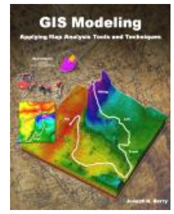
Epilog – Continuing Promise of GIS Modeling



GIS Modeling book

<*Click here*> *for a printer-friendly version of this topic (.pdf).*

(*Back to the Table of Contents*)

The Good, the Bad and the Ugly Sides of GIS

(GeoWorld, November 2013)

(return to top of Topic)

Sometimes GIS-perts imagine geotechnology as a super hero ("GIS Techymon," see figure 1) who can do anything— process data faster than a gigahertz processor, more powerful than a super computer, able to leap mounds of mapped data in a single bound and bend hundreds of polylines with a single click-and-drag—all for truth, justice and all that stuff. With the Spatial Triad for super powers (RS, GIS, GPS), the legacy of manual mapping has been all but vanquished and millions upon millions of new users (both human and robotic) rely on GIS Techymon to fill their heads and circuit boards with valuable insight into "where is what, why, so what and what if" expressions of spatial patterns and relationships.

In just few decades, vast amounts of spatial data have been collected and corralled, enabling near instantaneous access to remote sensing images, GPS navigation, interactive maps, asset management records and geo-queries as a widely-used "technological" tool. To the Gen X generation, technology is a mainstay of their lives—geotechnology is simply another highly useful expression.

A similar but much quieter GIS revolution as an "analytical" tool (see Author's Notes 1) has radically changed how foresters, farmers, and city planners manage their lands; how retail marketers, political forecasters and epidemiologists "see" spatial relationships in their data sets; how policemen, generals and political pundits develop tactics for engaging the opposition; plus thousands of other new paradigms and practices. This growing wealth of sophisticated spatial models and solutions did not exist a couple of decades ago, but now they have become indispensible and commonplace parts of contemporary culture. All is good …or is it?

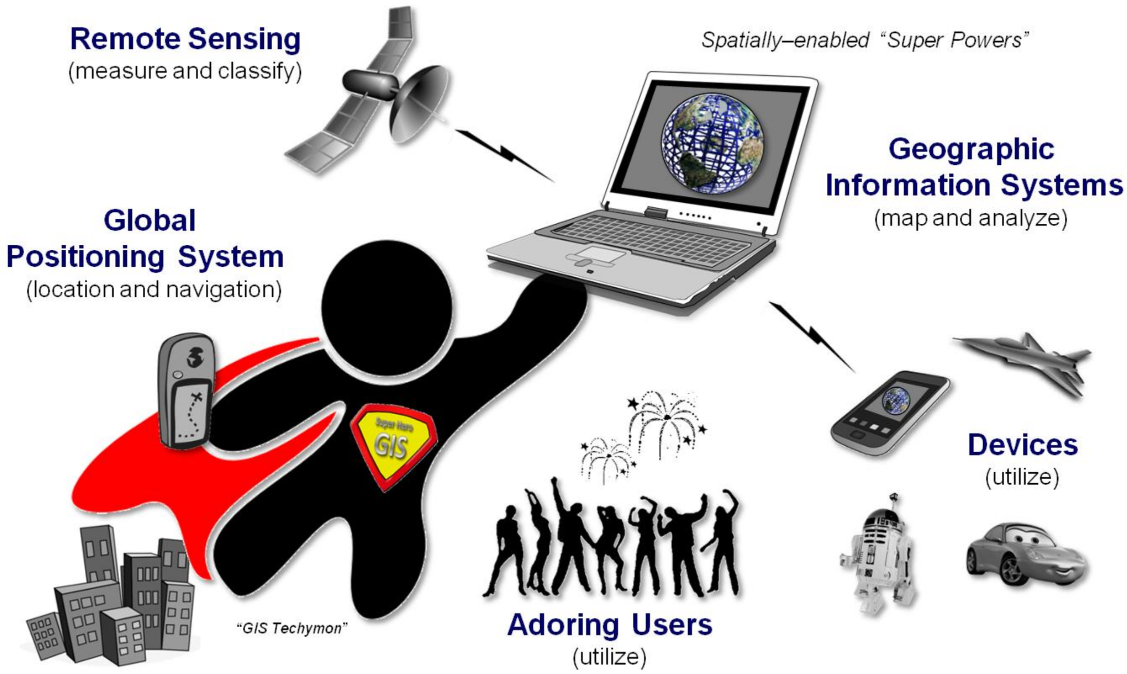


Figure 1. Look up in the data cloud, it's GIS Techymon to save the day…all is good (or is it?).

Some fail to see virtue in all things GIS and actually see the "law of unintended consequences" at play to expose a darker-side of geotechnology. Even the best of intentions and ideas can turn bad through unanticipated effects.

High resolution satellite imagery, for example, can be used to recognize patterns, map land cover classes and assess vegetation biomass/vigor throughout the globe—the greater the spatial detail of the imagery the better the classifications. But in the early 2000s when the satellite resolution was detailed enough to discern rooftop sun bathers in London the Internet lit up. It seems zooming in on an Acacia tree is good but zooming in on people is bad—an appalling violation of privacy.

Fast forward to today with drone aircraft tracking people as readily as it tracks an advancing wildfire. Or consider the thousands of in-place and mobile cameras with sophisticated facial recognition software that shadow private citizens in addition to criminals and terrorists. Or the concern for data mining of your credit card swipes, demographic character and life style profile in both space and time to better market to your needs (good) but at what cost to your privacy (bad).

Or just last week in my hometown, a suspect parking database was discovered that has captured license plates "on-the-fly" for years and can be searched to identify the whereabouts of any vehicle. The system is good at catching habitual parking offenders and possibly a bad guy or two, but to many the technology is seen as a wholesale assault on the privacy of the ordinary good guy.

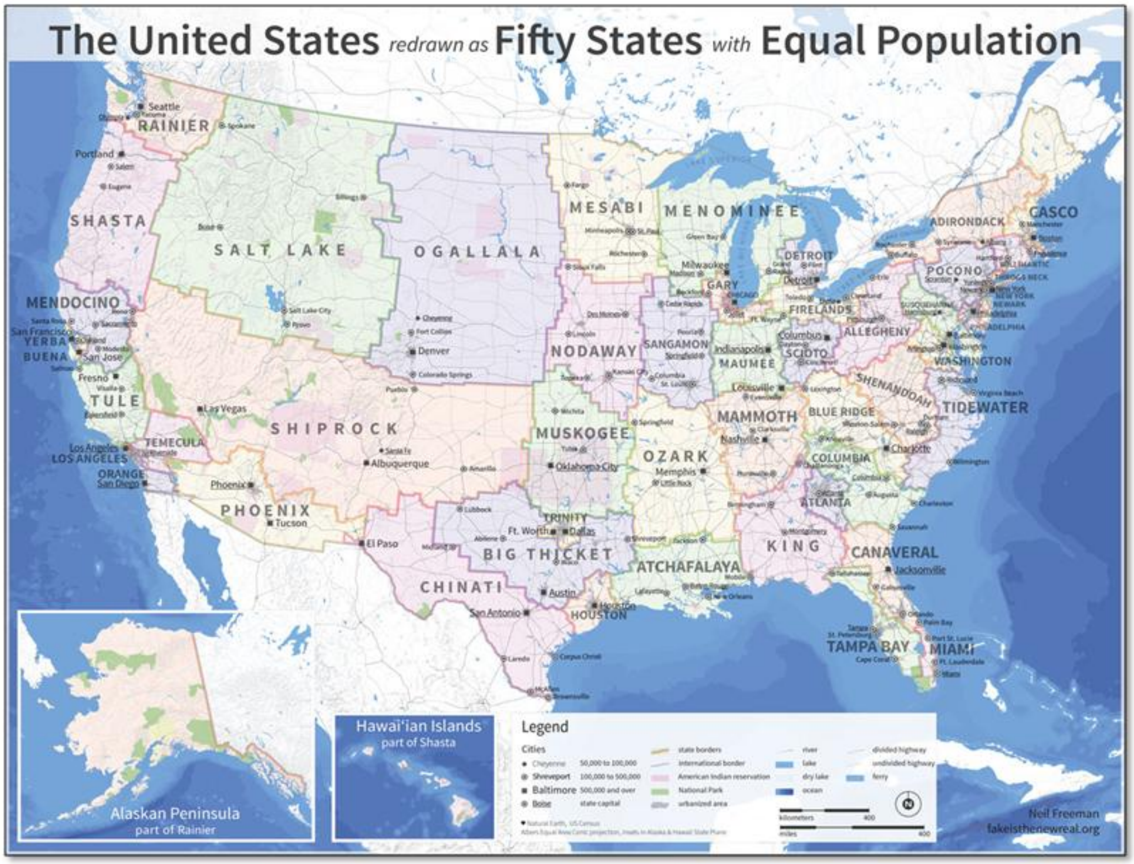
The Rorschach ink blot nature of most technology that flips between good and bad has been debated for decades. Several years ago I had the privilege of hosting a Denver University event exploring "Geoslavery or Cyber-Liberation: Freedom and Privacy in the Information Age" (see Author's Note 2). While the panel of experts made excellent points and provided stimulating discussion, an acceptable balance that encourages geotechnology's good side while constraining its bad side was not struck. The Jekyll and Hyde personality of geotechnology still persists, however it has been magnified many fold due to its ever-expanding tentacles reaching further and further into general society.

The collateral damage of unintended consequences seems to tarnish GIS Techymon's image as a classic super hero. However the purposeful perverse application of geotechnology is really ugly. Mark Monmonier's classic book "How to Lie with Maps" (1996, University Of Chicago Press) reveals how maps can be (and often must be) distorted to create a readable and understandable map. These cartographic white lies pale in comparison to the deliberate misrepresentation or misuse of mapped data to support biased propaganda or hidden agendas.

For example, the top inset in figure 2 depicts a hypothetical map that rearranges state borders to equally distribute the population of the United States so each of the imagined states has1/50th of the total population or about 6 million people (see Author's Note 3). This cartogram is far from an ugly distortion of fact as it effectively conveys population information in a diagrammatic form that stimulates thought.

The bottom inset addresses the spatial distribution of population as well. However, in this case it involves deliberate manipulation of polygon boundaries for partisan political advantage by combining census and party affiliation data to "gerrymander" congressional districts (see Author's Note 4).

The drafting of spindly tentacles and ameba-like pseudopods concentrate the voting power of one party into as many safe districts as possible and dilute opposition votes as much as possible. In the opinion of many political pundits, the GIS-gerrymandered districts are the root-cause of much of the current bifurcated, dysfunctional and down-right hostile congressional environment we face.



Inset (a). *Neil Freeman, fakeisthenewreal.org*

Inset (b). *Peter Wattson,* www.senate.leg.state.mn.us/departments/scr/REDIST/red907.htm

Figure 2. Inset (a) shows a redrawing of the 50 states forcing equal populations; inset (b) shows examples of deliberate manipulation of political boundaries for electoral advantage.

Map analysis is very effective in addressing the gerrymandered spatial optimization problem, regardless of any adverse moral and political ramifications. It also is good at efficiently keeping less technologically endowed peoples at bay, tracking children and the elderly for their own safety, monitoring the movements of parolees and pedophiles, fueling information warfare and killing people, and hundreds of other uses that straddle the moral fence.

GIS is most certainly an agent of good …most of the time. But it is imperative to remember that GIS isn't always good, or always bad, or always ugly. The technological and analytical capabilities themselves are ethically inert. It is how they are applied within a social conscience context that determines which side of GIS surfaces (see Author's Note 5).

____

Author's Notes: *1) See "Simultaneously Trivializing and Complicating GIS" in the Beyond Mapping Compilation Series at http://www.innovativegis.com/basis/MapAnalysis/Topic30/Topic30.htm 2) see http://www.innovativegis.com/basis/Present/BridgesGeoslavery/ for panel discussion summary. 3) See "Electoral College Reform (fifty states with equal population)" at http://fakeisthenewreal.org/reform/. 4) See Beyond Mapping column on "Narrowing-in on Absurd Gerrymanders" in the Beyond Mapping Compilation Series at http://www.innovativegis.com/basis/MapAnalysis/Topic25/Topic25.htm . 5) See "Ethics and GIS: The Practitioner's Dilemma" at http://www.spatial.maine.edu/~onsrud/GSDIArchive/gis_ethics.pdf.*

Where Do We Go from Here?

(GeoWorld, December 2013)

(return to top of Topic)

I have been involved in GIS for over four decades and can attest that it has matured a lot over that evolutionary/revolutionary period. In the 25 years of the Beyond Mapping column, I have attempted to track a good deal of the conceptual, organizational, procedural, and sometimes disputable issues.

In the *1970s* the foundations and fundamental principles for digital maps took the form of "automated cartography" designed to replace manual drafting with the cold steel of a pen plotter. In the *1980s* we linked these newfangled digital maps to traditional data base systems to create "spatial database management systems" that enabled users to easily search for locations with specific conditions/characteristics, and then display the results in map form.

The *1990s* saw an exponential rise in the use of geotechnology as Remote Sensing (RS) and the Global Positioning System (GPS) became fully integrated with GIS— so integrated that *GIS World* became *GeoWorld* to reflect the ever expanding community of users and uses. In addition, map analysis and modeling spawned a host of new applications, as well as sparking the promise of a dramatic shift in the historical perspective of "what a map is (and isn't)."

The *2000s* saw the Internet move maps and mapping from a "down the hall and to the right" specialist's domain, to everyone's desktop, notebook and mobile device. In today's high tech environment one can fly-through a virtual reality rendering of geographic space that was purely science fiction a few decades ago. Wow!

My ride through GIS's evolution has been somewhat akin to Douglas Adams' *Hitchhiker's Guide to the Galaxy Series*. Writing a monthly column on geotechnology finds resonance in his description of flying— "There is an art, it says, or rather, a knack to flying. The knack lies in learning how to throw yourself at the ground and miss." As GIS evolved, the twists and turns around each corner were far from obvious, as the emerging field was buffeted in the combined whirlwinds of technological advances and societal awakening.

In most cases, geotechnology's evolution since its early decades has resulted from outside forces: 1) reflecting macro-changes in computer science, electrical engineering and general technological advances, and 2) translating workflows and processes into specialized applications. The results have been a readily accessible storehouse of digital maps and a wide array of extremely useful and wildly popular applications. Geotechnology's "where is what" data-centric focus has most certainly moved the masses, but has it moved us closer to a "why, so what, and what if" focus that translates mapped data into spatial information and understanding?

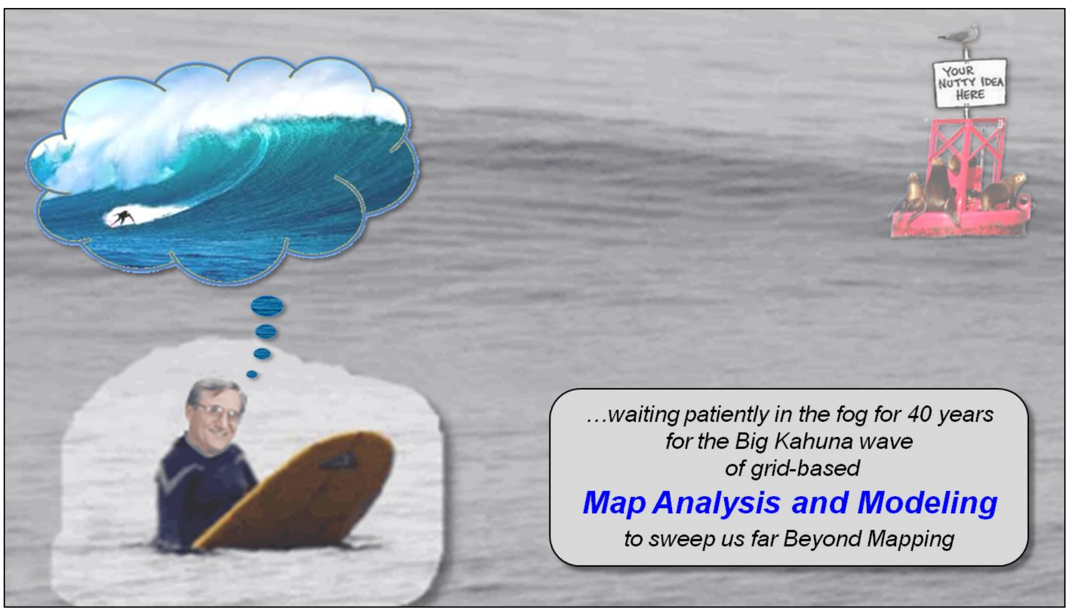


Figure 1. The idea of map variables being map-ematically evaluated has been around for decades but is still not fully embraced. (I wonder what other nutty ideas are languishing in the backwaters of geotechnology that have yet to take form).

While the technological expression of GIS has skyrocketed, the analytical revolution that was promised still seems grounded. I have long awaited a Big Kahuna wave of map analysis and modeling (figure 1) to sweep us well beyond mapping toward an entirely new paradigm of maps, mapping and mapped data for understanding and directly infusing spatial patterns and relationships into science and problem-solving.

In the 1970s and 80s my thoughts turned to a "map-ematical" framework for the quantitative analysis of mapped data (see Author's Notes 1 and 2). The suggestion that these data exhibited a "spatial distribution" that was quantitatively analogous to a "numerical distribution" was not well received. The further suggestion that traditional mathematical and statistical operations could be spatially evaluated was resoundingly debunked as "disgusting" by the mapping community and "heresy" by the math/stat community.

In the early years of GIS development, most people "knew" what a map was (an organized collection of point, line and polygon spatial objects) and its purpose (display, navigation, and geo-query). To suggest that grid-based maps formed continuous surfaces defining map variables that could be map-ematically processed was brash. Couple that perspective with the rapidly advancing "technological tool" expressions, and the "analytical tool" capabilities were relegated to the back of the bus.

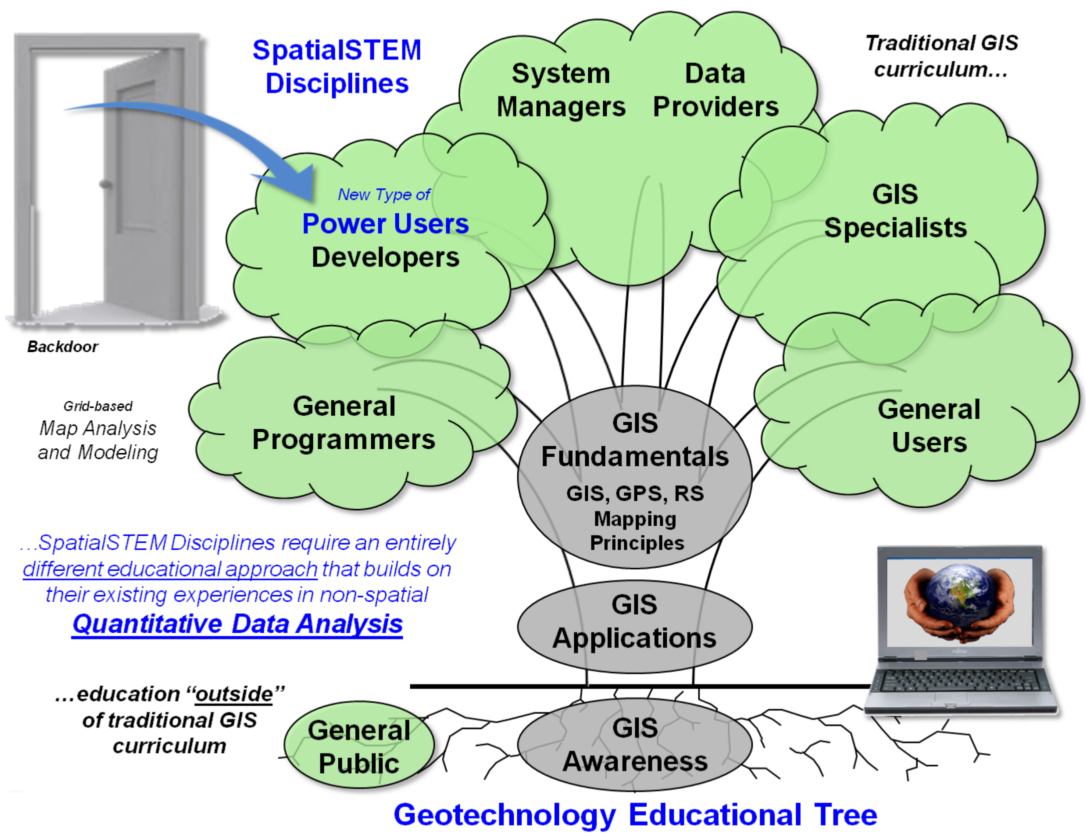


Figure 2. Traditional GIS education does not adequately address STEM disciplines' focus on quantitative analysis of mapped data.

Fast-forward to today and sense the changes in the wind and sea of thought. Two central conditions are nudging the GIS oil tanker toward grid-based map analysis and modeling: 1) the user community is asking "is that all there is" to GIS? (like Peggy Lee's classic song but about mapping, display, geoquery and navigation), and 2) a building interest in spatialSTEM that is prodding the math/stat community to no longer ignore spatial patterns and relationships—increasing recognition that "spatial relationships exist and are quantifiable," and that "quantitative analysis of maps is a reality."

Education will be the catalyst for the next step in geotechnology's evolution toward map analysis and modeling. However, traditional GIS curricula and programs of study (Educational Tree in figure 2) are ill-equipped for the task. Most STEM students are not interested in becoming GIS-perts; rather, they want to employ spatial analysis tools into their scientific explorations—a backdoor entry as a "Power User." What we (GIS communities) need to do is engage the STEM disciplines on their turf—quantitative data analysis—instead of continually dwelling on the technical wonders of modern mapping, Internet access, real-time navigation, awesome displays and elegant underlying theory.

These wonders are tremendously important and commercially viable aspects of geotechnology, but do not go to the core of the STEM disciplines (see Author's Notes 3 and 4). Capturing the attention of these folks requires less emphasis on vector-based approaches involving collections of "discrete map features" for geoquery of existing map data, and more emphasis on grid-based approaches involving surface gradients of "continuous map variables" for investigating relationships and patterns within and among map layers. AKAW!! … surfers cry when they spot a "hugangus" perfect wave.

However, after 25 years of shuffling along the GIS path, I have reached my last Beyond Mapping column in GeoWorld …the flickering torch is ready to be passed to the next generation of GIS enthusiasts. For those looking for an instant replay of any of the nearly 300 columns, you can access any and all of them through the four online/hardcopy books in the Beyond Mapping Compilation Series or Chronological Listing posted at—

http://www.innovativegis.com/basis/BeyondMappingSeries/

Author's Notes*: 1) See "An Academic Approach to Cartographic Modeling in Management of Natural Resources," 1979 and 2) "A Mathematical Structure for Analyzing Maps," 1986 …both historical papers posted at www.innovativegis.com/basis/Papers/Online_Papers.htm. 3) See "Topic 30, A Math/Stat Framework for Map Analysis" in the Beyond Mapping Compilation Series posted at www.innovativegis.com/basis/MapAnalysis/. 4) see "Closing Panel on Geospatial STEM" remarks about SpatialSTEM education made at the Geospatial Conference of the West, posted at http://www.innovativegis.com/basis/Present/GeCo_West2013/Panel/GeospatialSTEM_panel.pdf.*

(return to top of Topic)

(Back to the Table of Contents)