Cartography Research Project

Google Earth

Has the "Digital Earth" been achieved?

Kate Harvey S2108701

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Introduction

A little over 10 years ago, in 1998, then Vice President Al Gore presented a speech at the Californian Science Centre in Los Angeles, proposing the idea of a "*Digital Earth".* In this passionate speech Al Gore speaks of "A multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data." (Gore 1998) The following exert from that speech reveals the simple useability of that vision:

> "Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a "magic carpet ride" through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data with which she can interact. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population." (Gore 1998)

This speech paved the way for the Digital Earth initiative and spurred the collaboration and creation of several attempted Digital Earth models, of those Google Earth has by far become the most prevalent contender. Google Earth is now a tool that is freely used by millions of people, and is easily the front runner for a Digital Earth representation. It seems appropriate, now that a decade has past, to compare Al Gores' vision of a Digital Earth to the current version of Google Earth; to see to what extent it has been able to make this vision a reality, to analyse any short comings, and to look forward at the future to see if Google Earth will be able to reach the potential of Al Gores' vision of a Digital Earth.

Thoughts of a Digital Earth

Al Gore first initiated the idea of a Digital Earth some years earlier in his 1992 book, Earth in the Balance (Gore 1992). He later clarified this idea and brought it into the spotlight with his 1998 speech; following this he was able to use his power of office as Vice President to activate the "Digital Earth Initiative" (DEI). The Digital Earth Initiative began in 1998, chaired by NASA; it involved several US federal agencies and focused on interoperability, infrastructure and organisational issues (M. Craglia, M. Gould et al. 2008). This was purely a governmental project and was not yet open to public use as had been envisioned by Gore. Unfortunately in 2000, Gore lost his bid for the office of president and this saw the end of funding and influence for the DEI.

The newly elected Bush government saw Gore as an outspoken nuisance and promptly moved to bury anything that had ties to Gore; due to this all funding and resources were cut to the DEI by 2001.

Attempts at a Digital Earth

The Digital Earth Initiative saw the development of geobrowsers which allowed users to access various spatial data in a visual manner. The use of 3D maps and globes that could be manipulated with Geographic Information System (GIS) type tools; pan, zoom, displayed data such as points of interest, started to arise in the public domain. There has been a few examples of different approaches to the geobrowsers, some successful, some not. Some of the more notable contributions have been: Keyhole's *Earthviewer*, GeoFusion's *GeoPlayer*, NASA's *World Wind*, Microsoft's *Virtual Earth*, *Google Earth* and ESRI's ArcGIS *Explorer.* In Grossner's 2006 article, Is Google Earth, "Digital Earth?" – Defining a Vision, he gives a good explanation as to why Google Earth has been able to jump to the front of the queue.

"While *Google Earth* was not the first virtual globe geobrowser software, it has been easily the most successful. In June, 2006 the company claimed 100 million product activations. It has captured an enormous interest for a few key reasons: (1) it is free; (2) it is fast; (3) it has its own mark-up language (KML), which allows anyone to display and easily share their own data; and (4) it is by all accounts fun; this stems from its speed, an easy-to-use interface and its high quality imagery." (Grossner 2006)

He also comments on some of the other leading geobrowsers at the time. "The open-source *World Wind*, which has similar speed and somewhat lesser functionality, is targeted at users in the scientific community. GIS software developer ESRI has announced the release of *ArcGIS Explorer* for mid-2006—a true GIS application allowing "queries and analysis on the underlying data," something the others do not. Microsoft looms as well, promising greater functionality for their *Virtual Earth* application." (Grossner 2006) Only three years on we can see that Google Earth has far and away surpassed these other potential candidates, World Wind is unlikely to be known by many people within the public domain, and back in 2006 the launch of ESRI's ArcGIS Explorer was being predicted as the "Google Earth killer". Obviously this hasn't been the case, perhaps due to the heavy GIS content it's not seen as "fun" or as useable as Google Earth. This is a shame as it is quite likely that ESRI's application of measurable data sets within the use of ArcGIS Explorer holds the key to bridging the gap between Google Earth and Al Gore's Digital Earth vision.

Google Earth

Google Earth as we know it currently came about when Google bought out Keyhole's Earth Viewer in 2004, and launched Google Earth free to the public in June 2005. This opened up the world of geospatial information to the wider public in such a visually accessible way that it was immediately popular. "The appeal of Google Earth is the ease with which you can zoom from space right down to street level, with images that in some places are sharp enough to show individual people. Its popularity with a growing number of scientists lies in the almost-equal ease with which it lets them lay data with a spatial component on top of background imagery — a trick they can repeat with multiple data sets. By offering researchers an easy way into GIS software, Google Earth and other virtual globes are set to go beyond representing the world, and start changing it." (Butler 2006) Google Earths ever increasing popularity is mostly due to it having its own mark-up language (KML) allowing any user to publish and add data, this feature has turned what was a visually impressive geobrowser, into a global virtual community of experiences, images, models and so much more.

Google Earth has boomed, and as of August 2009, after only 4 years, it boasts more than 500 million activations, downloads would be a far greater figure, but activations giver a clearer indication of the actual number of users as it is

based on the number of new installs of the program, on a new computer. Google Earth is available in 41 languages making it globally accessible to the majority of users.

Google Earth has many layers of accessible data that can be turned off and on as required; just as you might in a GIS software package. Layers like: roads, borders and labels, places of interest, ocean data, 3D buildings and images change according to the level of elevation. Google has also eliminated the often confusing issue of scale for the general user, showing only an altitude, or elevation height.

Many of the features available within Google Earth link externally to other sites and information. Many Place markers link to external sites such as Wikipedia, YouTube, Panoramio and Google Street View. The pairing of Google Earth with Google's 3D drawing package Google Sketch up, has see the addition of 3D locations and buildings being merged into the framework, allowing any user to visually upload their business, home or favourite place, they can link this to a business website or personal home page. This opens a whole new avenue of business and advertising and this aspect of Google Earth is likely to expand rapidly as people see the opportunity for money to be made. This is already started to happen with various impressive 3D models now linking to the web sites of companies who can be hired to build professional 3D models of your location of choice. But not all data is good data and with the freedom for any user to freely upload almost anything they like into the Google earth framework, it is likely that much of it will be inaccurate, misplaced or misrepresented to a certain degree. It is possible that over time this aspect may hinder Google Earths path towards a true representation of reality. Even though most general users regard visual data to be accurate data, and probably wouldn't identify inaccuracies unless they were particularly familiar with that area, or place of interest, there is also a large community that appear to be dedicated to maintaining spatial accuracy. "More sophisticated applications are gradually appearing. One enterprising cartographer has mapped all of the places the author Jane Austen lived, the place names found in her published works, and provided photographs of the locales used in film adaptations of the novels. There are also numerous experiments with overlaying of historical maps and GIS data layers on the Google Earth globe." (Grossner 2006) There are many other examples of this type of work, some historical societies have created historical image layers to create visual timelines, or sets of places of interest, like the "Official World Heritage List" which can be toured.

Digital Earth vs. Google Earth

In his speech Gore gives a very detailed scenario of the accessible functions for a Digital Earth. His scenario revolves around the interests of a school age girl, clearly defining this vision of a digital earth to adhere to the child of 10 rule; meaning that a child of 10 years of age will be able to gain basic use and understanding of the system within 10 minutes. Gores vision was for a system that was accessible to all.

I have broken this scenario down into a list of components; I will compare each of these with Google Earth in its current version. As Gores Digital Earth is a concept or vision, it is obvious that some components are merely ideas or concepts, and will need to be logically compared to the components of Google Earth.

- Grassroots effort of thousands of individuals, companies, researchers and government organizations:
  This has been achieved with Google Earth; it is very much a growing collaboration of information from all sectors of public and private resource.

- Organic Internet-like growth:
  This has been achieved with Google Earth; due to the use of its own Keyhole mark up language, it is possible that Google Earth will continue to grow and evolve at a rapid rate.

- Government-sponsored test bed involving government, industry and academia:
  This has not been achieved by Google Earth; run by Google, it is a business and apart from it bringing forward new geospatial technologies, it isn't a test bed and isn't government sponsored, although Google Earth is used widely by government, industry and academia.

- Data from "thousands of different organizations"
  This is only partially achieved by Google Earth; the way that this was intended by Gore, was that the framework of this Digital Earth would be a collaboration of data and knowledge from thousands of different scientific, academic and government bodies. Google Earth does contain data from thousands of different organisations and individuals but not really in the organised sense that Gore envisioned.

- High-speed (10Gbps) networks
  This is not achieved by Google Earth; as technology has not hit this level of data rate transfer, and nor is it required. Google Earth runs comfortably on most modern computers with a broadband connection. The benefit of Google Earth is that it is so accessible, that it can be used on any personal computer and it isn't something that is only accessible at Museums or other "Digital Earth access points" as envisioned by Gore.

- Huge mass storage requirements:
  This is required by Google Earth; the huge amount of ever growing data and Google's seemingly constant expansion into new areas, will see the need for large data storage.

- Satellites providing imagery:
  This is achieved by Google Earth; this is the basic layer of visual data that makes up Google Earth, a mosaic of many different satellite images. Gore had imagined that this would be regularly updated to show near to current imagery, this isn't the case with Google Earth. It does update areas of imagery when old images are largely outdated, but in most areas the satellite images are several years old, this doesn't really affect the workability of the program as a whole it's still an affective visual framework.

- Public access points for highest bandwidth access, e.g. museums
  This is not achieved by Google Earth; but it isn't totally necessary either, it's probably far better that this type of Digital Earth is available to so many users in their own home, workplace or school.

- Metadata:
  This is partially achieved by Google Earth; data is available about the satellite images, when they were taken and by which satellite. For the most part, unless people who are uploading information, models or images, give credit or state source information, there really isn't much reliable metadata available.

- 3D globe:
  This is achieved by Google Earth; the 3D globe is very visually appealing, giving you a view as if from space at start up and then smoothly rotating and zooming down to your requested location. The terrain option also brings forward the 3D effect when it is turned on and you rotate your view from the standard bird's eye, this is being greatly enhanced as more and more 3D models are added to the framework.

- Zoom in, out to multiple resolutions; fly through:
  This is achieved by Google Earth; it allows you to zoom from space all the way down to street level, resolution varies globally, but accordingly, logically the resolution over New York is higher than for an area of the Gobi Desert. Fly throughs can be achieved by tilting the viewing access off the perpendicular.

- Request information:
  This is not achieved by Google Earth; there really isn't a standard for query within Google Earth, information can usually be found by following logical links. Google Earth does not have the query capabilities of a GIS.

- Control overlays, including terrain:
  This is achieved by Google Earth; there are many different layers that can be switched on or off, and people have now started to add 3D models of mountain ranges, or geographical points of interest, TIN's from ArcGIS can also be imported into Google Earth.

- Hyperlinks:
  This is achieved by Google Earth; most areas of information link through to informational web pages.

- Planned hike:
  This is achieved by Google Earth; planned hikes or journeys can be planned, Google Earth links to Google Maps which can be used to plan out trips. Screen shots can also be taken of Google Earth to produce, to some degree, an image map of an area.

- Virtual tour of museums:
  This is partially achieved by Google Earth; although as yet there is no standard of this within Google Earth, most major Museums are identified as points of interest, and these are often linked to the web site for the Museum, some of these larger Museums have virtual tours available within their sites, so although it's not exactly as Gore had envisioned it, it is available in some manner, in some cases, so it is likely that given time and advancement of technologies this can be wholly achieved.

- Personal compilations; email:
  This is achieved by Google Earth; as it is internet based it is easy to create emails, or link and send information.

- Timeline:
  This is starting to be achieved by Google Earth; there is a timeline option, and some historical societies are forming visual historical timelines by photo mosaic-ing old images.

- Generate and/or display model results, e.g. land use planning; ecological scenarios:
  This has been partially achieved by Google Earth; although it cannot generate these items, they can be uploaded and displayed within Google Earth to give a better real-world visualisation.

- Virtual reality helmet, glove:
  This has not been achieved by Google Earth; this is unnecessary, currently Google Earth provides an adequate 3D representation on screen and with so many personal users, it is unlikely that this will be something we will see in the future.

- Voice recognition:
  This has not been achieved by Google Earth; although this is possible considering there is some amount of useful voice recognition software available on the current market, it is probably excessive and unwarranted, if this is truly to be a global tool then the language and dialect variations needed to make this a smoothly operating voice recognition program is vast and ultimately expensive.

- Global " 1 meter imagery":
  This has been achieved by Google Earth; for the most part Google Earth provides high resolution imagery.

- Digital Elevation Model ("visualize terrain"):
  This has been achieved by Google Earth; the terrain mode can be turned on or off as needed.

- Land cover and land use:
  This has not been achieved by Google Earth; as a standard there isn't currently a layer that globally provides this kind of data.

- Plant and animal species' distribution:
  This has not been achieved by Google Earth; this also is more of a GIS based data set.

- Soils, climate:
  This has not been achieved by Google Earth; this also is more of a GIS based data set.

- Real-time weather:
  This has been partially achieved by Google Earth; it has a weather layer that is unreliable for real-time weather information on a global scale, locally in some areas it is regularly updated and fairly reliable, but as a whole this aspect still has a long way to go.

- Physically sensed (e.g. GLOBE):
  This has not been achieved by Google Earth; although GLOBE is still an operational scientific educational program for students, it doesn't base much of its work or findings to the benefit of Google Earth.

- Roads:
  This is achieved by Google Earth; the roads layer can be turned on or off as required. In some areas this has even moved forward into traffic conditions with overlays of different coloured lines indicating current traffic levels.

- Political boundaries:
  This is achieved by Google Earth; the boundaries layer can be turned on or off as required.

- Population:
  This has been partially achieved by Google Earth; as an information layer this has not been achieved but for most major cities it is possible to locate links that will lead you to population data.

- Newsreel footage:
  This is has not been achieved by Google Earth; although some newsreel footage may be accessible for certain points of interest or even links to YouTube, containing archived video, it isn't available as a standard on a global scale.

- Oral histories:
  This has been partially achieved by Google Earth; links to audio files are available within Google Earth and there are many historical societies that are dedicated to the presentation of accurate histories. But it is not available uniformly for every location

- Maps:
  This has been achieved by Google Earth; with direct links to Google Maps, it is easy to view maps of any particular area.

- Newspapers:
  This has not been achieved by Google Earth; it is possible in some cases to logically follow links to access current newspaper websites for a particular area, but as a whole this is not really a part of Google Earth.

As this breakdown clearly shows Google Earth in the large part has fulfilled, or is rapidly bridging the gap, of Gores vision of a Digital Earth. The areas where Google Earth fails to match up to this vision is in the areas of GIS and global uniformity.

Fulfilling a vision?

Al Gore's vision of a Digital Earth is that of a 3D globe with uniformly accessible GIS data, which is wholly usable by both child and adult. This is what stands between Google Earth and Gores Digital Earth; Google Earth, although abundant in information and resources, is not a GIS run program, it is not by any means uniform in its distribution of data and Gores idea of spatial queries (e.g. ground cover or animal species) is nonexistent. This is where we could envision the future partnership of Google with ESRI, although unlikely to happen, the ArcGIS Explorer is the closest program on the market today that makes any reasonable steps to fulfilling this GIS aspect of Gores vision. "Unlike Google Earth, the ESRI viewer comes equipped with a series of analytic tools. Scientists can run models on their servers, and simultaneously view them over the Internet in ArcGIS Explorer by dragging and dropping data files. They can fuse multiple data sources on screen, and export them in whatever format they choose." (Butler 2006) But it is most likely that a program with uniformly accessible global GIS data is a long way off or perhaps even an unobtainable goal.

Gore makes some mention towards the conclusion of his speech about the future potential of advancing technologies, in application to the Digital Earth. "Of course, further technological progress is needed to realize the full potential of the Digital Earth, especially in areas such as automatic interpretation of imagery, the fusion of data from multiple sources, and intelligent agents that could find and link information on the Web about a particular spot on the planet. But enough of the pieces are in place right now to warrant proceeding with this exciting initiative." (Gore 1998)

Interestingly this idea of intelligent acquisition, and geo-referencing of imagery, may not be such a far off reality. In a recent keynote address, the Chief Technology Advocate for Google, Michael Jones, revealed that the future marriage of Street View and Panoramio photos will make it possible for people to upload photos to the "cloud" and have photos automatically geo-tagged. How? By comparing your photo with large repositories of known photos (like Street View and Panoramio) until you find a match. (Taylor 2009)

It seems that Gore also had enough foresight to recognise the commercial possibilities that this type of system would draw. “Although some of the data for the Digital Earth would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services.” (Gore 1998) In this respect Google is a business and its true goal is to make a profit, something Google is very good at, and Google Earth is no exception to this. Currently many businesses have made use of the 3D modelling capability within Google Earth to make their business stand out amongst the rest of the terrain; these models then often click through to a business website, to generate business. As Google Earth is free, and looks to stay that way, revenue needs to be made via other channels, most often through advertising; and this is the path that Google seems to be taking. Google has already begun testing AdWords; this causes advertising to appear in the browser window within Google Earth, when you click on a point of interest, for example a Starbucks coffee shop; advertising and website information also appear within the location bubble.

Considerations

There are many considerations that need to be thought about before a fully functional digital earth system could even be implemented successfully. Some of these considerations are the biggest issue standing in the way of Google Earth ever fulfilling Gores vision.

- Privacy

  The basic right to privacy is something that most individuals hold dear; recent court cases involving citizens fighting Google's Street View are evident that some people don't wish to have images of their property accessible to anyone. Extrapolate that to incorporate anyone being able to access information about soil types and vegetation on any section of private property, and undoubtedly it will not only concern the private landholder, but a large range of businesses and even countries.

- Uniformity

  Closely related to the issue of privacy, uniformity of data is not really a reasonable goal, due to the reluctance of land holders to grant access to all areas. Even if you rule out the issue of privacy and imagine that it was possible to gather all of the required data on any location; uniformity then becomes an issue of time and resources, which can ultimately be summed up by money. How reasonable is it to collect data in extremely remote locations, the poles, desserts or the Amazon? How often would this data have to be updated? Does the general public really need, or even want, this type of data access?

- Government contributions

  To achieve a digital earth with this range of data access would have to involve, for a large part, the participation and contribution of government bodies. This seems reasonable on a local scale, but globally it becomes almost unfeasible as it would mean co-operation and information sharing between countries and governments and without world peace, it's very remote that this will be achievable.

- Copy write

  Because Google Earth allows users to use KML to upload content, it is near to impossible for Google to closely monitor copy write issues, as any user can load up any content and portray it as their own work.

Conclusion

As we pass the decade milestone since Al Gore envisioned his "Digital Earth" and brought about the birth of the geobrowser, it is more than clear that Google Earth has established itself as the closest working model on the market today.

Google Earth satisfies almost every aspect of Al Gore's vision, with the only gap really being the lack of uniformly measurable data sets; although, considering that Google Earths massive popularity mostly stems from it being a fun, free, accessible mapping product, it is likely that GIS data sets are not required by the majority of users. Advanced data on soil makeup and animal species really isn't something that the average user would be likely to use often enough to warrant Google outlaying the kind of money it would cost to collect and present this data. It would certainly mean the end of the free Geobrowser, and as we have seen earlier in this paper, it is unlikely that it is even possible to get global access to this kind of information. Currently Google Earth does, in some areas, allow users to access weather and traffic information; this is the type of data sets that users will be more likely to use and be interested in as it affects their daily lives. Google should be looking towards making this type of data uniform, reliable and frequently updated.

Another big difference between the vision and the reality is that Gore saw his digital earth as a kiosk type model that would be available at museums or leaning centres, with the availability of advanced technologies like voice recognition and data gloves. From this point of view I feel Google Earth has surpassed Gores vision, although it isn't able to be manipulated by voice recognition or data gloves, it is freely available to anyone with a computer and reasonable internet access, and really if a user has their own personal access to Google Earth, at any time, in the comfort of their home or office, do they really need this excess technology; isn't it better that this geobrowser is at the forefront of our everyday lives, available to all, than to have it slightly more advanced, but tucked away in museums and institutions?

In conclusion I think that Google Earth has fulfilled and surpassed Al Gore's vision of a digital earth, with the trade off being a lack in some technology and available data sets, for a geobrowser that is easy to use and wholly accessible. The only concern is how Google will proceed in the future, with the coming addition of advertising, and ever increasing likelihood that more and more users will see Google Earth as a way of advertising their business; will the value and potential of this geobrowser be destroyed by the need to make money.

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