Where Do We Go from Here?

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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?

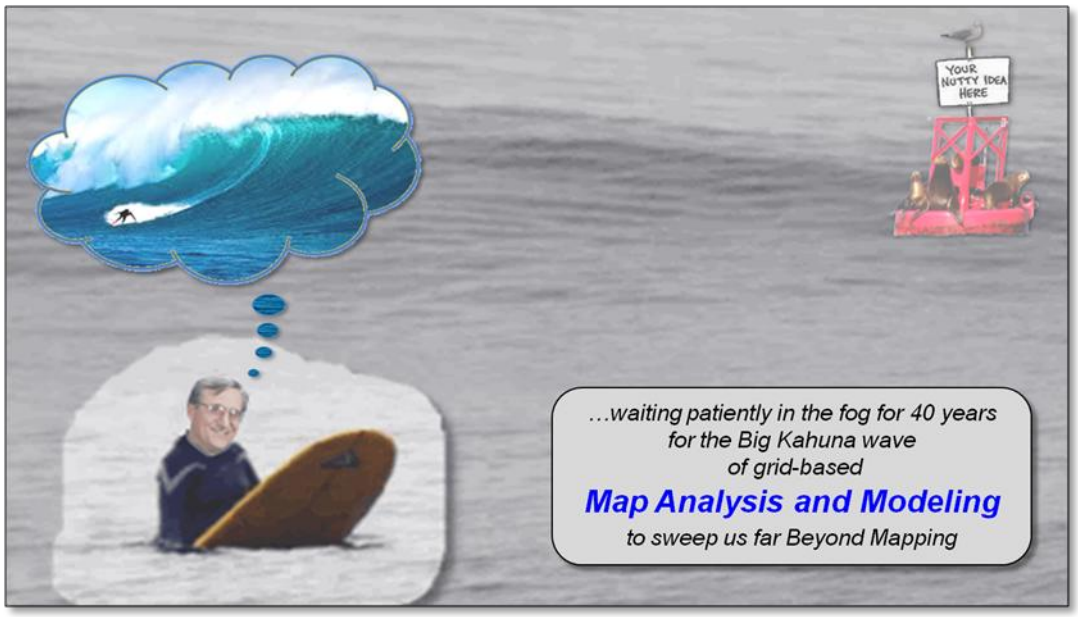

Figure 1. The idea of map variables being map-ematically evaluated has been around for decades but is still not fully embraced. (I wonder what other nutty ideas are languishing in the backwaters of geotechnology that have yet to take form).

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.

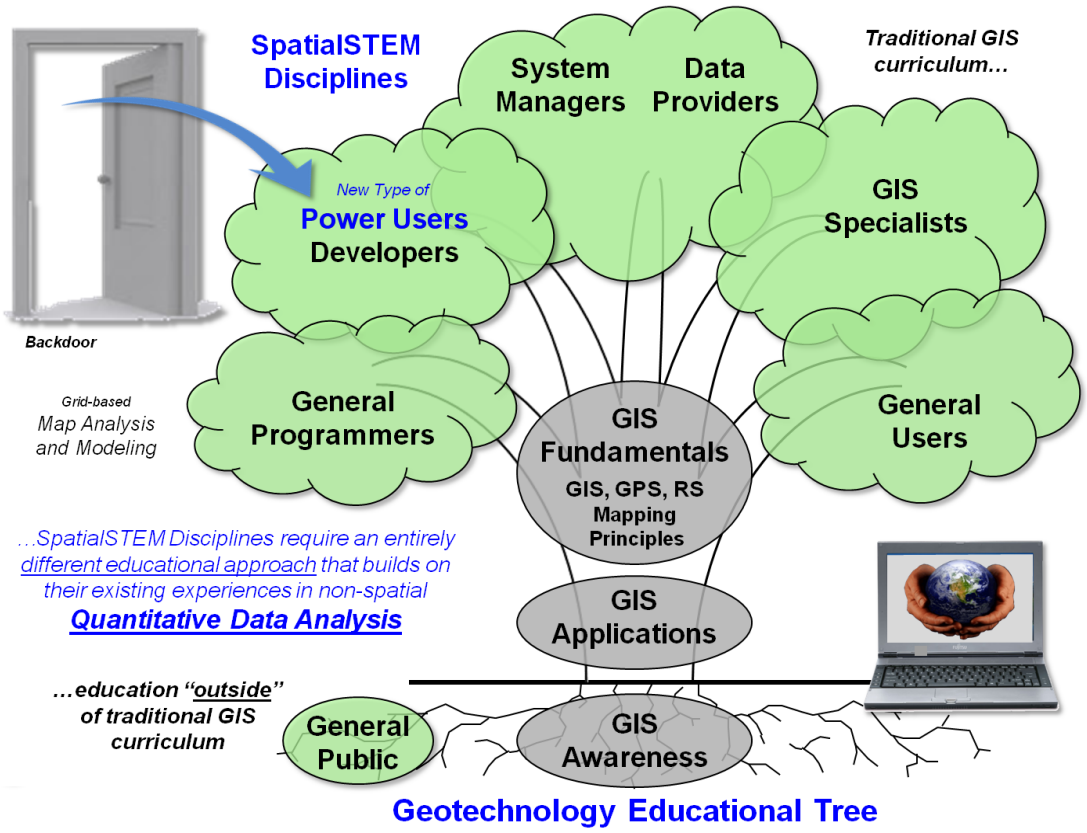

Figure 2. Traditional GIS education does not adequately address STEM disciplines' focus on quantitative analysis of mapped data.

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 through five organizational listings with links (Chronological, Applications, Operations, Interactive and Index) 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 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.*