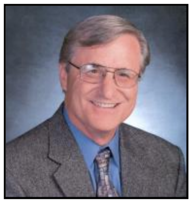
GeoWorld Editorial Board Industry Outlook

Opening Panel Remarks at GeoTec 2009



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(Click here for a .pdf version) The following is a synopsis of Dr. Berry's notes/remarks to the questions on Industry Outlook—

KEY QUESTIONS

1. First we'll start with a "broad-brush" question. ***What's the most radical change(s) that 1) we have seen in geotechnology's evolution, and 2) that we will see in geotechnology's future?***

(Part 1 – Evolution of geotechnology). It wasn't until the late 1990s that I fully realized the impact of the "perfect geotechnology storm" brought on by the convergence of four critical enabling technologies; 1) the personal computers' dramatic increase in computing power, 2) the maturation of GPS and RS (remote sensing) technologies, 3) a ubiquitous Internet and 4) the general availability of digital mapped data. If any one of these elements were missing, the current state of geotechnology would be radically different and most certainly not as robust or generally accepted. Much of our advancement, particularly of late, has come from external forces.

Keep in mind that geotechnology is in its fourth decade—the 1970s saw Computer Mapping automate the drafting process through the introduction of the digital map; the 80s saw Spatial Database Mining link digital maps to descriptive records; the 90s saw the maturation of Map Analysis and Modeling capabilities that moved mapped data to effective information by investigating spatial relationships; and finally, our current decade that focuses on Multimedia Mapping that emphasizes *data delivery* through Internet proliferation of data portals and *advanced display mechanisms* involving 3D visualization and virtual reality environments, such as in Google and Virtual Earths.

In the early years, GIS was "down the hall and to the right," sequestered in a relatively small room populated by specialists …users would rap on the door and say "Joe sent me for some maps." Today, geotechnology is on everyone's desk and in nearly everyone's pocket. Contrary to most GIS perspectives, our contributions have been as much a reaction to enabling technologies as it has been proactive in the wild ride to mass adoption.

(Part 2 – Future of geotechnology). The future of our status as a mega-technology alongside the giants of biotechnology and nanotechnology will be in large part self-determined …that is, if we step out of the closet and fully engage other disciplines and domain experts. The era of "maps as data" is rapidly giving way to the "age of spatial information" where mapped data and analytical tools effectively support decision-making. The direct relevance of geotechnology isn't just a wall hanging, it's an active part of the consideration of geographic space …whether it's a personal "*what should we do and where should we go?*" decision on a vacation, or a professional one for locating a pipeline, identifying wildlife management units or establishing a marketing plan for a new city.

The key element for developing applications beyond data delivery lies in domain expertise as much as mapping know-how. The geometrical increase in awareness and use of geotechnology by the masses will lead to entirely new and innovative applications that we haven't even dreamed of …nor can we as geotechnology specialists. The only way we could drop the ball is to retreat further into our disciplinary cave.

On a technical front, I see a radical change in georeferencing from our 400 year reliance on Cartesian "squares" in 2-D and "cubes" in 3-D to hexagons (2-D) and dodecahedrals (3-D) that will lead to entirely new analytic capabilities and modeling applications. To conceptualize the difference, imagine a regular square grid morphing into a grid of hexagons like a tray in a bee hive. The sharp corners of the squares are knocked-off resulting the same distance from the centroid to each of the sides defining the cell …a single consistent step instead of two different types of steps (diagonal and orthogonal) when moving to an adjacent location. Now consider a three-dimensional world with 12-sided volume (dodecahedral) replacing a cube …a single consistent step instead of a series of differing steps to all of the surrounding locations.

This seemingly slight shift in spatial theory, however, will revolutionize our concept of geographic space. At a minimum, it finally will dispel the false assumption that the earth is flat …at least in the map world that stacks two-dimensional map layers like pancaes. At a maximum, it will enable us to conceptualize, analyze and actualize spatial conditions within the full dimensionality of the real world.

Now all we need to do is to figure out a way to fully account for time, as well as space, in our mapping for a temporally dynamic representation of geography—but that's another story to be written by tomorrow's geotechnologists.

2. The next question sounds basic, ***'where do we go from here?'*** *But the answer is anything but simple. As a background, we have established the basic means of encoding, analyzing, visualizing and storing geographic information, and the compute power to do these operations everywhere is widespread. We have some nascent standards and a large quantity of data (content) in terms of vector and image data. So do we need to think in terms of an all-the-time integration of business processes that deal with the real world--from land management to building design to environmental protection.* **But how do we get there? And how do we make it happen?**

While I am sure there are technological waypoints along the path we take from here, the human element likely will be the most critical determinant of forward progress. Chief among these is the education component. It's interesting to note that our earliest tinkering with geotechnology had a huge tent with zealots from all disciplines tossing something into the stone soup of an emerging technology—foresters, engineers, geographers, epidemiologists, hydrologists, geologists to mention but a few. As the field matured the big tent contracted considerably as "specialists" emerged and formal programs of study and certification have surfaced.

There are many positive aspects in this maturation, but there also are some drawbacks. In many universities, the GIS Center of Excellence is housed in a single college or department, and thereby becomes lodged in a disciplinary stovepipe. A "one shoe for geotechnology education" is not sufficient. It shouldn't be the exclusive domain of any discipline due to the breadth of its emphasis—from those "of the computer," such as Programmers, Developers, and Systems Managers, to those more "of the application," such as Data Providers, GIS Specialists, General Users—

Of the Computer	*… ← Continuum of Focus within Geotechnology → …*				**Of the Application**
Programmer	*Developer*	*Systems Manager*	*Data Provider*	*GIS Specialist*	*General User*

Another characteristic is the growing gap on campus between the "*-ists*" and the "-ologists." The ***"-ists*,"** GIS Specialists, for example, are seeking in-depth knowledge and view geotechnology as a "Stand Alone discipline." On the other hand, the "***-ologists***," such as Ecologists are after practical skills and see it as an "Applied discipline."

An academic analogy that comes to mind is Statistics. While its inception is rooted in 15th Century mathematics, it wasn't until the early 20th Century that the discipline broadened its scope and societal impact much like contemporary geotechnology. Today it is difficult to find a discipline on campus that does not develop at least a basic literacy in statistics. This level of intellectual diffusion was not accomplished by funneling most of the student body through a series of one-size-fits-all courses in the Statistics Department. Rather, it was accomplished through a dandelion seeding approach where statistics is enveloped into existing disciplinary classes and/or specially tailored courses, such as Introduction to Statistics for Foresters, for Engineers, etc.

This doesn't mean that deep-keeled geotechnology curricula are pushed aside. On the contrary, like a Statistics Department, there is a need for in-depth courses that produce the theorists, innovators and specialists who grow the technology's capabilities and databases. However, it does suggest a less didactic approach in which all who touch GIS need to "start at the beginning and when you get to the end...stop" as suggested by The Cheshire Cat.

In large part, it can be argued that the outreach to other disciplines is our most critical waypoint in repositioning geotechnology for the 21st Century.

3. Many industry analysts and technology leaders suggest that "cloud computing" is likely to become the next phase in Web and enterprise computing. ***How do you envision geospatial technologies and services to interact with and be deployed with a cloud-computing environment?***

My technical skills are such that I can't address what cloud computing architecture will look like or what enabling technologies are involved. However, I might be able to help some of you get a grasp of what cloud technology is and what might be its near-term fate.

The usually crisp Wikipedia definition for cloud computing is riddled with techy-speak, as are most of the blogs. However, what I am able to decipher is that there are three distinguishing characteristics—that the technology

1) involves virtualized resources …meaning that workloads are allocated among a multitude of interconnected computers acting as a single device;
2) acts as a service …meaning that the software and data components are shared over the Internet; and,
3) is dynamically scalable …meaning that the system can be readily enlarged.

In other words, cloud computing is basically the movement of applications, services, and data from local storage to a dispersed set of servers and datacenters …a particularly advantageous environment for data heavy applications like GIS.

While there is some credence in the argument that cloud computing is simply an extension of yesterday's buzzwords of object-oriented programming, interoperability, web-services and mash-ups, it ingrains considerable technical advancement (as my esteemed colleagues can attest). For example, the cloud offers a huge potential for capitalizing on the spatial analysis, modeling and simulation functions of a GIS, as well as tossing gigabytes around with ease …a real step-up from the earlier expressions.

However, there are four important non-technical aspects to consider: *1)* liability concerns, *2)* information ownership, sensitivity and privacy issues, *3)* economic and payout considerations, and *4)* legacy impediments.

Liability concerns arise from decoupling data and procedures from a single secure computing infrastructure— What happens if it is lost or compromised? What if the data is changed or basically wrong? Who is responsible? Who cares?

The closely related issues of ownership, sensitivity and privacy raise questions like: Who owns the data? Who is the data shared with and under what circumstances? How secure is the data? Who determines its accuracy, viability and obsolescence? Who defines what data is sensitive? What is personal information? What is privacy? These lofty questions rival Socrates sitting on the steps of the Acropolis and asking …what is beauty? …what is truth? But these social questions need to be addressed if the cloud technology promise ever makes it down to earth.

In addition, a practical reality needs an economic and payout component. The alchemy of spinning gold from cyberspace straw continues to mystify me. It appears that the very big boys like Virtual and Google Earth can do it through eyeball counts, but what happens to smaller data, software and service providers that make their livelihood from what could become ubiquitous? What is their incentive? How would a cloud computing marketplace be structured? How will its transactions be recorded and indemnified?

Governments, non-profits and open source consortiums, on the other hand, see tremendous opportunities in serving-up gigabytes of data and analysis functionality for free. Their perspective focuses on improved access and capabilities, primarily financed through cost savings. But are they able to justify large transitional investments to retool under our current economic times?

All these considerations, however, pale in light legacy impediments, such as the inherent resistance to change and inertia derived from vested systems and cultures. The old adage "*don't fix it, if it ain't broke*" often delays, if not trumps, adoption of new technology. Turning the oil tanker of GIS might take a lot longer than technical considerations suggest—don't expect GIS to "disappear" into the clouds just yet.

4. ***Has GIS technology become commoditized? What are the advantages/disadvantages of commoditization? And how can we continue to add value to our product?***

Commoditization implies the transformation of goods and services into a commodity thus becoming an undifferentiated product characterized solely by its price, rather than its quality and features. The product is perceived as the same no matter who produces it, such as petroleum, notebook paper, or wheat. Non-commodity products, such as televisions, on the other hand, have many levels of quality. And, the better a TV is perceived to be, the higher its value and the more it will cost.

So where is geotechnology along this continuum? Like the other two mega-technologies (*bio* and *nano*) it has a split personality with both commodity and non-commodity characteristics. In our beginning, research dominated and the mere drafting of a map by a plotter was perceived as a near miracle in the 1970s. Fast forward to today and digital maps are as commonplace as they are ubiquitous—a transformation from "knock-your-socks-off" to commodity status.

But we shouldn't confuse mass adoption of a map product with commoditization of an entire technology. It is like the product life cycle in pharmaceuticals from trails, to unique flagship drug, to generic forms and finally to commodity status. While the products might cycle to commodity, the industry doesn't as innovation keeps adding value and new product lines.

What is rapidly becoming a commodity in our field is generic mapped data and Internet delivery. However, contemporary value-added products and services are extremely differentiated; such as a propensity map for product sales, a map of wildfire risk, and a real-time helicopter routing map that avoids enemy detection. The transition is a reflection of a paradigm shift from mapped data to spatial information—less of a focus on automating traditional mapping roles and procedures, to an emphasis on new ways of integrating spatial relationships into decision-making.

The bottom line is that commoditization of geotechnology is neither good nor bad, nor an advantage or disadvantage. It just is a natural progression of product life cycles and renewed advancements in value-added features and services through continued innovation. If we fail to innovate, the entire industry will become commoditized and GIS specialists will hawk their gigabytes of graphics in the geotechnology commodity market next to the wheat exchange in Chicago.

EXTRA QUESTIONS (as needed)

1. Government can be a boon to geotechnology, as seen here in Vancouver concerning the Winter Olympics and in the United States with the so-called "stimulus package." ***What role should federal governments have in demanding geotechnology, and is that role currently expanding or contracting?***

Governments traditionally provide goods and services that cannot be efficiently, effectively or economically delivered by the private sector. They also can provide a kick-start for emerging technologies, particularly those with extensive reach that is difficult for a gaggle of individual companies to gain a common foothold.

At another level, governments are consumers of technology just like any business. These and a myriad of other factors suggest that governments will have increasing direct role in the consumption, as well as its traditional role in the development of geotechnology through policy, legislation, standards and certifications.

2. As a related question, specific types of geotechnology can become more or less popular in large governments, depending on the world situation. For example, military-type applications grew dramatically in the last decade, and it's expected that infrastructure spending will increase now. ***What other types of geotechnology could receive boosts from upcoming federal government programs?***

Public safety and disaster planning and response will likely be the next stimulated sector. Geotechnology has well-established its descriptive mapping capabilities, however full engagement of its predictive and prescriptive capabilities will become generally accepted. For example, wildfire risk and impact modeling first applies fire science to create maps of relative threat levels throughout an area based on terrain, weather, fuels and historical ignition occurrence. Then wildfire threat is combined with existing maps of facilities, infrastructure, census data, sensitive areas and other descriptors to generate probable loss in economic, social and environmental terms.

In a similar manner, crime data and related descriptors can be used to generate crime risk and impact maps. In a potentially more sinister way, maps can linked with advanced image processing and recognition software to track individuals as they move throughout a network of remote video cameras …a well-established application lead by the British.

Heck, in Denver this has already been taken to a new level—robotics. As a parking enforcement officer drives along a street a camera recognizes your license plate, checks your registration information and then "asks" the parking meter if time has expired; if so, a ticket is issued and mailed to you. It even checks its memory to see if you are in the same place more than two hours …running out to "feed the meter" is no longer an option in Denver.

It's a fine line between the "cyber-liberation" of the parking cop and the "geo-slavery" that has taken a lot the "gaming" out of being a good citizen.

3. ***Are new laws aimed at protecting privacy, such as the U.S. Health Insurance Portability and Accountability Act (HIPAA), for example, inadvertently decreasing GIS-related research? If so, what can be done to mitigate the effect? Or, more broadly, where is the current "balance point" of privacy and results, and do you see it swinging in one direction or the other?***

With any significant technological advancement there comes a potential downside. The threat of "geoslavery" is real but it is greatly exaggerated, and for the most part, offset by the "cyber-liberation" brought on by shredding the paper map and tossing-out the magnetic compass. While the thought that "great-honking computers" will know everything that "we do, what we buy and where we go" affronts our private space psyche and smacks of Orwellian control, the reality is much different.

In modern society spying and control occurs without geo-referencing all the time. Your shopping basket is scanned to automatically total the bill, keep an inventory, help determine in-store specials and out-of-store marketing. If you use a preferred customer card "they" know who you are and, yes, where you live. But that's a far step from a knock on your door and confrontation over purchasing a sleazy brown-bag novel …it hasn't happened yet, and Orwell's book spoke of 1984.

There are numerous ways that individual privacy can be maintained while still mitigating the informational content in data and images. Census data has struggled with this dilemma for years by employing "aggregation procedures" as necessary. I believe the "balancing point" teeters on two principles—individual anonymity versus group characterization.

For example, if you are caught in a routine image of the landscape your privacy isn't compromised. Viewsheds are public spaces as Madonna discovered several years ago in her suit over high resolution coastal imagery of her Malibu estate. However, a private (or governmental) plane targeting her estate is an entirely different matter and threatens her privacy—an interpretation that might put a lot of shutter vultures out of business.

Judicial, political, cultural and societal opinions will continue to fluctuate around this balance point like a teeter-totter with the current position a bit more on the individual privacy end. As GIS specialists, our charge is to develop innovative technologies that are applied within current policy constraints. Just because a procedure is technically feasible doesn't mean it is automatically viable.

4. Google Earth, Microsoft Virtual Earth and others seem to be growing exponentially, in both the amount of information available and popularity. ***Are such platforms the definitive future of the industry, or do you expect new technologies to take their place?***

The current set of major actors and technological expressions are in the driver's seat of geotechnology …and will be for some time. The baton transfer of "all things geographic" from flagship GIS companies to more generic information and access companies began a decade ago. The exponential growth of the technology and breadth of its applications has sealed the transfer—like the boutique store (viz. GIS company) losing customers to the big box stores (viz, GE and VE).

It might warm your heart, to hear that the geotechnology baton is posed for at least two other forward passes. It seems that Tweeter and Facebook are awakening to the idea that geography is a really cool way to show friends exactly what are doing AND WHERE you are doing it. Location stamps on photos and video are becoming as common as time stamps …throw-in a link to GE or VE and the transfer is complete.

Less on the radar is the interest of big database companies in geotechnology (viz. Oracle and Sybase). They have been developing "spatial data-blades" for several years and have incorporated considerable GIS capability into their software. What has been holding them back is an easy way to automatically stamp data with a universal geographic identifier. The complexity and multiplicity of current referencing systems and transformations keep them "pulling at the bit" at a slow trot. Soon they will be galloping with geotechnology when a standard "universal key" is in play.

Personally, I believe that key is already here but most folks, even in the GIS community aren't aware. USGS in conjunction with numerous other groups have established a raster/grid-based referencing schema for the globe using Lat/Lon WGS84—1m, 10m, 30m, 90m and 1km patterns. This means that there is a consistent "square partition" for every location on the face of the earth. That suggests that any spatially dependent record can be easily plunked into one of these "bins" as a single compound number for column/row, and all other data and database systems will immediately know where it is. No more geodedic hoops to hop through for the geographically-challenged among us (viz. "unwashed" IT types) …the gates have sprung open and the race is on.