Control and Freedom in Geographic Information Systems

Like the Internet, the Global Positioning System (GPS) was developed first with military applications in mind. GPS enabled a precise, autonomous, and facile location of any point on the globe. The development of this technology was critical to the broad merger of cartography with database technology and statistical analysis in the second half of the 20th century. This new science, termed Geographic Information Systems (GIS), has profoundly changed our views and interactions with physical reality at both continental and minute scales. The potential for highly detailed monitoring is exhilarating for scientists, but often terrifying for divergent or contestational voices. At the same time access to these technologies is not highly controlled, which has thrown open the door for popular participation in map creation and publishing. Through GIS and GPS, cartography has become a crucial new media for expression and critique. How we choose to map reality is a cornerstone of our consensus on what exists, has existed, or will be created in a place.

The science of cartography has always had deep implications for increased control. Creation of useable world maps in the colonial period was essential to developing global shipping routes. Better maps facilitated the massive transport of resources from less technologically developed regions to those holding the most accurate picture of the world. Among the most famous are the transfer of precious metals from Central and South America to Europe, and the middle passage of African slaves to North America. Maps have historically empowered control on much smaller scales as well. Violently enforced consensus on terrestrial boundaries is the defining ingredient enabling land ownership and regulatory extents. On the other hand, iterative improvement of maps has hugely augmented our concepts of physical reality. Without a ‘birds eye view’ our notions of Earth extend only so far as we have seen, perhaps a small area only reaching the borders of town. Without a map, all the rest is unknown, the other. Early maps highlight precisely this

erroneous notion, placing a given civilization at the center of the world and filling the unknown space with nothing [Figure 1]. In modern times we can view the entire globe, explore its topology, civic organization, and boundaries without leaving the house. This constitutes a major widening of perception for the human race.

Still, greatly enhanced apprehension of geographic space has been a hotly contested arena. A famous example is the conflict over the distortions inherent in the Mercator projection, one of the most common translations of the Earth's spheroid onto a rectangular, flat map. The choice of technique for transferring the curved surface of the earth to a flat plane can easily promote seriously erroneous conceptions – such as anchoring Great Britain as the focal point of a map or depicting Africa much smaller than it actually is. Maps are generally regarded as credible views of reality, so misrepresentation of focus or size have serious effects on attributed importance. A formal analysis, in what might be called an art critical sense, can be applied to different vantage points: the Pacific Ocean alone accounts for one third of the surface of the earth, but the Mercator projection makes this rather unobvious [Figure 2 and 3]. As map related misconceptions go, this is unfortunately only the tip of the iceberg. The conflict over 'full' and 'empty' space is one that will be familiar to indigenous and conservation activists on one side and city planners and developers on the other. To assert that it has been common for governments and industrialists to present wild or unterraformed areas as utterly vacant is not a political statement but rather a historical fact. This notion has been used to justify countless frontiers.

Map creation is actually a highly subjective practice and it is easy to manipulate the view of an area. A given space can be represented as a gray box, or perhaps only populated by a drawing of some exotic looking animal. The alternative is a detailed map showing precisely what is there, and what has been there, such as datapoints for plants, counts of animals, remarkable physical features, or historical population boundaries. Populations endemic to an area typically have their own mental maps of what exists in their space. This subjectivity, often ignored, is as much the reality of what exists as a political map of

planned neighborhoods and jurisdictions. The subjectivity inherent in map making, however, is not a completely open ended artistic endeavor. Since a map is a representation of reality, simply placing points or shapes that are not in fact present would constitute lying. Cartographical subjectivity is instead a question of focus. In a given space, there is so much that exists, and so many ways to divide up and represent the space, that it would be impossible to capture it all on one map. There are many, many foci that have been left off the maps we find at the store or on our devices; there is much more we could be seeing. The incorporation of this lost information is probably the finest aspiration of popular access to digital cartography.

On the Map

Today, it is more and more true that everything is on the map. High res aerial images are easily available to everyone with access to the internet, and GPS is a completely public resource. Because GPS works by receiving messages from a network of 24 satellites constantly transmitting location information, there is no easy way to deny GPS capability to enemies without also denying it yourself. Therefore, though the system is completely operated by the US Air Force, it is a free system open to anyone with a receiver [1]. The ubiquity of this technology means that we must re-evaluate all concepts of places and spaces that are seen as being 'off the map.' From underground music events to hole in the wall restaurants and revolutionary political groups, cultural significance has often be ascribed to constructions that are difficult to find or hidden from public sight. Today, these conceptions are no longer so valid as it's just too easy to geotag a location or view high definition cartographic details. This development can be shocking as the specter of complete and absolute surveillance looms. Nevertheless, there are many positive paths forward in this changed terrain.

Being on the map can give us the ability to place our voices within the sociopolitical milieu in new ways, and lateralize cartographic authority. What's more, through important open source and free softwares the tools to do so are remarkably accessible. Every place on the planet is unique, with its own history and perspective to share. With access to map making

and sharing tools all communities can become accessible to the world discourse rather than ignored or pushed aside by reductionist strategies that consolidate perspectives. Still, there are also severe consequences to the GPS/GIS enabled Earth. These must be considered and elucidated before any development of new expression can be celebrated.

Consequences

For the average person, the most immediate interaction with GPS and GIS systems arises from location aware computers. Smart phones, tablets, and cell phones are most commonly recognized, while location aware cars, airplanes, aerial and terrestrial drones, and RFID or facial scanning computers are less commonly discussed. The world already has a huge level of GIS instrumentation, with literally millions, and probably over a billion, location aware devices already in use [2]. A clear commercial consequence of this reality has been the arrival of a new technology called geo-fencing. Parties can easily draw a virtual 'fence' on a digital map, and receive notifications when a subscribed devices enters or leaves the circumscribed area. Accuracy can often be as detailed as 1 meter [3]. This should give us pause. We are now creating an entire virtual layer of heavily subdivided spaces, but in an invisible terrain – a vast array of unseen, triggerable barriers is upon us. This technology is already in heavy use for compliance and human resource management, enforcing disallowed areas and jurisdiction rules; while interactive billboards, changing when you are near to match your recent purchases are surely soon to follow. It will be important to remember that while, at least in the Western world, there is often a way to opt out officially, there is and will continue to be a huge incentive to skirt privacy regulations to generate valuable stores of data. There is also no reason to believe that more autocratic regimes won't jump at the opportunity to use detailed, virtual fences to strengthen hard line control or consolidate power.

More generally, clandestinely logging the history of a device's location is a huge invasion of privacy. Consider the case of a file that was discovered in 2011 on all iPhones running iOS 4 that essentially tracks a user's location for the entire history of the device. Once revealed to the public by independent researchers, Apple explained that this file didn't

specifically track the user but rather cached nearby wifi hotspots for faster geolocation. This response is probably credible, but since this file was not encrypted and since users were completely unaware, it means that a complete log of an individual's movements was made available to anyone gaining access to the device. For those living under totalitarian regimes, this situation can be quite bad. A device that tracks locations can easily destroy plausible deniability for dissidents or whistleblowers, a very negative consequence for the cause of freedom and free association.

One of the most significant outcomes of GIS technology, and yet one that gets only a small amount of airplay, is the arrival of location aware vehicles. Airplanes have used autopilot extensively for over 50 years, but self driving cars and unmanned drones are significantly newer additions. In America, the state of Nevada has already approved Google's auto driving cars for testing. Unmanned drones are also extensively in use for spying and targeted killings around the world, as well as being available to hobbyists as open source DIY kits [4]. This science fiction reality can be difficult to accept, but it is upon on us. As more and more driverless machines appear, decisions are displaced from the area of activity to a separate control room, where remotely collected statistics are crunched by powerful computers. We would be wise to consider to what extent this is desirable.

Dividing up Spaces and Places

The consequences of cartography in the information age are quite complex, and quite technical. Still, there are several difference approaches one might take in working with geo-spatial information. Each approach has its own priorities and ends, and we can build the case for positive directions by considering some loosely defined modes for map authoring.

I. Geographic

The most fundamental view of a space, the geography of an area. The location of mountains, streams, cliffs, oceans, etc. This is the least subjective layer of a map, the raw

satellite imagery and topographical information.

II. Political

Probably the first subjective layer that people come into contact with, these are the boundaries of local authorities and international sovereignty. Unlike most other layers, the political layer is ultimately enforced with a threat of violence from established states.

III. Civic

The mode of city planning, constructed space, zoning, regional statistics, and possibly agriculture.

IV. Commercial

The area of location aware advertising; proximities to commercial establishments and planned behaviors. Augmenting reality to encourage consumption.

V. Bioregional

The locations of species and their behavior patterns, along with weather, hydrology, and biogeochemistry. Regions as defined by macroecology.

VI. Subjective

How people see an area, a neighborhood, a street, a clan, a zone. How people in a place mentally subdivide their space, the aspects of a space that are in prominent focus to the endemic population.

Dividing up space, and the naming of areas and locations is fundamental to apprehending the world. A lexicon of spaces allows us to communicate about what is around us, to plan, and to make decisions. The important point is to make better decisions about what modes we use to look at the space around us. Of those presented above, the bioregional and subjective modes seem to have the most potential for working with GPS and GIS in

positive directions that enhance freedom and pluralism, while political, commercial, and civic modes at least offer the opportunity for détournement. Armed with some theory and a good basis for understanding what's at stake, we can now look into the tasks at hand.

Directions and Détournement

Creating our own maps is an incredibly powerful mode for communication, and one in which all the necessary technology already exists. By downloading the correct software along with a set of publicly available shape files (the data that describes the shapes of geographical features) anyone can choose what data to represent on a map, or collect their own data to publish. Many projects have already taken advantage of these technologies. One famous story features Chief Almir Narayamoga Surui, the first of his Amazonian tribe to attend college, who used GIS technologies to graphically show the consequences of loggers' steady encroachment on the tribe's land. The tribe used the data to pressure the government to enforce laws on environmental crimes [5]. In this way a map gives voice to dissenting views of a space, and empowers them globally. Because GIS is more pluralized than classic cartography, the endemic populations can speak of their area's map rather than those who hold the financial or military power. Because much of the technology is open source, free, or at least an open standard, we are only now at the beginning of a major contestational period in the history of maps, and a good moment for those interested in electronic media to incorporate these tools.

Map making has several components, with data collection and digitization being the most immediate skills relevant to the beginner. An important development in the last 2 years has been the work of the grassroots mapping community and the PLOTS project, which supplies tools for creating ariel maps of a given location. By simply using a weather balloon or kite, a digital camera can be used to photograph an area from the air. The images are then loaded into GIS software and geo-referenced to create an up-to-date map of an area. If the user so desires, they can then use Photoshop/GIMP style tools to draw geo-referenced shapes or notes on top of the map. These tools are significant because they remove the high cost barrier of running your own satellites or airplanes to collect ariel

maps, and allow interested parties to generate imagery they would not otherwise have access to. One of the main gains is the ability to show change over time. If you seek to show or discuss change in an area, online satellite imagery typically will not supply up to date imagery, or allow for a historical series of imagery at an interval of interest. The range of applications is huge: from the artistic (showing how an area changes due to the seasons) to human interest (historical maps of how civic areas change with development) to direct activism (before and after pictures from an ecological catastrophe). The ability to join temporal information with spatial photographs opens new terrain for unheard narratives. The key is that maps can show us aspects of reality that have been hidden, and enable us to react to this new information in more productive ways.

GPS technology also allows for specific photographs, information, or sound to be collected at precise points in time and space. Some current open source technologies, such as Ushahidi, focus on publicizing incidents during times of ecological or political crisis, while others are more invested in environmental and ecological issues. One project of particular interest to this writer is Rhus, which is being used to support an alternative view of Detroit as a city full of wild flora and fauna, rather than waste spaces in need of redevelopment [Figure 4]. These examples and many others allow individuals in a community to collect together in a distributed manner, by sending information tagged with GPS locations to a central location. This practice collects historically irrefutable evidence about what has occurred in a place, a joint effort between photojournalism and science offering public credibility to perspectives that could otherwise be quickly discarded. Distributed collection of geo-tagged photographs, pollution readings, or sound bites can tell the stories of the tenants rather than the landlord, the workers rather than the owner, or the trees instead of the sawmill. GIS facilitates this joining of narratives, and open standards allow this information to be shared publicly as a feed for anyone wanting to publish this information, provide bases for community decision making.

Despite the exciting potential of GIS tools, the fact remains that many of the most negative consequences will be unavoidable. However, for those that would offer creative critique of

these developments many new directions exist. If GIS will be used to increase control, there is little to stop divergent voices from using the same technologies to map the structures of control themselves, again loosening the grip of surveillance. If a dissident in an un-democratic country knows the points of control, their stance is that much stronger. On a less radical path, visually publishing land ownership records or city construction plans encourages the highest standards of public responsibility. In general, so called 'points of interest' on online maps tend to favor a commercial view of a given space over the social or ecological, but all that it takes to change this is an effort to place alternative kinds of locations on the map. Artistic endeavors as well have yet to deeply explore this new technological arena, as we have yet to see rigorous location aware music or interactive art. Actively discouraging the commercial mode also has a part to play: geo-fences were discussed as a form of further control, but since all the involved technologies are available to the public there is no reason one cannot geo-fence the commercial geo-fences themselves, updating a user on how to walk around them completely. Perhaps a mobile application to alert an individual that they have entered a commercial zone and supply the fastest route out. . .

The possibilities for map making range from the socially activist to the comical, but the most important work is found in remaking the way we see spaces and places. The maps that are most familiar generally depict diametric spaces: a location is either part of one area, or part of another. It is worth asking if this is always the most natural way to view reality. A more universal method might recognize that the lines between spaces are more often quite blurry, with a notion of blending being more typical than a hard and fast, unmovable line. This becomes irrefutable when an average is taken over time, as boundaries of watersheds, communities, or migratory paths fluctuate by the year. Unfortunately, many wars have been fought over precisely the areas that do not have clear, natural borders. While the geographic or subjective mode clearly indicate that a gradient would be more appropriate, the often completely artificial lines of the political mode are instead enforced by violence. A political map with gradients between sovereign states is inconceivable in our time – an almost farcical notion. Nevertheless, we might take this

opportunity, as GIS technology makes radical changes to the practice of map making and allows us to experiment with it as a public media, to consider the fluctuating, smooth or abrupt transitions of ecosystem boundaries, bioregions, and watersheds as a hint to a more grounded and complete apprehension of our world.

Appendix: Advanced Technologies

The technologies explored in this article are only a primer of emerging Geograpic Information Systems. A quick overview of other interesting items will serve those whose interest has been perked.

LiDAR

LiDAR technology uses lasers to create 3D models of physical structures with a high degree of accuracy. These models are commonly geo-referenced to topological data for scientific and disaster analysis. There is currently no working DIY technology.

Indoor GPS

GPS does not normally work indoors, as a line of site to satellites is necessary. Many companies are hard at work at making precision GPS a reality in your favorite bar.

Line of Site

Line of Site analysis uses GIS tools and elevation data to determine what can be seen from a given location. This is used in the design of parks, and to hide various things from view.

RFID

RFID chips are now in place in many passports, credit cards, and IDs as well as on great number of animals and commercial packaging. They can be passively scanned, and locations geo-tagged by various apparatus.

Appendix: Open Source and Free Tools

OSGEO : http://http://www.osgeo.org/

QGIS : http://www.qgis.org/

Open Street Map : http://www.openstreetmap.org/

Google Earth : http://www.google.com/earth/

MapKnitter : http://mapknitter.org/

PostGIS : http://www.postgis.org/

Leaflet : http://leaflet.cloudmade.com/

KML Specification : https://developers.google.com/kml/documentation/kmlreference

Endnotes:

1. http://geography.about.com/od/geographictechnology/a/gps.htm

2. http://www.bizjournals.com/seattle/blog/techflash/2012/02/a-billion-smartphones-seen-by-2016—.html

3. https://geoloqi.com/, http://urbanairship.com/

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