A hospital campus in Whittier, California, is bisected by the edge of resolution in a version of Google Los Angeles dated April 16, 2013. Image: Google Earth, © 2014 DigitalGlobe, Image Landsat. Top: The Home Depot in Glendale, California, is sheared along its northern edge in a version of Google Los Angeles dated April 16, 2013. Image: Google Earth, Data LDEO-Columbia, NSF, NOAA, Image Landsat, SIO, US Navy, NGA, GEBCO.

Erin Besler
& Ian Besler

Along the Frontier Of Resolution

The city of Google Los Angeles is brimming with images of palm trees and edged on one side by sparkling beaches. At its south end is a bustling port replete with thousands of shipping containers in an array of colors. There's a valley sprawling with single-family homes, light industrial warehouses, and car dealerships at its north end. The foothills of the Google Santa Monica Mountains divide the valley to the north from the basin to the south – not unlike the City of Los Angeles depicted in film and on television. But there's also something strange tucked into that range of foothills in Google Los Angeles. It's another kind of division. There's an edge, a frontier of resolution.

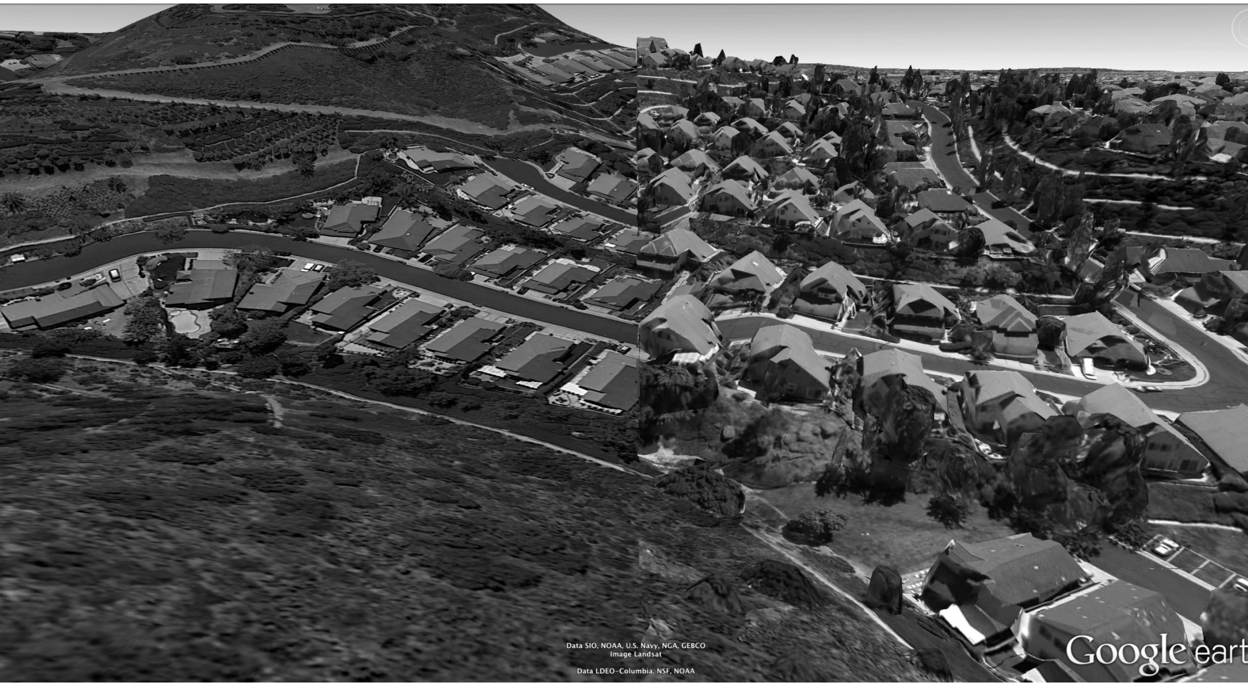
Early global sea explorations were supposedly plagued by superstitions of the looming edge of a flat Earth. A similarly unsettling edge is present in the exploration of Google Earth – a boundary between pixelated flatness and approximated form, an index of the extents of Google's latest efforts to model the entire surface of the planet. This boundary – a digital artifact that sits between image and evidence – is common to most Google cities. These edges often betray a certain impertinence. They don't always seem to recognize architectural form, caring nothing for the fabricated material edges of the built environment. In the company's 2014 rendering of Google Alhambra, east of Google Los Angeles, the edge erased roughly half of the 12-story steel-and-glass headquarters of the Los Angeles County Department of Public Works, bisecting the tower almost exactly along its diagonal. A housing development on the northeastern edge of Google Mexico City exhibits a similar cutoff. There, parked cars, driveways, backyards, and gardens disintegrate into a hillside of projected low-resolution satellite imagery.

Before the proliferation of browsing platforms for satellite images and mobile mapping applications like Google Earth, Apple Maps, and Waze, comprehensive renderings and depictions of cities were rare. They commonly consisted of a flat map published by Rand McNally or Thomas Bros. Maps, publishers of the *Thomas Guide*, once a fixture in the automobile of any serious Southern California motorist. Any other point of encounter would have been novel or privileged – say, the panoramic vista from the viewing deck of the Gateway Arch in St. Louis, the high-rise executive offices depicted in Antonioni's *Zabriskie Point*, or the Eiffel Tower in Paris. Roland Barthes touches on the implications of these relationships in his essay "The Eiffel Tower": "To perceive Paris from above is infallibly to imagine a history; from the top of the Tower, the mind finds itself dreaming of the mutation of the landscape which it has before its eyes; through the astonishment of space, it plunges into the mystery of time, lets itself be affected by a kind of spontaneous anamnesis: it is duration itself which becomes panoramic."[1]

The window seat of a passenger airliner or an adequately elevated interstate overpass would have been a more common site from which to glimpse, through the mediating frames of windshields and portholes, the city's expanses and boundaries. Otherwise, rare exhibitions like the General Motors Futurama display at the 1939 New York World's Fair, the US Army Corps of Engineers Bay Model in Sausalito, California, or The Great Train Story at the Museum of Science and Industry in Chicago afforded unique occasions to study the built environment as an abstraction. These scale models represent space differently than images, but here too a frame is always present. Whereas panoramic vistas compel one to look out, scale models invite the viewer to look in. But these are distinctions that Google would prefer not to acknowledge: "Gone are the days when the only way to get a bird's eye view of your favorite city was from the window of a penthouse apartment or helicopter. Now you can soar above the skyline by simply opening Google Earth on your desktop or mobile phone."[2]

Using Google Maps and Google Earth, hours can disappear in aimless exploration of a rendering of the city framed by a display screen. While variable, these renderings are generated from a dataset defined by characteristics of the buildings, roadways, and other pieces of the urban landscape as they existed at the moment that Google captured them. A number of tools and platforms, such as SketchUp, Building Maker, and 3D Warehouse, have been employed in Google's effort to populate its city models. Since 2012, however, these renderings have been generated through photogrammetry, a remote-sensing technique that interpolates sets of overlapping oblique images captured by low-flying aircraft and then processes them, along with satellite imagery and other geographic data, to produce a photorealistic 3-D model of the earth's surface. Zooming in from an all-encompassing view

1. Roland Barthes, "The Eiffel Tower," in *The Eiffel Tower, and Other Mythologies*, trans. Richard Howard (Berkeley: University of California Press, 1979).
2. "Showcase: 3D Imagery," Google Earth, accessed January 13, 2016, http://www.google.com/earth/explore/showcase/3dimagery.html.



An Albertsons grocery distribution center in Brea, California, is bisected by the edge of resolution in a version of Google Los Angeles dated April 16, 2013. Image: Google Earth, Image Landsat. Top: A gated community in Orange, California, called Rocking Horse Ridge Estates is bisected by the edge of resolution in a version of Google Los Angeles dated April 16, 2013. Image: Google Earth, Data SIO, NOAA, US Navy, NGA, GEBCO, Image Landsat, LDEO-Columbia, NSF, NOAA.

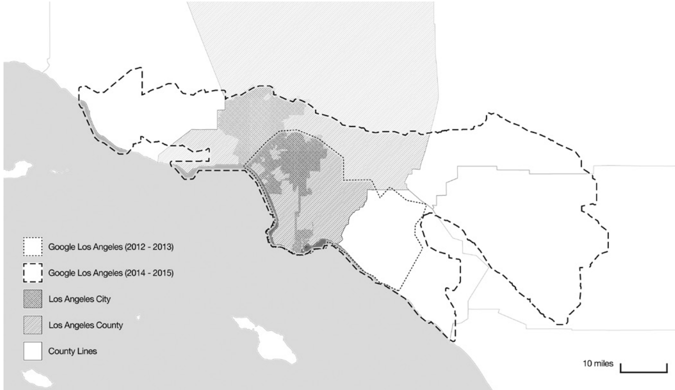
of the entire planet (roughly 40,000 miles in altitude) to an eye-level perspective view (roughly six feet in altitude) takes no more than 15 seconds. Nearly two decades after the technology to render an entire planet's surface was first demonstrated, the phrase "from the scene in front of your face to the view from outer space," coined by the creators of EDGE Whole Earth, one of the predecessor technologies to Google Earth, is still apt.[3]

The edges of Google's photogrammetric model are the frontiers at which algorithmic geomodeling ends and the handmade model is allowed a stay of execution – until Google's scanning efforts inevitably envelop the entire surface of the planet. Prior to the company's efforts to generate a comprehensive algorithmically generated 3-D model of Earth, users were able to contribute to the Google Earth project by submitting their own digital models for inclusion in the software: skyscrapers, gas stations, houses, churches, shopping malls, and trees – anything that a user deemed worthy of depiction – could find its way into the model. The last of these submissions were accepted in October 2013.[4]

This history parallels the development of computer and machine vision, or "the automation of sight," in the words of media theorist Lev Manovich.[5] Google's initial ambition to augment human labor with free, user-friendly modeling software like SketchUp and Building Maker ultimately proved a cumbersome and time-intensive means of populating virtual cities with realistic models of buildings. The "handmade" models found in previous iterations of Google Earth looked consistently realistic, both from the ground-level perspective (from which modelers were probably accustomed to encountering physical objects) and from the bird's-eye view. But many virtual cities were becoming an inconsistent patchwork of heavily modeled areas and neglected bald spots on the planet's surface. In recent versions, however, the photogrammetric mesh betrays the methods of its production – a process of extrapolating the geometry of objects from aerial photographs. When viewed in the overhead mode, the algorithmically generated city model sprawls in convincing detail (right up to the frontiers of resolution). Closer to ground level, however, it collapses into a distorted landscape of rough geometry, fuzzy pixelation, and imperfect seams that one user has compared to "a world made of melting ice cream."[6]

A video generated from Google Earth – a "tour" in the software's parlance – is not so much composed by the user as it is scripted. Unlike the "cameras" available in other 3-D

3. Autometric Incorporated, "EDGE Product Movie," Internet archive, captured January 28, 1999, https://web.archive.org/web/19990128203605/http://www.autometric.com/AUTO/PRODUCTS/EDGE/edge_movie.
4. Google Craig to "3D Modeling for Google Earth & Maps," Google forum, posted October 15, 2013, https://groups.google.com/forum/#!msg/3dwh/epXUQA2bJ2s/pw7G8E6wtZ4J.
5. Lev Manovich, "Automation of Sight: From Photography to Computer Vision," 1997, http://manovich.net/index.php/projects/automation-of-sight-from-photography-to-computer-vision.
6. Comment posted by "NitroRPG on "HR 3D models of North Adelaide in Google Earth - aero3Dpro," YouTube video, 1:19, posted by "AEROmetrex," April 18, 2013, https://youtu.be/yebsY9yhQI0.



The area of land depicted in versions of Google's digital 3-D model of Los Angeles more than quadrupled between 2012 and 2016, from roughly 953 square miles to about 4,133 square miles. Map courtesy the authors.

software platforms like Maya or Rhino, the Google Earth interfaces resist the use of a framed perspective view or movement through space as a recording device. Rather, the software provides property windows and "get info" dialogue boxes for manipulating views of a "path." Properties relating to the simulated "speed of movement" and the rendering rate of the software, among others, are defined in the "preferences" window. In promotional material and tutorials, Google presents "touring" and its Tour Builder as a beneficent tool placed in the hands of humanitarians, land-use activists, and other well-intentioned generators of narrative content.

Yet a YouTube search for "Google Earth" yields an abundance of videos exposing "strange discoveries," "crimes caught," "hidden places," and "Google Earth secrets."[7] Through rapid shifts in location, evocative soundtracks, bombastic gesticulation with cursor arrows, and provocative captions (invariably set in Arial and rife with misspellings), these videos insist that human-made disasters, elaborate conspiracies, and prehistoric symbols can be collected, constellations drawn, and rational conclusions reached through Google Earth – a powerful affordance for one piece of software. Such is the aura of objectivity that imagery generated with Google Earth possesses, despite its status as a resolutely consumer-grade tool.

Google Earth, notwithstanding the loyalties its name implies, is actually indifferent to astronomical objects. It allows users to view topographical renderings of not only Earth but also the moon and Mars via the "explore" submenu.[8] If a user is "exploring" the moon in Google Earth, any location pin, track of points, or other geographic notation saved in the software's library – regardless of the surface layer upon which it was originally based – will be casually projected, as if by default, onto that astronomical body and scaled for differences in mass and surface area. A user-defined

7. See "10 Strange Discoveries On Google Earth," YouTube video, 2:57, posted by "Alltime10s," August 9, 2011, https://youtu.be/nuiE0hc77NY; "10 Crimes Caught On Google Earth," YouTube video, 3:57, posted by "Alltime 10s," December 11, 2014, https://youtu.be/5EaZIpqIjK8; "GOOGLE EARTH Mystery Secret UFO & Hidden Places PART 1," YouTube video, 9:52, posted by "Rob Rock," August 29, 2007, https://youtu.be/U_9p2eepVQo; and "Time to Wake up Google Earth secrets," YouTube video, 6:31, posted by "Marionette 511," March 18, 2010, https://youtu.be/S8iYKvbwRxs.

8. Though "explore" is perhaps not a perfect term as it refers to carrying out computational processes.

Political borders layer projected onto the moon in Google Earth. The Apollo 11 landing site is at the center, in the Democratic Republic of the Congo. Image: Google Earth, Image NASA, USGS, JAXA, SELENE.

pin labeled "Mom's House," for instance, could appear suddenly marooned among the craters and gray boulders of the moon, or cast off even more distantly somewhere on Mars.

Plotting Earth's political boundaries onto the surface of the moon in Google Earth reveals that the Apollo 11 landing in Mare Tranquillitatis took place somewhere in the north of the lunar Democratic Republic of the Congo, roughly 34 miles southeast of the river port of lunar Bumba. Furthermore, according to the projected map, four of the six manned moon landings were located in Africa; the two others, in the Atlantic Ocean. The remapping of American moon landings across Africa and the Atlantic basin suggests the ever-expanding range of possible misuses of software affordances and appropriations of digital maps and models.

As digital representations become the predominant imagery that shapes our routine experiences and understanding of the environments around us, our capacity to influence, edit, reject, or undermine the objectivity and apparent immutability of the depiction is critical. Delineating and giving names to edges like the frontier of Google Los Angeles, or appropriating the humorless sobriety of Google Earth's rendering of Africa on the moon, opens a discussion around the embedded assumptions for all simulations and representations that might appear on our screens. It isn't so much that, as a place, Google Los Angeles is less legitimate or real than the County of Los Angeles or the lunar landing site in Google Sudan. Google Earth collapses the distinction between geopolitical or historical boundaries and the user's own contrivances.

In November 2010, perhaps the most potent example of this confusion was made apparent in media coverage of a military standoff between Nicaragua and Costa Rica. What had been a long-running border dispute was catapulted to notoriety as "The First Google Maps War."[9] The notion conveyed by much of the coverage – that a Nicaraguan commander used nothing more than "la foto satelital de Google"[10] as his justification for troop movements in contested territory – was enough to prompt Google to issue a statement clarifying the intent of its technology and asserting that the information it provides "should not be used as a reference to decide military actions between two countries."[11] Another response from the company tried to shift the blame for the cartographic blunder onto "an error in the compilation of source data" from its supplier, the US State Department.[12]

The resolutions and fidelities that Google Earth favors and neglects point to the mutability of all maps, models, territories, borders, and frontiers. The spaces that dictate the encounter, whether engineered by Google, Apple, Microsoft, governments, militaries, or open-source communities, rely on certain concessions from the user: for instance, that political borders and place names are as real as coastlines and mountain ranges. But geobrowsers and mapping applications provide interfaces, authoring tools, and means of distribution with a certain amount of influence that was previously unattainable. Who says that Apollo 11 didn't land in Google Africa? Can't you read a map?

9. Frank Jacobs, "Borderlines: The First Google Maps War," *New York Times*, February 28, 2012, http://opinionator.blogs.nytimes.com/2012/02/28/the-first-google-maps-war.
10. Estaban Mata, "Nicaragua usa 'error' en mapa de Google para justificar incursión," *La Nación* (San José, Costa Rica), November 4, 2010, http://www.nacion.com/archivo/Nicaragua-error-Google-justificar-incursion_0_1157084342.html.
11. Google statement quoted in Simon Usborne, "The man who's making Google Maps smarter," *The Independent*, November 17, 2014, http://www.independent.co.uk/life-style/gadgets-and-tech/features/the-man-whos-making-google-maps-smarter-9544478.html.
12. Charlie Hale, "Regarding the boundary between Costa Rica and Nicaragua," official blog for Google Maps, November 5, 2010, updated November 8, 2010, http://google-latlong.blogspot.com/2010/11/regarding-boundary-between-costa-rica.html.

Erin Besler and Ian Besler are cofounders of Besler & Sons, a multidisciplinary practice in Los Angeles, and teach at the University of California, Los Angeles, and the University of Southern California, respectively.