery of Port-au-Prince for rescue organizations and news



Figure 3. (From top left to bottom right). Deforestation in Brazil; Coalfields in Tanggu Port, Tianjin, China; Gold Mine in Kalgoorlie, Australia; Salt Fields, Dampier, Australia; Tar Sands Operations, Alberta, Canada; Oil fields in Baku, Azerbaijan; SOS, Playing Field, Minamisanriku, Japan; Deepwater Oil Spill, Gulf of Mexico.

outlets. This imagery helped save hundreds of lives, and was featured prominently in news clips around the world' (Google, 2013). Similarly, within days of the Deepwater Horizon Oil spill, the Moderate-resolution Imaging Spectroradiometer satellite data were incorporated into keyhole markup language (KML) plugins that demonstrated the relative size of the oil spill in relation to users' chosen home towns and cities.¹⁰ Finally, in the Japanese earthquake in particular one instance stood out most starkly as it became a leading global news media story. Isolated in an elevated section of Minamisanriku survivors of the Tsunami-carved 'SOS' onto the playing field of their local school; a message that may have been created for passing planes and helicopters, but which quickly appeared on Google Earth and from there quickly made it to the global news media.

Earlier I argued that Dürer's attempts to simulate and render the whole earth perspectively and mathematically was an example of the first time its representation was rationalised within the logic of industrialisation. We might also say, however, that Dürer's drawing represented one of the first times that the whole earth's representation was brought within the auspices of panoptical surveillance. Whilst the image was simulated and hand drawn, it nevertheless belied the desire to see the earth as a whole and therefore from a panoptical position. Similarly, the mathematical rendering of the earth by Dürer (and more specifically his mathematical co-creator Stabius) can be seen as the 15th-century analogue of an European Space Agency (ESA) or the National Aeronautics and Space Administration (NASA) project to measure and map the earth in a new and mathematically empirical way.

Once Dürer had rendered the earth in this way, not only were its geography and topography represented but its ecology was too. Notably, the planet in Dürer's image is surrounded by personified trade winds blowing down upon the seas and continents. For many hundreds of years before and after this image, maps famously represented strange creatures and dangerous geographical/ecological features (be it trade winds or lack thereof in the doldrums, or rocks and whirlpools dangerous to seafaring travellers). This did not change with the coming of the moving image. Drawing attention to panoramic and aerial views of war-damaged landscapes in early cinema, Teresa Castro notes that early films served a panoptical function. Rather than operating according to the usual picturesque logic of the panorama, these films both mapped and visually neutralised dangerous and damaged landscapes (Castro, 2009: 12) by conveying the scale of damage inflicted upon them.¹¹ In the contemporary context, Google Earth renovates this relationship anew, its imaging an echo of the panoptical environmental monitoring so central to NASA from the outset. Google Earth and emergent earth simulation programs can be seen as ultimate attempts to map and neutralise the dangerous and damaged terrain. With the increasing prominence of global warming as a central paradigm in our culture, all of the earth becomes damaged and potentially dangerous terrain. Google Earth acts as a visualisation of a far broader mapping; not just mapping in the visual spectrum but mapping of information about the planet provided by complex spectrometers, mathematical equipment and satellite imaging technology. Like the personified trade winds rendered to warn seafarers of ecological danger, the ecological visualisations of Google Earth similarly warn the user of the damage and the changes currently underway (Figures 3 and 5).

As we saw with the school graffiti,¹² however, Google Earth's relationship with ecological representation is far more complex than its preceding media forms. On the one hand, Google Earth can represent environmental destruction in ways similar to environmental films or the documentary photographs; on the other hand, this very same interface also communicates a profound industrialisation inherent within this process of representation. With its basis in visual nominalism and the computer algorithm, Google Earth's model is bound by the same parameters that govern

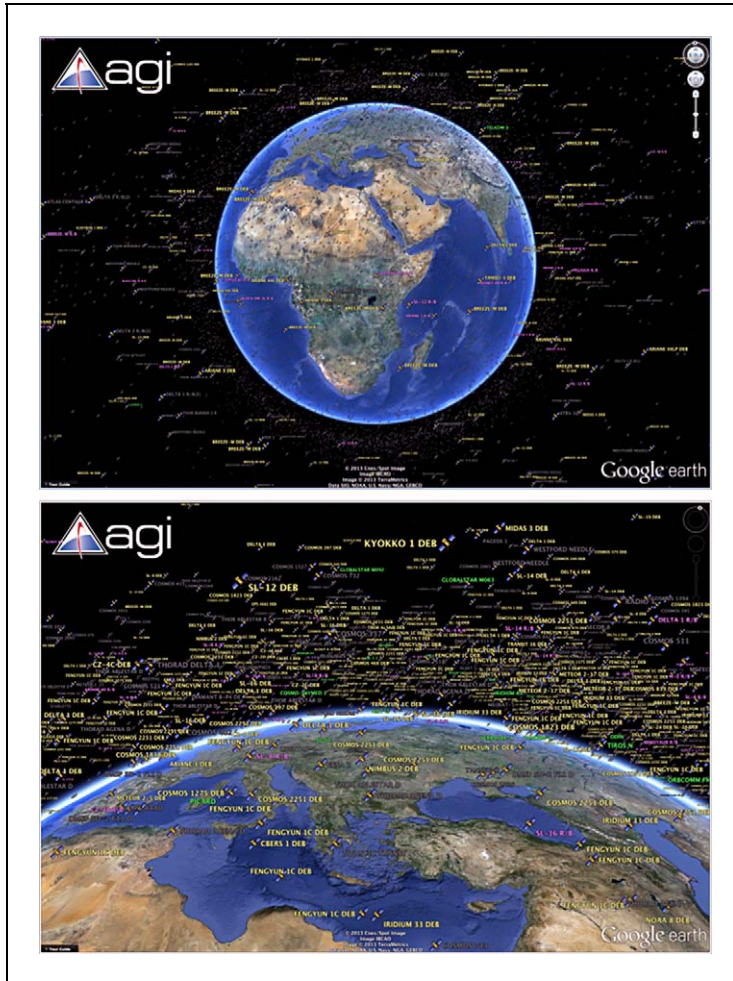


Figure 4. The 13,000 panoptical satellites in orbit around the earth are made visible in real time on Google Earth through the AGI plugin. AGI: Analytical Graphics Interface.

other areas of industrial digital culture. Like the scientific simulations of potential climate futures, Google Earth does not exist in one form in one place at one time but in many forms in many places at all times. Rather than follow the mass-mediated logic of the mechanical reproduction, Google Earth's interface follows the semi-individuated logic of digital production. This means that not only are there many Google Earths in use at any one time but that within the interface itself there are always almost infinite potential variations. This engenders a very different philosophical response than the *Blue Marble* (Figure 2) and is where the notion of geoengineering and Google Earth converges; in both cases, the Earth is envisaged as a malleable entity that can be acted upon in conjunction with, or response to, a digital simulation. This contrasts sharply with the *Blue Marble* image that engendered environmental alarm on the basis that our industrial actions were leading to unknown, unknowable and irreversible consequences. The fundamental difference in



Figure 5. (From top left to bottom right). Helmut Smith's 'Dead Pixel'; Clement Valla's 'Postcard from Google Earth'; Viennese Art Collective Gelitin's 200 ft pink rabbit discarded in the Italian Alps; Asterix and Obelix Field Art near Munich, Germany.

these image forms is ultimately the result of the role that computer code plays in facilitating both a dynamic interface and a uniquely empowered user.

When Google Earth operates as a machinima of the visible, it does so in two mutually reinforcing ways. First, the programme feeds panoptically gathered and visualised data (Figure 4) to the user about the environments they are travelling through, constituting them in specific ways (omniscient, scopically automobile, seemingly divine in their powers of influence over the physics and informatics of the space). The Google Earth user is not simply a viewer of the space or a creator of their scopic journey, they are literally placed in the position of divine manufacturer of the very environments they wish to travel through. This is more than just a visual experience, it is a function of the dynamic interaction between data and its visualisation in the same interface. Second, the programme and its panoptical interface also feeds back into the way in which the earth is acted upon. This is not to say that Google Earth literally feeds directly back into scientific research and discourse; there are many more accurate and professional earth simulation programmes than Google Earth that do this (see Foresman, 2008; Goodchild, 2008). Nevertheless, Google Earth's capacity to place the viewer in the omniscient position that Jeremy Bentham's watchmen could have only dreamt of (Figure 4) cannot help but feed into wider public attitudes and discourses regarding the cultural object, that is, 'the earth'. Indeed, Parks (2009: 538) has already claimed that Google Earth shapes policy decisions on humanitarian matters, and it seems unlikely that the same would not be true of ecology.

If the perspectival images and the celestial points of view that accompanied Renaissance imaging bequeathed their viewers deified scopic positions, then Google Earth provides users with

an experience several orders of magnitude greater. As Margaret Wertheim has described in her study of the relationship between Renaissance structures of space and the contemporary rise of cyberspace, the striking parallels between past dreams of omniscience and today's networked and data-based digital equivalent is more than coincidental but marks a historical continuum. Wertheim inadvertently demonstrates this deep-seated cultural association between structures of knowledge, deified scopic capacity and the perception of landscape when she argues that, in contemporary online informatics, 'the fantasy of omniscience shimmers over the digital horizon' (Wertheim, 1999: 28). Wertheim's deployment of a visual metaphor to describe increased access to data is particularly apt when thinking about Google Earth; nothing could better describe the intertwined function of information and data 'omniscience' that is acted out in the representational structure of the digital globe. Data omniscience is literally played out on its 'digital horizon'. Equally, in a peculiarity made striking with hindsight, it seems that contemporary computational simulation of the earth marks a historical circularity; Ellie Dekker has argued that early Renaissance globes, in their capacity to help users quickly calculate geolocated data such as relative local times in different places can be regarded to have served as some of the first analog computers (Dekker, 2007: 150).

Wertheim is not the only person to link notions of scopic and spatial omniscience to the data processes that underpin computer culture, however. In her study of source code in contemporary culture and its fetishised status as a function of programming 'sorcery', Wendy Hui Kyong Chun argues that the coder has taken on the cultural position of an omnipotent creator in the popular imagination. Quoting Massachusetts Institute of Technology professor and member of the Artificial Intelligence lab, Joseph Weizenbaum, Chun uncovers a distinctly theological theme underpinning the metaphorical constructions of both the programmer and the program:

The computer programmer . . . is a creator of universes for which he alone is the lawgiver. So, of course, is the designer of any game. But universes of virtually unlimited complexity can be created in the form of computer programs. Moreover, and this is a crucial point, systems so formulated and elaborated act out their programmed scripts. They compliantly obey their laws and vividly exhibit their obedient behaviour. No playwright, no stage director, no emperor, however powerful, has ever exercised such absolute authority to arrange a stage or field of battle and to command such unswervingly dutiful actors or troops. (Chun, 2011: 47)

Both Chun and Weizenbaum refer here to the programmer rather than the program but the point still stands; if the programmer is the creator of universes and lawgiver, so too the user of a program inherits some of these apparent powers.¹³ To contextualise in relation to Google Earth; its interface encourages its user to operate in a limited sense as a programmer. Through KML plugins, the user can select new and different data sets that translate visually into different environmental skins. Through these skins, users can raise and lower sea levels, slow down, speed-up and even reverse time, change ocean temperature, insert visualisations of historical data or manipulate any other environmental variable that has been observed and programmed into a layer. Whilst the possibilities are not endless (unless the user chooses to programme new data sets in KML themselves), they are so numerous as to hand the user a near infinite range of 'law-giving' capacities with which to set and change the parameters of the simulated earth.

Weizenbaum's reference to the programmer as more powerful than the playwright, stage director or emperor is of particularly apt relevance when we recall Marshal McLuhan's now generally forgotten claim that 'at the moment of Sputnik the planet became a global theater in which there are no spectators but only actors' (McLuhan, 1974: 50). His claim that the earth

became a form of art in this exchange is all the more fitting when we consider that Google Earth's machinic interface realises McLuhan's metaphor in ways that he may not have expected. Whilst McLuhan noted the centrality of data in this paradigm shift, he did not discuss the omniscience inherent in the process. By contrast, Wertheim, Weizenbaum and Chun's appraisals of data culture and computer code are distinctly theistic in their descriptions and metaphors. As Chun states of the coder, in a biblical reference that points towards the digital earth's cultural foundation in the relationship between panoptical data and religious metaphor: 'as a lawgiver more powerful than a playwright or emperor, the programmer can say "let there be light" and there is light' (Chun, 2011: 47). Here then, the opening lines of the bible, with its explicit reference to God's capacity to act as the panoptical viewer and omniscient creator, is conflated with the 'sorcery' of contemporary programmers. Crucially, the relationship between notions of the playwright, the stage director or even God and seemingly omniscient scopic capacities over landscape and environment ('God looked upon the face of the earth and he said let there be light' [my emphasis]) are not limited to Christian iconography. The words 'panoptical' and 'panorama' in part refer back to the Greek God of nature (Pan) at the same time as they also reference the broader use of 'pan' for 'all', 'every' and 'whole'. Similarly, the history of panoramic and panoptical sight can be traced back to ancient Greek theatre that saw natural landscapes function as the stage upon which drama unfolded below semi-circular seating carved into hillsides above (Gold and Revill, 2004: 90).¹⁴

Unsurprisingly then, artists have started to use Google Earth as a machinic canvas or theatre set (depending on how one approaches the program as a machinima of the visible). A genre of Google Earth-based machinima has emerged through which the effects of climate change are visualised and the destructive effects of anthropogenic industrialisation of the earth's surface are documented. Indeed, Google has pages ('Google Earth Outreach Showcase') dedicated to the collection of machinima surrounding climate change and wider social, ethical narratives. Here, videos narrated by environmental celebrities such as Al Gore, Jane Goodall, Steve Schneider and others feature at the same time as narrated videos of layers that users can view and explore for themselves are demonstrated. There is a whole article to be written simply on the taxonomy of these emergent machinic Google Earth videos; from shorts on the effects of global warming to more specific, localised and immediate industrial destruction such as narrated Appalachian Mountain top removal layer fly-throughs. Equally, news media organisations regularly refer to Google Earth in the event of environmental catastrophe or in envisioning potential geoengineered futures (see Gurevitch, 2013).

It is important to note here that Google Earth and the Google Corporation do not gather the data on the earth's climate itself. Rather, Google Earth functions as the representational interface through which third-party data are visualised. Consequently, and in addition to the visual structure of the interface, the ideological structure of Google Earth has implications for our understanding of Google Warming. For the effects of climate change are not only presented as dynamic and reconfigurable but also presented as the product of multiple and endlessly multiplying sources. And yet, Google Earth's function as the interface through which these different sources are funnelled have particular implications for the user's encounter with the data. The specific industrial capitalist nature of Google Earth is a case in point. As Parks (2009) has argued in relation to humanitarian crises visualised in the programme, its interface marks the application of a neo-liberal market logic to the process by which both public and private research data are rationalised as the property of the private corporation. In response to this (consciously or otherwise), artists, farmers and collectives are responding to Google Earth in ways that reflect a wider social and philosophical reconfiguration regarding the nature of the interface (Figure 5). Artists such as Helmut Smith carve 'dead

pixels' into the earth, whilst Clement Valla finds flaws in the interface to make 'postcards from Google Earth'. Similarly, a farmer near Munich in Germany grows field art images of Da Vinci's Vitruvian Man and Asterix and Obelix, whilst Viennese art collectives knit giant (200 ft) pink rabbit teddy bears and leave them 'discarded' in the Italian Alps. These interpretations step outside the boundaries of 'machinima as video output' I described earlier but do explore facets of Google Earth as a quasi-game engine commonly found in hacker and machinima culture. Valla's identification of glitches in the interface and Smith's deliberate introduction of a 'glitch' in the form of a dead pixel derive from the same philosophical origin. In both cases, the common theme is the testing of boundaries between the physicality of the earth and the inculcation of that physical reality in a less than perfect, corporately owned interface. This is environmental art in a new form and it is likely to be just the start.

Deus Ex Machinima? Law, code and deified vision

Google Earth is, then, a visual manifestation of the scientific, cultural and political rationalisation of the earth within a simulated industrial structure. With its machinic, informationally networked interface, the user is offered the earth as an engineered (or at least engineerable) object. The Google Earth program is symptomatic of a new, computer-simulated, blend-based scopic regime that now feeds into the actions that humanity performs upon the earth's environments as climate models are played and counter played over and over. Such simulations, based upon the continually growing body of panoptically observed data, are not just reflective of an ever more sophisticated scientific consensus on the earth's environmental status, they also contribute to public perception of the potential scenarios emerging for restoring its global eco-systemic balance. In this sense, Google Earth is the scopic manifestation of an emerging eco-industrial regime (Figure 6) in which the program is symptomatic of a wider representational shift in the way in which the earth is conceptualised.

We must be careful, however, in summoning a generalised constituency ('humanity') as if it is a unified actor. Rather, it is more accurate to see Google Earth as a program that gathers some of the myriad data sets and visualisations (representing multiple institutions and discourses) emerging from earth observing environmental science under the same interface. Elsewhere I have started to sketch out some of these institutions and the implications of their competing representational uses of digital earth programs for the climate change and geoengineering debate (Gurevitch, 2013), but a great deal more work is still to be done in this area.

To return, by way of conclusion, to the subject with which I opened this exploration of Google Earth, the condition of new representational capacities facilitated by visual nominalism during the Renaissance returns in the contemporary context through computer automation, calculation and simulation. The mathematically precise modelling and representation of data that propels a new expansion in science and technology recalls a similar development – described by Manovich, Ihde and others – from the 15th century onwards. This time round, however, technoscience's visualism extends beyond botanical renderings, engineering drawings or earth renderings of the Renaissance, occupying extremes of both representation and calculation previously inconceivable. From micro-scale genetic decoding and rendering to macro-scale whole earth simulation, software facilitates an expansion in our conceptualisation, quantification and representation of the physical universe. Like the Renaissance viewer positioned by a perspectival painting to engage with a new scopic regime that placed the humanist subject at the centre of the

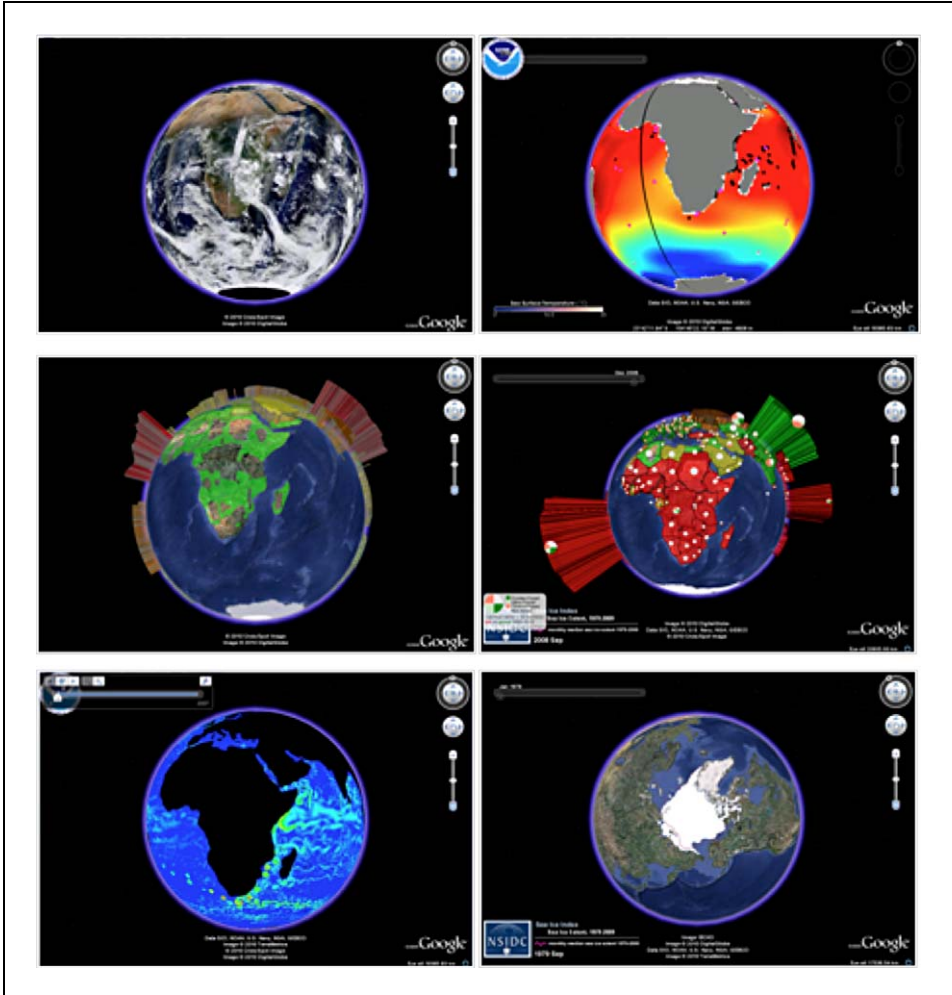


Figure 6. (From top left to bottom right). Google Earth with daily MODIS sat data mapping; ocean acidity level data; global oil consumption data; global deforestation data; global ocean temperature data; NSIDC mapping of ice melt at North Pole. MODIS: Moderate-resolution Imaging Spectroradiometer; NSIDC: National Snow and Ice Data Center.

universe, the contemporary Google Earth interface user is granted a new and extensive host of scopic powers that reconfirm the apparent primacy of our command over the world.

With this in mind, it is notable that geographic information system scientists are already mapping out scenarios in which ubiquitous computing allows for a dynamic digital earth in which users function as continual real-time ‘nervous system’ sensors (see especially De Longueville et al., 2010). One can only imagine the kinds of digital ‘nervous system’ flash mob performance artists that may emerge if these possibilities come to pass, especially in the sphere of environmental protest. Such a concept contains a curious blend of micro- and macro-visualism at the same time. More importantly, however, it sustains a conception of the earth as a *machina mundi* that has

existed for almost a thousand years (see Johannes Sacrobosco C. 1230), but this time positions humanity as the central actor in the machinery. Suggestions that the digital earth could act as a benevolent, crowdsourced, ubiquitously networked 'nervous system' are reminiscent of James Lovelock's Gaia theory (2006) except that it places a revisionist, techno-utopian gloss on a condition for which Lovelock only has alarm.

The idea that humanity is viral in nature is central to James Lovelock's work with its overarching structural belief in the biological interconnection of all earth's systems. Whilst Lovelock compares humanity and its effect in the linguistic and conceptual framework of virology, his metaphors remain strictly biological rather than cybernetic. Consequently, whilst Lovelock does not treat the question of earth observation in terms of software and computer culture, his intervention on whole earth conception is still tellingly central.¹⁵ Particularly interesting when considered in the context of earth representations that function as panoptically constituted machinima of the visible is his warning against treating geoengineering as a panacea:

In the longer term we have to understand that however benign a technological solution it may seem it [geoengineering] has the potential to set humanity on a path to the ultimate form of slavery. The more we meddle with the earth's composition and try to fix its climate, the more we take on the responsibility for keeping the Earth a fit place for life, until eventually our whole lives may be spent in drudgery doing the tasks that previously Gaia had freely done for over three billion years. This would be the worst of fates for us and reduce us to a truly miserable state, where we were forever wondering whether anyone, any nation or any international body could be trusted to regulate the climate and the atmospheric composition. (Lovelock, 2006: 152)

Here, Lovelock's suggestion that geoengineering could herald the 'ultimate slavery' of humanity left in charge of the environment 'forever wondering' what might go wrong is strikingly reminiscent of Foucault's claim that the logical conclusion of a panoptical penal system would be:

an indefinite discipline: an interrogation without end, an investigation that would be extended without limit to a meticulous and ever more analytical observation, a judgement that would at the same time be the constitution of a file that was never closed, the calculated leniency of a penalty that would be interlaced with the ruthless curiosity of an examination, a procedure that would be at the same time the permanent measure of a gap in relation to an inaccessible norm and the asymptomatic movement that strives to meet in infinity. (Foucault, 1979: 227)

We might argue, then, that Google Earth as a panoptical machinima of the visible functions simultaneously as a representation of Lovelock's fear that humanity will be endlessly entangled in the drudgery of eco-system monitoring and management, and Foucault's file that is never closed. As a representation, Google Earth manifests, in visual form, scientific and cultural processes already underway in constituting the planet. As machinima of the visible, Google Earth represents the computerisation of what Foucault refers to as the 'panoptic machine' and (as we know) what Comolli refers to as 'the machines of the visible'; an industrialised social, cultural, political and technological feedback loop sees representation and response bound together.¹⁶ The 'file that is never closed' now incorporates the capacity of the software programmer to enact code as law as Foucault's legal file becomes Chun's computer file containing the digital subroutine that determines the parameters of such law.

To maintain the broad rhetorical tone of Foucault's analysis, by becoming our own scopic gods we monitor ourselves and our environment at the same time as we must discipline ourselves

endlessly. Where, as Foucault notes, God previously brought plagues and pestilence upon us – an upset ecological balance symptomatic of God’s wrath – we now bring it upon ourselves. Where God disciplined and punished us, we must now discipline ourselves to reduce our carbon output or face the punishment that we have created for ourselves. Of course (as I suggested above), the ‘we’ here is neither a simple nor a unified entity. As a consequence, it is hard to imagine a scenario in which future debate over the severity of coming climate change will not involve disputes over differences in panoptically gathered data and the nature of code that governs consequent simulations.

Here, we finally come full circle and return to Dürer and Stabius’s original mathematically calculated earth image as progenitor of Google Earth. Whilst Dürer’s image may be treated as the initiation of earth representation into the industrial structures emergent with mathematically calculated perspectival representation, understanding the function of Google Earth as a contemporary eco-media form requires a wider cognizance of the machinima of the visible as a product of both source code and its subsequent facilitation of the data-visualisation process. This is a dynamic regime in which the boundaries between representation, simulation and reality are now porous and interactive upon each other in ways previously unimagined. This is the machinima of the visible; a virtual and actual feedback loop in which we move from media ecology to ecology as media. In recent years, earth scientists have increasingly called for the recognition of a new category of earth system era. The ‘anthropocene’ has been so labelled for the need to recognise the enormous, rapid and earth changing effect that the human race is now having upon every facet of the earth’s systems. By the same token, we might argue that we are entering a ‘mediacene’; the rationalisation of the earth’s systems under the auspices of digital media’s simulative effects (witness the mobilisation of the scientific community upon the shoulders of a computer culture processing big data to divine the severity of future climate change scenarios) in which the planet’s ecological future is role-played and counter role-played in the processors of the world’s desktops and servers, whilst the environmental present is spectacularly visualised, like an interactive disaster movie, on their screens. Welcome to Google Warming.

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Notes

1. Robert Poole and Frank White both consider this topic in very specific and focused detail. Poole argues that the origins of James Lovelock’s Gaia Theory can be approached through the viewfinder of the Apollo missions ‘*Blue Marble*’ photographs, quoting Lovelock himself who has stated that ‘When I first saw Gaia in my mind I felt as must as astronaut have done as he stood on the Moon, gazing at our home, the Earth’. Aside from this, it is worth noting that there are even now appraisals of the appraisals that have been made (Henry and Taylor, 2009).
2. It has been noted before that space-based photography is inherently panoptical (Franklin et al., 2000: 28). From the military drive into space to NASA’s subsequent mission to survey the earth and gather data on its

changing status (be it geopolitical, geological or ecological), multilayered networks of surveillance pervade Google Earth and the user's interaction with it. Indeed, both the original Central Intelligence Agency-funded company and software that Google purchased and rebranded as Google Earth was named after 'Keyhole', the US military spy satellite programme.

3. For the best overview of this debate, see Martin Jay's (1988) essay *Scopic Regimes of Modernity* in which he outlines the considerable attention that Cartesian perspective has received amongst visual scholars from Panofsky and Ivens to Richard Krautheimer, Samuel Edgerton and Michael Kubovy.
4. Please note, I choose to deploy the phrase 'climate change' here rather than the phrase 'climate variability' now more commonly deployed in earth science discourse. This is because I am not simply referring to variability in the climate but changes in the natural environment and landscape that we are actively involved in effecting.
5. This is reminiscent of the earlier 'spaceship earth' metaphor deployed by Buckminster Fuller in the 1960s: 'we can make all of humanity successful through science's world-engulfing industrial evolution provided that we are not so foolish as to continue to exhaust in a split second of astronomical history the orderly energy savings of billions of years' energy conservation aboard our Spaceship Earth. These energy savings have been put into our Spaceship's life-regeneration-guaranteeing bank account for use only in self-starter functions'. It is worth noting that whilst the notion of the earth as a space ship became popular amongst many commentators during the 1960s, it goes back as far as Henry George's 1879 book *Progress and Poverty*.
6. Indeed Google Earth is used as a plugin for games.
- 7 This is less a video capture feature than a means of directing the path of a virtual camera and saving the result as coordinates that the programme then procedurally replays when requested.
8. If we are to limit the notion of machinima only to the use of a graphics engine explicitly in conjunction with the capture of video, however, then this article will have to be considered an exploration of Google Earth as a *machinic interface* rather than *as machinima*. Understanding the notion of machinima only in relation to the graphics engine and its use for video capture, however, fails to take account of the myriad ways in which increasing numbers of users deploy and experience the virtual camera in a cinematic and machinic manner without ever necessarily recording the experience. It also presents a problematically limiting account of the relationship between 'recording' and machinima. That is to say that reducing the capture of 'machinima' only to video recording runs contrary to one of its primary principles; its basis in the procedural. If a dramatic, virtual, spatial experience is procedurally constructed and procedurally replayed in a game engine (as is the case with Google Earth's 'play tour') are we to say that this is not machinima?
9. Aside from Comolli, Michael de Certeau (1988), Margaret Wertheim (1999) and Alison Griffiths (2008) have all described the drive towards scopic divinity in visual culture: be it in 15th- and 16th-century Renaissance painting or contemporary virtual imaging. Where the Renaissance art viewer of a painting (de Certeau, 1988), the baroque ruler attending the theatre (Schivelbusch, 1995: 189–203) and the 20th century film viewer in the cinema (Comolli, 1985) were simply placed centre stage by a Cartesian perspective that constituted them as the subject of an externally generated scopic production, the 21st century user of Google Earth becomes part creator of their own scopic reality.
10. Perhaps the best example of this is Paul Rademacher's interactive demo: <http://www.paulrademacher.com/oilspill/> (accessed 1 December 2013)
11. In the contemporary context, this confluence of image form, function and subject has not waned. From Godfrey Reggio's *Koyaanisqatsi* (1982) to Ron Fricke's *Baraka* (1992), from Edward Burtynsky's epic images to Jennifer Baichwal's subsequent *Manufactured Landscapes*, the relationship between panoptical imaging and the earth's ecologically damaged and dangerous geographies remains strong. For a

- particularly good appraisal of these films and filmmaking of the earth's environments, see Martin Roberts (1998) excellent *Baraka: World Cinema and the Global Culture Industry*.
12. This kind of graffiti is now being given the term 'roofiti' in popular cultural dialogue.
 13. Indeed, Chun points out that the emergence of the graphical user interface was instrumental in 'chipping away at the boundary between user and programmer' computer programmer (2011: 61).
 14. Perhaps it is small wonder, then, that the space programme that captured much of the first whole earth photography was named 'Apollo'. For much more on this relationship between the American space programme and the social, cultural and historical relationship with European mythology, see Denis Cosgrove (1994).
 15. Ironically, however, his Gaia theory was a result of the computerization of science and culture that facilitated his research in the first place. Starting his career in NASA during the 1960s, the sophistication of Lovelock's key claim that all earth systems were fundamentally interconnected was undoubtedly facilitated by the growing complexity afforded by the arrival of computer modelling and simulation. Similarly, the data captured by Lovelock's work was the consequence of NASA's panoptical mission to survey the earth and all its changes (human, ecological and geological).
 16. Foucault hits a strikingly similar chord to Comolli's claim that the 'social machine *manufactures representation*, it also *manufactures itself from representations*' when he goes on to assert that 'we are neither in the amphitheatre, nor on the stage, but in the *panoptic machine*, invested by its *effects of power*, which we bring to ourselves since we are part of its mechanism' (my emphasis) (Foucault, 1979: 227). It is no accident that both Foucault and Comolli choose the metaphor of the machine with which to link vision, surveillance and behavioural feedback loops, rather, it is a long-running cultural trope with which the world has often been conceptualised. For more on this, see Paul Edwards excellent 2010 book *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*.

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