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Virtual Domes. Utopian architecture at the dawn of Virtual Reality*

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Abstract. This paper examines the theoretical and practical aspects of geodesic dome architecture in North America as part of an aesthetic of virtualization. Geodesic domes can be conceived of as virtual environments designed as alternatives to the contemporary world and its internal crises. They were originally a tool of the American counterculture of the 1960s to search for futuristic housing solutions which responded to ecological concerns. The contribution traces some of the most important phases of dome architecture, which crossed paths with the emerging technoculture linked to the rise of virtual reality. Indeed, the idea of the dome as a means of imagining new virtual environments, as was the case of Biosphere 2, intersects with the career of VR pioneer Jaron Lanier. Today, virtual reality technologies have merged geodesic architecture with visualization devices, as happens in the case of “virtual domes”, offering a unique way to experience virtual reality and connect with others in a shared environment.

Keywords: Virtual Reality, geodesic dome, 1960s American counterculture, virtualization.

INTRODUCTION

The paper explores some theoretical and practical trends related to geodesic dome architecture in North America, as part of an aesthetic of virtualisation. After briefly discussing the origins of recent geodesic architecture, attributed to inventor and theorist Richard Buckminster Fuller, I will outline some of the aesthetic and political dimensions of this kind of utopian – or dystopian – building. The

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main thesis is that geodesic domes are intended as worlds within worlds, like spaceships on SpaceShip Earth, to quote Buckminster Fuller's famous phrase. They form virtual environments that can be designed as alternatives to the present world and its internal social, ecological and ethical crises. In fact, dome architecture was a tool for the American counterculture of the 1960s, which gathered around revolutionary publications such as Steward Brand's *Whole Earth Catalog*: it was a futuristic housing solution that could be a response to the gentrification of the metropolis, as happened in New York City with the CHARAS action group, or a modern way of repopulating the countryside or even the desert, seeking a new sustainable and rural lifestyle (Nelson [2014]). The idea of a dome as a tool for virtualisation may have found its realisation in the Biosphere 2 experiment, which will be briefly discussed. This colossal structure, built in Arizona in the 1980s, became a self-contained world, giving tangible form to the possibility of humans living on other planets or in enclosed environments in the event of ecological collapse. Unfortunately, the Biospherians' first mission failed, making it clear that these escapist hopes are likely to remain purely "virtual" for some time to come. It is notable that the concept of the dome as a means of imagining new ways of living intersected with the career of Jaron Lanier. Lanier, who is credited with coining the term "virtual reality", built and lived in a dome during his teenage years, immersing himself in the counter-cultural values of the hippie movement that would shape his ethical and theoretical approach to the emerging technology.

Today, geodesic architecture remains an old symbol of these now extinct political movements and the imagery associated with them. However, geodesic architecture has found new life in contemporary virtual reality technologies. One example of this is "virtual domes", which incorporate these structures into a shared virtual experience. Unlike head-mounted displays, virtual domes allow users to immerse themselves in the virtual world without feeling enclosed. By fusing geodesic architecture with virtual reality technologies, vir-

tual domes offer a unique way to experience virtual reality and connect with others in a shared virtual environment.

1. GEODESICS BASICS: FROM BUCKMINSTER FULLER ARCHITECTURE TO DIY COOKBOOKS

In geometry, geodesics are curves that represent the shortest path between two points on a surface. This concept forms the basis of the geodesic dome, a lightweight hemispherical structure that is both autonomous and habitable. The father of the contemporary geodesic dome, and of much of the theoretical and practical discussion surrounding it, is undoubtedly the theorist and inventor Richard Buckminster Fuller (1895-1983). Buckminster Fuller developed his idea of geodesic architecture in an age marked by fears of ecological collapse due to overpopulation and nuclear apocalypse. He envisioned the dome as an enclosed space that could facilitate a "circular economy" of air and liquids, effectively acting as an "environmental valve".

Geodesic architecture is an intellectual enterprise that began with the project for the Dymaxion House, accompanied by the manuscript *4D Time Lock*, and culminated in the United States Pavilion at Expo 67 in Montreal, which is actually a monumental geodesic dome.

The Dymaxion House is «the most important failed architecture project of the twentieth century» (Brennan [2017]: 189), since it was never mass produced and distributed as sustainable "dwelling machine", as Buckminster Fuller had wished. Developed between 1927 and 1946, the project centred on the formulation of the Dymaxion "credo". This phrase, a fusion of "dynamic" and "maximum", describes a structure designed to achieve maximum dynamics with minimum energy. Aesthetically and ideologically, the Dymaxion House was made from the raw material of aeronautics, aluminium. The only functional Dymaxion house ever built was converted into a holiday home in Wichita and lived in for twenty years. In 1992, after a further twenty years of neglect, the struc-

ture was carefully dismantled and moved to the Henry Ford Museum in Detroit.

In Fuller's thinking, the dome would be a means of transforming existing anthropic environments into sustainable and protected systems, saving energy and resources. This tendency to find the shortest and smartest route can be traced in many of his visionary projects: the most interesting, in terms of our thesis regarding the virtualisation of dome architecture, are those that deal with the knowledge of planet Earth. In this regard, the Geoscope project (Buckminster Fuller [1982]: 161-197) represents a unique synthesis of architecture and epistemology, and can be considered a precursor to digital virtual globes such as Google Earth. Originally developed as an educational tool, akin to a planetarium, it also served as a predictive instrument. The Geoscope was intended to offer an interactive and captivating representation of the Earth, allowing users to simulate scenarios, observe long-term changes, and predict future developments using simulations, tactics, and historical data. The Geoscope would be linked to a comprehensive global database, which would transform it into an exceptional platform for increasing personal engagement and global education. It would provide an opportunity for people from all over the world to work together to experiment with solutions to global problems and develop plans to tackle the world's most intractable issues.

As we have just seen, Fuller devoted an enormous theoretical and architectural effort to providing a rich conceptual framework for this design. Indeed, the idea of a closed, autonomous, yet entropic environment in dynamic equilibrium, always in motion, seems to be central to the architect's intellectual challenge. In the architect's words, «All the system's paths must be topologically and circularly interrelated for conceptually definitive, locally transformable, polyhedral understanding to be attained in our spontaneous-ergo, most economical geodesicly structured thoughts» (Buckminster Fuller [1969]: 67).

The image of the geodesic dome is more than just a visually striking object: it represents an ideal

and a model that underpins the utopian aspirations we will explore in the following pages. In fact, according to Fuller, our planet can be seen as a spaceship – a self-contained and autonomous environment travelling through the emptiness of space. In Fuller's view, all earthlings are actually unaware that they are astronauts on “Spaceship Earth”: a constantly moving, enclosed environment that travels through space and survives thanks to energy exchanges and consumption. Buckminster Fuller's striking imagery was destined to leave a lasting mark on the counterculture of the time. Here is his fascinating description:

Spaceship Earth was so extraordinarily well invented and designed that to our knowledge humans have been on board it for two million years not even knowing that they were on board a ship. And our spaceship is so superbly designed as to be able to keep life regenerating on board despite the phenomenon, entropy, by which all local physical systems lose energy. So we have to obtain our biological life-regenerating energy from another spaceship - the sun. (Buckminster Fuller [1969]: 50)

Domes are actually planets within our planet, spaceships on Spaceship Earth, virtual worlds where we can imagine alternative ways of life. That was the focus of the do-it-yourself dome movement, which, as we shall see later, represents a convergence between the popular culture associated with the rise of VR in the United States and the revolutionary thinking of Buckminster Fuller. This movement used domes as light and sustainable ecological architectural structures, modelled on the idea of creating a self-contained environment. Domes were seen as the perfect structure for this purpose because of their lightness, flexibility and ease of construction. They offered a creative lifestyle free from conventional constraints, embodying a sustainable and self-sufficient way of living.

For instance, the New York-based community action group CHARAS provides an illustration of how dome architecture and utopian political social movements can intersect. Named after the acronym of its founders, ex-gang members in the

Lower East Side, Chino Garcia, Humberto Crespo, Angelo González Jr, Roy Battiste, Anthony Figueroa, and Sal Becker, CHARAS envisioned dome structures as a potential solution for affordable housing in disadvantaged urban areas or as an escape from the frenzied downtown lifestyle. Photographer and Buckminster Fuller's consultant Syeus Mottel documented CHARAS' journey during the five months in which they worked on the dome, from September 1972 to January 1973, collecting testimonies from members. The CHARAS experience is grounded in a holistic approach to community action in response to bureaucracy and pessimism. In James Echevarria's words «CHARAS is more of a lifestyle. [...] What I have learned down at the loft hasn't been about domes and geodesics, it's been more about people. What people can do when they feel it is their friendship that is being called on» (Mottel [1973]: 73).

The experiences offered by the do-it-yourself (DIY) dome movement would have been impossible without the efforts of those who propagated Buckminster Fuller's ideas and provided practical instructions for actually building domes. As we will see, many of these utopians played a significant role in the development of "dome thinking". They contributed greatly to the movement by sharing their knowledge, expertise, and ultimately philosophy.

DIY dome culture and utopian aesthetics are perhaps best reflected in the project of the counter-cultural magazine *Whole Earth Catalog*, founded by Stewart Brand and modelled on Buckminster Fuller's insights. This intriguing intellectual and socio-political endeavour is a sort of «internet before internet» (Cadwalladr [2013]). With a subheading that read «access to tools», it aimed to provide its readers with useful and accessible material: an instruction manual for reimagining society. The catalogue contained several types of objects, from theoretical books to dome-construction manuals, which could be useful for those who tried to pursue the dream of alternative ways of living. Especially in its first issues, it was very much shaped on Brand's personal experience: there it was in fact «virtually impossible to find an

item offered that is not intimately linked to a community to which Brand belonged, if only somewhat marginally, between 1960 and 1968» (Turner [2006]: 82).

Its holistic, and also geodesic, character was made patent by its covers, which were almost always photographs of the Earth seen from Space. From a theoretical point of view, this image and its imagery in a way merged with dome philosophy, transforming these structures into "lifeboats", rather than spaceships. This convergence has been recently clarified by Douglas Murphy in his book about contemporary utopian architecture. As he explains, «Throughout the era, again and again the notion of the spherical environment, the dome or the bubble, came to represent the new-found sense of the earth as a small, vulnerable globe in the vastness of space, and the quest, for some, was to expand that protective interior zone to encompass ever-greater aspects of life» (Murphy [2022]: 2). Its influence on what would become the Silicon Valley community (Markoff [2022]: 3-4) is evident in the famous quote «Stay Hungry. Stay Foolish», which became Steve Jobs' motto in his influential Stanford commencement speech, but which originally appeared on the back cover of the 1974 issue of the catalogue, with a photograph of dawn seen from space and a Wild West landscape promising adventure and discovery (Brand [1974]: 3). In Jobs' words, *The Whole Earth Catalog* «was sort of like Google in paperback form, 35 years before Google came along: it was idealistic, and overflowing with neat tools and great notions» (Jobs [2005]). Contributors to the *Whole Earth Catalog* focused primarily on developing tools and technologies for sustainable living, rather than engaging in the political and protest strategies of the New Left. However, the *Whole Earth* community embraced a wide range of values, including both liberal and conservative perspectives. The *Whole Earth Catalog* was in fact modelled on dome culture, not only because Buckminster Fuller was a major inspiration for its founder, Stewart Brand, but also because the catalogue included numerous instructions for building domes, such as *Domebook 1 and 2* (Kahn [1970 and 1971]) and David

Kruschke's *Dome Cookbook of Geodesic Geometry* (1972). These resources were intended as practical tools for building the dome, which was seen as a small version of the earth within the earth. The dome was not only a symbol of an alternative society, but also a concrete way to build it. As we shall see, the utopian and escapist aspects of dome culture can be read as a potential form of virtual reality in the flesh, as is the case with the ambitious undertaking of Biosphere 2.

2. BIOSPHERE 2: A MODERN-DAY ARK OF GLASS AND STEEL

The curious case of Biosphere 2 is a perfect example of this dome-oriented utopian (or dystopian) framework from an ecological, architectural, theoretical and ethical point of view. Located in Oracle, Arizona, Biosphere 2 is a site where many of the tensions of dome theory and practice were brought to a critical point. As we shall see, geodesic architecture can be understood here as a virtualisation device: a technique capable of reconstructing a simulation of the world based on an elaborate network of vital exchanges between apparatuses, people, biomes, animals, insects and plants. As recently noted, «As a kind of utopian spectacle to sell a techno-optimistic future, [Biosphere 2] was engineered to draw attention to possible solutions for the coming environmental apocalypse – itself a *dystopian* spectacle» (Koch [2021]: 36).

Developed in the 1980s by Space Biospheres Ventures, with financial support from philanthropist and oil tycoon heir Ed Bass, in collaboration with the University of Arizona, Biosphere 2 is a 12,000 square meter structure that houses the largest artificial ecosystem ever built. Biosphere 2, so called to distinguish itself from Biosphere 1, the Earth², includes the technosphere, which consists of a microcity and a farm, and the “wilderness”: a rainforest, a savannah, a marsh, an ocean

and a desert. As a «miniversion of the real thing» (Gentry, Liptak [1991]: 25), it was designed as a closed and sealed environment, autonomous and sustainable, to experiment with ways for humans to survive on other planets (or on Earth in the event of ecological collapse). In 1991, expectations about its anthropological value were at their highest point: even though not perfect «just as Biosphere 1», Biosphere 2 appeared as a «modern-day ark of glass and steel» which will «teach everyone a great deal about protecting our home planet and preparing for Mars and beyond». (Gentry, Liptak [1991]: 84) Only two missions were eventually carried out: the longest was the first, where a crew of eight carefully selected Biospherians lived inside the dome complex for two years between 1991 and 1993.

The engineer and adventurer John Allen, who founded the Institute of Ecotechnics in 1973, is considered the inventor of Biosphere 2. The “mini-world” of Biosphere 2 was designed to provide the opposite of the “overview effect” experienced by the first astronauts to see the Earth from the outside: an “innerview” effect that would raise awareness of the fragile and endangered equilibrium of “Spaceship Earth”. The idea of building an enormous geodesic dome, which would replicate Planet Earth’s ecological complexity, is credited to Buckminster Fuller himself. During the Galactic Conference, organized by the Institute of Ecotechnics at *Le Marronniers* Conference Center in Provence in September 1982, Fuller said «“I didn’t think you could do it, but what you’ve proposed here does make sense.” Addressing the members of IE, Fuller continued, “If you don’t build the biosphere, who will?”» (Nelson [2018]: 12).

In fact, as architect Peter Pearce has shown, the design of Biosphere 2 can be seen as an advanced and syncretic version of Buckminster Fuller’s dome architecture. According to Pearce, Fuller «was focused on the singular-key-to-the-universe idea and I think that the dome was a manifestation of that. Whereas I have been known to say that the key the universe is a combination lock» (Allen [1991]: 62). The overall look of the structure ended up being a sort of cultural and

² The word “biosphere” was first used by the Russian sage-geologist, crystallographer and cartographer Vladimir Vernadsky [1926].

exotic mash-up «that paid homage to world architecture: barrel-vaulted space frames inspired by Babylonian forms, stepped pyramids like those of the Middle East and the Americas, and geodesic domes as a nod to the modern architectural masterpiece invented by Buckminster Fuller» (Nelson [2018]: 32).

The less scientific aspects of the enterprise provide interesting clues to our virtualisation hypothesis: for example, the Biospherians who completed the first trials in the test capsule were given nicknames such as Vertebrate X, Vertebrate Y and Vertebrate Z, as if they were to transform themselves into “avatars” of specimens of the human race – while remaining Western white Anglo-Saxons, of course. To reinforce the metaphor of Biosphere 2 as an almost virtual Eden, each biome was managed by a captain who compiled a wish list of animals to be included, following aesthetic and even childish desires: «Dr. Ghillean Prance, the captain of the rainforest, had hoped to have a monkey. But they eat too much». (Gentry, Liptak [1991]: 38). The ideology behind the project was heavily influenced by aesthetic values: beauty was a fundamental criterion in the design of the entire experience. (Gentry, Liptak [1991]: 40). The first and longest mission mentioned above is generally regarded as a failure³, although reading the enthusiastic later memoirs of Biospherian Mark Nelson [2018] it does not seem so: the crew left the biosphere malnourished and weakened by the progressive oxygen decline in the domes, which was later explained by the imbalance between photosynthesis, soil respiration, and the oxidation of concrete.

Leaving aside for the moment many of the cultural and ethical implications of this curious and

partly forgotten human endeavour, I would like to emphasise its virtualising character. As its creator, John Allen, has stated, the ultimate goal of the enterprise – which takes on a form similar to that of the starship of the same name in the Star Trek series (Murphy [2022]: 185) – was to «change the coordinates of reality» (Allen [1991]: 153). Biosphere 2 can thus be seen as part of a current of thought surrounding the emerging technology of virtual reality, particularly that developed by the computer scientist Jaron Lanier, whose path crossed several times with Biosphere 2 itself (Markoff [2022]: 294) and with dome architecture.

3. FROM JARON LANIER'S DOME TO VIRTUAL DOMES

Jaron Lanier is considered the father, or grandfather, of virtual reality as we know it today. In the late 1980s, he had a clear vision of what virtual reality would look like in the decades to come, which made him a prominent figure in the political thinking around information technology. His critical views on social media (Lanier [2018]) and artificial intelligence (Lanier [2023]) represent an important voice in a debate that today risks being silenced by a dangerous, almost religious enthusiasm. Far from being a technophobe, Lanier's clear thinking advocates a humanistic approach to shaping our relationship and ideologies towards new immersive media, since «It is impossible to work with information technology without also engaging in social engineering» (Lanier [2010]: 4). The ultimate goal is to restore the centrality of the individual, to prevent the anonymous model of Wikipedia from triumphing over the entire internet, while users' data is effectively given away for free to companies (especially social networks) that use it for profit.

Let's go back to a time before Lanier became the founder of VPL, where he started developing virtual reality technologies and data gloves. As he recalls in his atypical autobiographical memoir *The Dawn of the New Everything* (Lanier [2017a]), his intellectual path crossed the *Whole Earth Cata-*

³ The University of Arizona took over research at Biosphere 2 on 26 June 2007, saving the structure from demolition. Private donations and grants enabled the university to cover research and operating costs for three years, with the possibility of extending funding for ten years. The funding was extended, and Biosphere 2 is currently owned by the University of Arizona and involved in research projects including the study of the terrestrial water cycle, ecology, atmospheric science, soil geochemistry and climate change.

log experience, the cultural cluster that found its synthesis in the Silicon Valley movement. When Jaron was only 11, he and his father Ellery, who supported the family by writing science fiction for New York magazines, found themselves alone and impoverished after Jaron's mother died in a car accident (Lanier [2017a]: 22-32). After buying an acre of land in New Mexico and finding a job as a teacher, Ellery allowed his son to design and build their house from scratch: the beginning of a therapeutic and highly symbolic work to eventually build a geodesic dome⁴. The resulting complex merged the "traditional" DIY geodesic dome with more irregular and strange designs. In the end, Lanier's dome house was reminiscent of the Starship Enterprise from the Star Trek saga, but also of a soothing female body (Lanier [2017]: 28). The experience of spending a significant portion of his teenage years designing and living in a dome, which presented him with a multitude of technical challenges⁵, left a strong impression on Lanier. In his words: «Having grown up in such an odd environment, I found it quite a challenge to live in a normal place. I had a hard time adjusting to orthogonal walls, and normal schedules. I spent much of my thirties forcing myself to live more conventionally, without clutter» (Lanier [2017]: 32).

Interviewed by Dave Eggers about *The Dawn of the New Everything*, Lanier explained one of the possible links between the basic structure of virtual reality and the design of geodesic domes. Speaking about the geodesic dome complex he and his father built, he said that «The house was made of triangles, including geodesic domes. The computer graphics objects that one sees in VR are usually made of triangles in the same way, even though the triangles are often obscured, so there is a similarity» (Lanier [2017b]). This similarity in

⁴ Among the young Lanier's sources, he cites *Plants as Inventors* by Raoul Heinrich Francé [1920] and *Domebook 1 and 2* (Kahn [1970 and 1971]).

⁵ In this regard Lanier recalls: «About ten years later I'd meet Stewart Brand for the first time, and my first words to him were, "I grew up in a geodesic dome." His first words to me were, "Did it leak?" "Of course, it leaked!"» (Lanier [2017a]: 29).

the composition of geodesy and digital design is echoed in the concept of "geographical metaphor", which Lanier used in a widely quoted interview he gave to *Whole Earth Review* in 1989. Here is the full passage:

Virtual Reality is conceived of as an expansion of reality, the provision of alternate realities for people in mass in which to share experiences, and so the types of metaphors that come up are things like cars, travel, different countries, different cultures. For instance, you might very well have a virtual car that you ride around even though physically you're in one place. It would go through different territories in Virtual Reality so that you could get around them – or transporter booths, perhaps. So you could have geographical metaphors. There might very well evolve a new geography, let's say – a fictitious planet with new continents that you can dive into to find new realities (Lanier [1989]: 112).

Geodesic architecture can thus be seen as a flesh-and-blood "geographical metaphor" that stands for some of the potentials that virtual reality seemed to have. If we look at another prophetic early interview from 1990 in the cyberculture magazine *Mondo 2000*⁶, we find an interesting parallelism between virtual reality and architecture:

The weird thing is, if you look at modern buildings, they look like they're in Virtual Reality already. They look like they're a computer rendering, because they're all made out of pre-fab parts, they have these funny proportions that naturally come out of computer modelers that weren't designed by artists, and they have these textures that are straight from a Garould shading engine (Lanier [1990]: 48).

As Lanier argues, virtual reality and architecture, particularly geodesic architecture, have a symbiotic relationship. Lanier's appreciation of the

⁶ In the same issue there is another interesting sci-fi fantasy about domes by Nick Herbert entitled *The Proposal for a Pleasure Dome* (1990), curiously inspired by the "politics of pleasure" of Ilona Staller and her Party of Love.

utopian ideals of geodesics serves as evidence of the potential for virtualisation inherent in this cultural project. Conversely, tracing this genealogy of virtual reality space can shed light on some of its political and social implications. By understanding this historical development of virtual reality, we can gain insight into how it was intended to impact society, and culture generally.

CONCLUSION: VR AS A VIRTUAL DOME AND VICE VERSA

As we have just seen, Jaron Lanier's humanistic approach and political awareness paint a stimulating picture of some of the social and historical features of VR. Indeed, examining the cultural context of VR's emergence, at least in the United States, may prove useful in understanding some of the meanings that the virtualization process can take on. In this respect, Lanier's fascination with geodesic domes signifies more than his affiliation with the cultural movements that have shaped the cultural and technological landscape of Silicon Valley.

It has significant implications for understanding the meanings of virtual reality from both a historical and philosophical perspective. This point of view can present an idealistic, epistemological, and aesthetic interpretation of virtualization through VR. Perhaps, but it is only a hypothesis, this could provide a different framework to that offered by the monopoly of the Menlo Park company. A potential alternative to this latter is the fusion between VR and dome architecture through the creation of VR domes. These structures are an adaptation of the CAVE (Cave Automatic Virtual Environment). As VR requires 360-degree vision, the curved surface of the dome becomes the projection surface, allowing users to be positioned at the centre of the virtual environment and share it with others in real-time. Unlike VR headsets, the VR dome provides a shared experience where users are not confined to their

individual fields of view⁷. Ironically, therefore, it could be argued that the philosophical and political model of virtualization that Lanier promoted is perhaps best embodied in an environment, the virtual dome, which paradoxically resembles the precursors of virtual reality more than the head-mounted displays that he personally contributed to developing.

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⁷ For a recent example, very technologically advanced and refined in terms of design, see the DomeLab designed by Sarah Kenderdine, as part of her experimental museology proposal (Kenderdine [2019]).

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