

Google Earth: Mathematical Art Forms

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Abstract

We trace the development of Google Earth and consider various artifacts, natural and anthropogenic, ancient and modern. These artifacts are only obvious from high elevations and some have a mathematical form and artistic appeal. We also illustrate how Google Earth's high-altitude imagery can be fruitful inspiration for mathart and provide some example.

Google Earth

A new perspective for landscape painting: looking down on Earth from a satellite up there in space! Google Earth has made it possible for anyone with a computer and internet to roam the Earth like a birds or even an astronaut. For an artist like me this has become a huge new source of inspiration. Is this the revival landscape painting needs?
by EEF (<http://googleearthart.blogspot.com/>)

The progenitor to Google Earth (GE) [3], EarthViewer 3D was developed by Keyhole Inc., which was founded in 2001 in association with the Central Intelligence Agency (CIA). Google acquired EarthViewer in 2004 and renamed it Google Earth. GE was released to the public in 2005. By October 2011, one billion copies had been downloaded worldwide. GE maps comprise overlaid scenes from multiple satellite platforms that are continually updated with the aim of every scene being cloud-free and high-resolution, with no gaps.

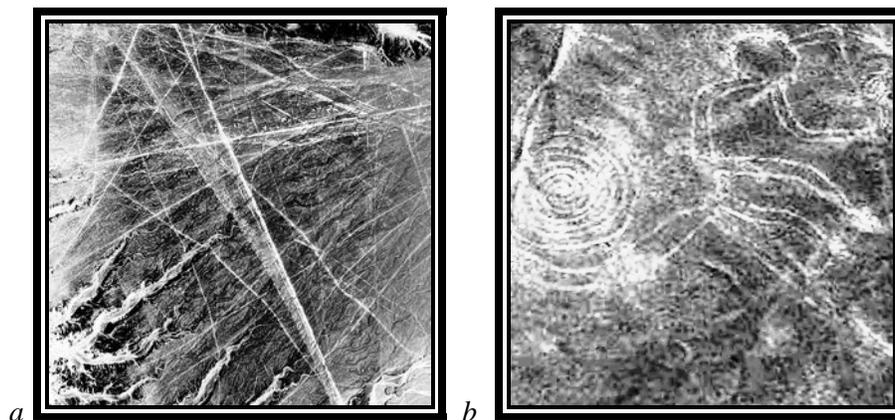


Figure 1: Nazca artifacts, Peru, captured from Google Earth and converted to high contrast: a) Lines and b) Monkey.

Keyhole Markup Language (KML) is a form of geographic annotation for displaying geo-referenced satellite scenes and map data on the GE browser. KML has since become an international standard. Users can add map pins; some with links to Wikipedia pages, photos or other information and organizations can generate entire map overlays for GE, such as roads or borders. These may be saved into KMZ files and shared with other software applications or with other users. A recent addition has been 3D models of buildings, such as skyscrapers in New York City or literally your house in the suburbs. These can be made using Google SketchUp. The GE browser allows the user to move across the Earth's surface in any direction, rotate, zoom in to see more detail, and change the viewing angle from straight down to make it appear as though the user is flying across the landscape. The browser also allows the user to select different combinations of overlay data, such as 3D buildings, weather information or ocean floor maps. GE runs on all major operating systems (Mac OS, Windows, Linux), including those for smart phones and tablet devices (IOS and Android). GE Apps allow a wide variety of functions, including GPS navigation for vehicles.

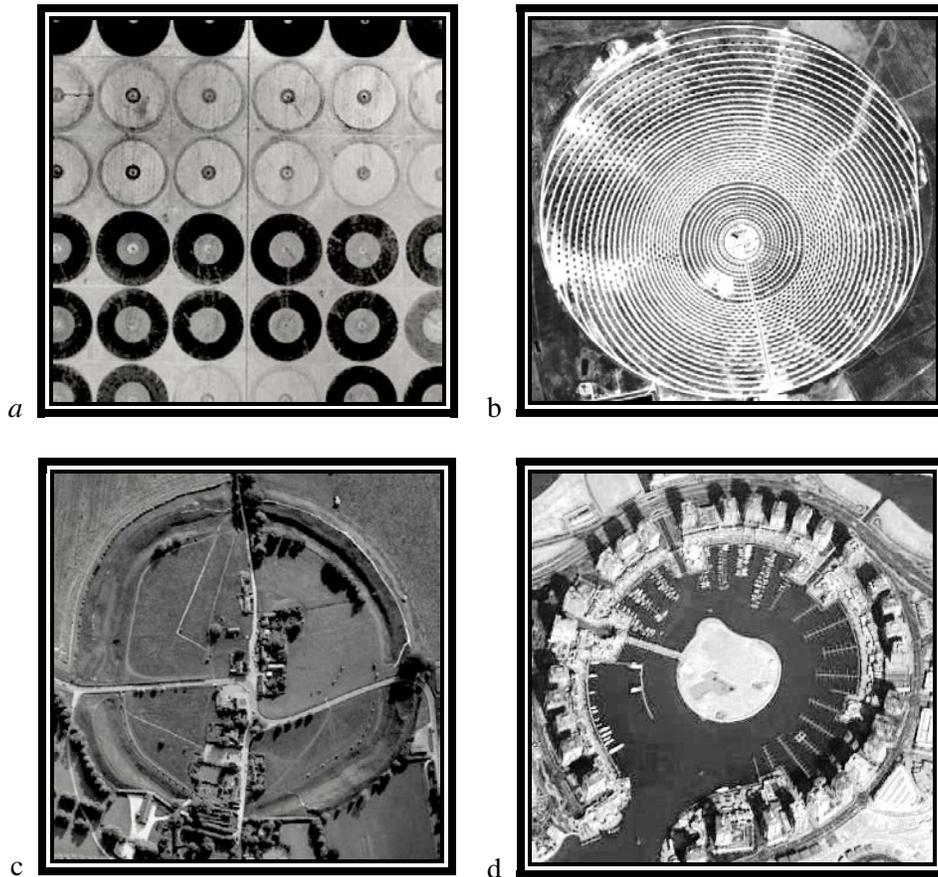


Figure 2: *Anthropogenic circular artifacts captured from Google Earth and converted to black and white by authors from: a) pivot-arm irrigation circles in Al Qassim, Kingdom of Saudi Arabia, b) Gemasolar Thermosolar Plant in Fuentesa de Andalucía in the province of Seville, Spain; c) Avebury Village Henge Stone Circle, UK; and d) The Pearl-Qatar in Doha, an artificial island.*

Development of Google Street View (GSV) began in 2007 and involved a fleet of vehicles—cars, tricycles and snowmobiles—equipped with 360-degree cameras with nine lenses, GPS and lasers driving along every street in the world, some five million miles in more than 3,000 cities and 43 countries, including the continent of Antarctica. GSV has since been integrated with GE so the user can zoom in and

navigate at ground level through streetscapes around the world. Extensions to GSV include internal views of buildings, Sea Views of coral reefs and views within Amazonian rainforests.

In the following section we report about some Google Earth artists and their various interpretations. We include some of our Google Earth artworks, creatively transformed from natural and anthropogenic images at specified Google Earth locations (Figures 1-3).

Google Earth Math Art

Exploration of the Earth's surface, using GE, reveals examples of ancient anthropogenic artifacts, such as the famous lines of the Nazca Plain in Peru (Figure 1). It remains a mystery how people of the Nazca culture made the lines between 400 and 750 AD without the aid of aircraft [4]. Crop circles are examples of modern anthropogenic artifacts viewable on GE. Aside from anthropogenic artifacts, there are many natural landscapes that may be aesthetically appealing and exhibit mathematical properties—fractal-like or geometric. Art works may be derived via transformations of GE scenes or inspire creative works.

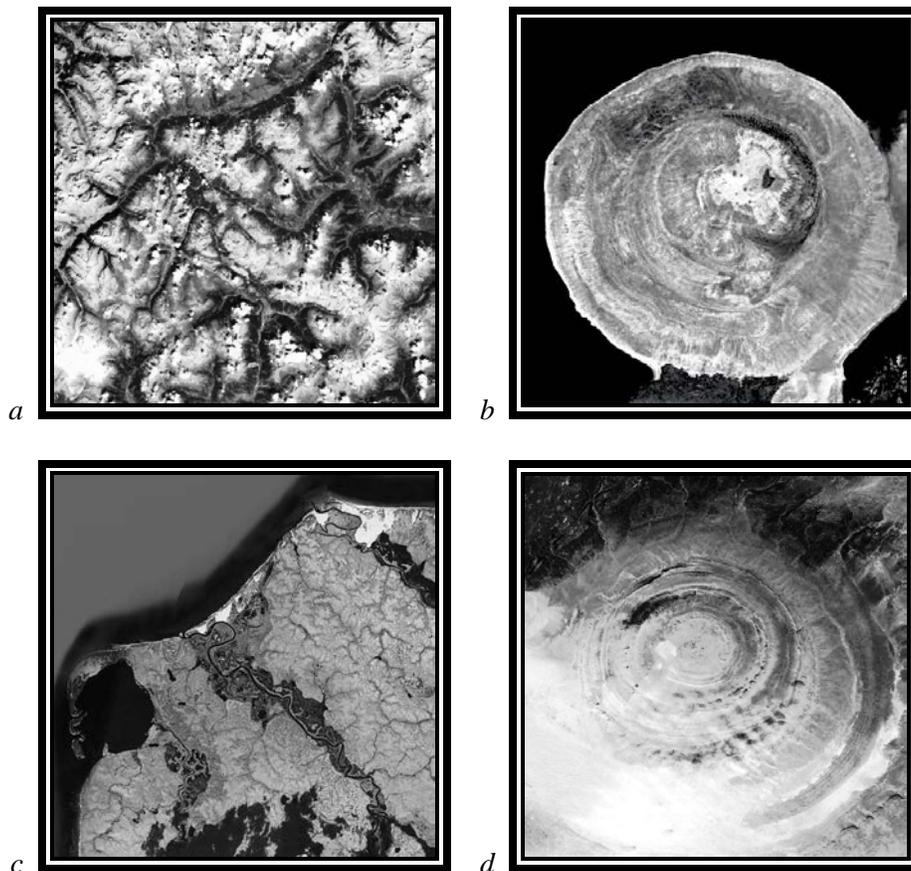


Figure 3: Natural forms captured from Google Earth and converted to high contrast: a) fractal-like form from the Swiss Alps; b) circular form of Barrier Volcano, Lake Turkana, Kenya; c) fractal-like form of an unnamed river delta $66^{\circ} 30' N$, $72^{\circ} 30' E$, Russia; d) circular Earth's Eye, Sahara Desert, Mauritania.

In the article *Street View and Beyond: Google's Influence on Photography*, Paul Moakley [2] reports his interviews with 12 artists who have been inspired by Google Maps and Google Earth and how they used the technology as part of their creative process. In the five years from a, "...revolutionary, if not a little

insane...,” idea of collecting images of the world from the street perspective, Google had accumulated tens of millions of still images from all over the planet and photographers were documenting the world while, “...simultaneously redefining the boundaries, quite literally, of contemporary art photography.”

Jon Rafman is a contemporary artist who exhibits images captured from Google Street View. His *9-Eyes* project (<http://9-eyes.com/>) captures surreal images of reality and provides an example of objective aesthetic grounded in Google Street View. Moakley [2] quotes Rafman, “There is a tension between the indifferent robotic camera, and the human gaze that sees meaning and interprets narratives in these images. That tension is the essence of the project. People often say that technology is changing our perception of the world, changing our perception of reality, but I think that the inverse is also occurring—a technology becomes successful because it taps into something fundamental about contemporary consciousness, it expresses how we are already experiencing the world.” Interdisciplinary artist, *Aram Bartholl*, explores the relationship between the digital and physical world by creating sculptural objects that represent virtual objects. His *Map* project is a public space installation that questions the red map location marker icon based the Google Maps search engine (<http://datenform.de/mapeng.html>). He is quoted by Moakley, “The map marker icon is just a 20 pixel interface on the screen, but when you switch to satellite mode and then zoom in more, it looks like it becomes part of the actual picture, casting a shadow on the city.”

Clement Valla (<http://clementvalla.com/>) explores a different aspect of Google imagery, the glitches and anomalies that have been unintentionally captured by Google Earth’s lens and documents them as illustrations of technology’s limitations. These are documented in his *Postcards* project (<http://clementvalla.com/work/postcards-from-google-earth/>). “Because, there’s kind of no archive of these particular moments or situations,” he says, “So I thought it would be interesting to take them and print them as postcards. In the Creators Project blog, *User Preferences: Tech Q&A With Google Earth Artist, Peter Root*, written by Kevin Holmes [1] describes Peter as someone who loves to, “tinker around with Google Earth”. Digital Detritus Dover is part of Root’s digital installations situated in Google Earth, was created specifically for the 2011, LIVELIVE Project Dover (<http://www.liveliveproject.com/>). *Digital Detritus Dover* was created by building 3D digital models and using KML to locate and animate them within Google Earth. An associated soundtrack was created using a well-known song about the White Cliffs of Dover.

The images presented and examples described here represent but a tiny fraction of existing GE art work, and the remaining potential for further exploration of GE artifacts. GE has untapped educational potential to engage and inspire students to learn more about the bridge between mathematics and art.

References

- [1] Holmes, K. (September 26, 2012). *User Preferences: Tech Q&A With Google Earth Artist Peter Root*. Retrived March 12, 2013 from <http://www.thecreatorsproject.com/blog/user-preferences-tech-qa-with-google-earth-artist-peter-root>.
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- [4] Silverman, H., & Browne, D. (1991). New evidence for the date of the Nazca lines. *Antiquity* 65 (247): 208–220