Geospatial Technology Outlook, *Opening Panel Remarks at GeoTec 2007*

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(Note: these notes outline J.K. berry's remarks at the Plenary Opening Panel on Geospatial Technology Outlook for the 2007 GeoTec Conference, Calgary, Alberta, Canada, May 14-17; click here for .pdf version)

Moderator: **Matt Ball, Editor**, GeoWorld Magazine, Denver, CO, USA

Panelists:

• **Joseph Berry**, Keck Scholar in the Geosciences, University of Denver, Denver, CO, USA

Joseph K. Berry is a leading consultant and educator in the application of GIS technology. He is the principal of BASIS, consultants and software developers in GIS technology and the author of the "Beyond Mapping" column for *GeoWorld* magazine for over 17 years. He has written over 200 papers on the theory and application of map analysis techniques, and is the author of the popular books *Beyond Mapping* and *Spatial Reasoning*, as well as his newly released book, *Map Analysis*. Since 1976, he has presented college courses and professional workshops on geospatial technology to thousands of individuals from a wide variety of disciplines.

• **Ed Parsons**, Geospatial Technologist, Google, London, United Kingdom

Ed Parsons was the first Chief Technology Officer in the history of Ordnance Survey. Parsons developed technology strategy, identified strategic technology partners and market opportunities. He also directed all Information Systems activities, including IT strategy, direction, and positioning. Parsons came to the Ordnance Survey from Autodesk, where he was an EMEA Applications Manager for the GIS Division. Earlier in his career he was a part-time geospatial technology consultant and full-time Senior Lecturer at Kingston University.

• **Elizabeth Cannon**, Dean, Schulich School of Engineering and Professor, Department of Geomatics Engineering, University of Calgary, Calgary, AB, Canada

Elizabeth's expertise is in the area of satellite navigation for land, air and marine applications and she has been involved with GPS since 1984 in both industrial and academic Environments. Her research has encompassed the development of new satellite navigation methods, algorithms and integrated systems that have been applied to such areas as vehicular navigation, precision farming, and aircraft flight inspection. The results of her research have been commercialized through the licensing of software to over 200 agencies worldwide. Elizabeth holds a B.Sc. in Mathematics from Acadia University as well as a B.Sc., M.Sc. and Ph.D. in Geomatics Engineering from the University of Calgary.

• **Peter Batty**, ex-CTO, Intergraph, Denver, CO, USA

Peter Batty is recognized as a technical leader in the geospatial industry. Batty has worked in the geospatial industry for 20 years and has served as CTO for two leading companies in the industry, Intergraph and Smallworld (now part of GE Energy), as well as a being a founder and CTO of a leading-edge startup, Ten Sails (now Ubisense). He has successfully led a number of major spatial software development projects. He has been a member of the *GeoWorld* magazine Editorial Advisory Board since 1996, has spoken at many conferences around the world, and has received a record seven speaker awards from GITA.

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

Geospatial Web

Consumer-oriented geospatial Web tools, such as Google Maps and Earth and Microsoft Virtual Earth, have taken the industry by storm over the past year. We see that geospatial capability has become a primary battleground for search. Where will this flurry of activity lead the geospatial technology industry vendors and practitioners?

The Google Earth (GE) and Virtual Earth (VE) competition is less with technology as it is with "business models." The battle ground for Internet search has radically different strategies— GE is looking for "eyeballs" (increase visitation) while VE is focusing on integration with Office products to increase software sales.

Both GE and VE are representative of the visualization "*Killer Ap*" of 2007, meaning a GIS application that is significant and adopted by the masses. An earlier *killer ap* was MapQuest's maps and driving directions, that now is a field of many including Yahoo Maps, MapPoint and Google Maps (aside: GM happens to have the most hits of any webpage on the Internet).

During the heady Dot Com days, MapQuest that started in a garage was sold for 1.2 billion dollars …a figure that captured my attention, so as a class assignment we attempted to determine its significance with respect to the "greater" GIS industry. We roughly estimated the value of publicly traded GIS companies (e.g., MapInfo), pro-rated the GIS activities of multi-tiered companies (e.g., Intergraph) and estimated the worth based on market share for privately held companies (e.g., ESRI). While a bit of guesstimating was involved, as hard as we tried, we couldn't get the total worth of the entire GIS industry to reach even 1.0 billion dollars.

My point is that one killer GIS application, that only involves a small subset of the discipline's capabilities and data, can catapult the industry based on a wholesale "new way" of doing business with maps. While automation of current business practices can make strides in efficiency and cost-savings, it is the innovative application of GIS that leaps forward and has the masses re-thinking the value of geospatial data/information.

Visualization

New 3-D collection hardware and software make 3-D data collection easier and less expensive. 3-D data viewing in Geographic Exploration Systems is fueling some interest, but so too are the parallel interests of architectural design, military planners and online gaming platforms. What are the implications of this development and what kind of advancements can we expect in how we are able to visualize and interact with our data?

Visualization has had a huge impact on geospatial technology …particularly in advancing acceptance and adoption by mass consumer markets. The gee-wiz/wow factor of 3D is a large part of the current usage/interest. Maps by their very nature are abstractions and the movement from traditional 2D representations using colors and symbols to interactive 3D terrains with draped aerial images as background lessens the abstraction and is very powerful in creating a sense of place.

However visualization isn't the sole domain for 3D environments and 3D in a visualization context is radically different from an analytical context. A case in point is Kansas that is collecting airborne LIDAR for the entire state and making the raw data available, as well as the processed 2-foot contour map. This means that additional value-added processing can deliver much higher spatially resolved DEMs that can be used for agriculture field leveling/terracing, civil engineering cut/fill and other applications—sort of opening a flood gate on advancements in terrain modeling.

But there is a much bigger picture—interest and use of terrain analysis will spur the movement from current 2D "coincidence" dominated map analysis (map layers) toward true three-dimensional "flows" in geographic space… now that's a revolution in our 8,000 year old mapping paradigm.

Geospatial for Infrastructure

There is increasing pressure on those that create and maintain infrastructure to increase efficiency. The concepts and tools for Building Information Management (BIM) are maturing. Through the work of the Open Geospatial Consortium, standards to enable greater integration between CAD, BIM and GIS are being worked out. What is the future of GIS for infrastructure?

CAD (Computer Aided Design) and BIM (Building Information Modeling) provide detailed information on spatial objects and their linkages. Imagine a cut-away drawing of an engine …CAD (and BIM for buildings in an analogous manner) keeps track of each bolt and washer and what assembly they are screwed into— object-oriented drawings with extended information like "that screw goes on the left side and holds the water pump to the block (object relationships) and costs 39 cents (object attributes)."

GIS, on the other hand, provides information on geographic context …once the engine is assembled with the car, GIS/GPS can track where the car goes—it places objects in geographic space.

What **GIS can learn from CAD & BIM** is that object relationships need to be part of our simple descriptive attribute tables. For example, a road line segment might be identified as a bridge and linked to the electric conduit, gas and water pipelines sharing the structure (spatial linkages). In another context, a property line might coincide with a road segment …a spatial linkage would automatically adjust if one of the feature's alignment was updated.

What **CAD & BIM can learn from GIS** is that real world positioning of objects is critical for assessing spatial relationships and extended geographic contexts. For example, "off-line" analysis of integrity/risk/impact assessment for pipeline infrastructure …it's not enough to know where, what and linkages for the structure itself, but many critical decisions need information on how the feature relates to its surroundings.

The bottom line is that the line between CAD/BIM and GIS is blurring and expect future software to meld the two spatial mindsets.

Analysis

Large global problems such as our energy demands and climate change require a greater breadth of analysis tools to make the most of the detailed global data that we've collected. Adding the dimension of time to such analysis holds the promise to unlock a much richer understanding of the interconnectedness of global systems. What's the current state of geospatial analysis and what types of functionality can be added for greater global awareness?

The bulk of the current state of geospatial analysis focuses on "*static coincidence modeling*" using a stack of geo-registered map layers. But the frontier of GIS research is shifting focus to "*dynamic flows modeling*" that tracks movement over space and time in three-dimensional geographic space.

The impact of this evolution will be huge and shake the very core of GIS—the Cartesian coordinate system itself (a spatial referencing concept introduced by mathematician Rene Descartes 400 years ago).

The current 2D square for geographic referencing is fine for "static coincidence" analysis over relatively small land areas, but woefully lacking for "dynamic 3D flows." It is likely that Descartes' 2D squares will be replaced by hexagons (like the patches forming a soccer ball) that better represent our curved earth's surface …and the 3D cubes replaced by nesting polyhedrals for a consistent and seamless representation of three-dimensional geographic space. This change in referencing extends the current six-sides of a cube for flow modeling to the twelve-sides (facets) of a polyhedral—radically changing our algorithms as well as our historical perspective of mapping.

The new geo-referencing framework provides the needed foothold for solving complex spatial problems, such as intercepting a nuclear missile using supersonic evasive maneuvers or tracking the air, surface and groundwater flows and concentrations of a toxic release. While the advanced map analysis applications coming our way aren't the bread and butter of mass applications based on historical map usage (visualization and geo-query of data layers) they represent natural extensions of geospatial conceptualization and analysis …built upon an entirely new set analytic tools, geo-referencing framework and a more realistic paradigm of geographic space.

Marginalizing geospatial analysis and focusing on the number of website hits today misses the true future of GIS. It's akin to the questioning the idea several centuries ago of sailing West to get to the East (Indies) and bumping into a couple of new continents on the way.

Keep in mind what Socrates almost said "…the unanalyzed map is not worth keeping" *(actually the quote is "…the unexamined life is not worth living…" from Plato's Allegory of the Cave in Book VII of the Republic.)*

Enterprise Systems and Integration Issues

GIS is increasingly being integrated with other large-scale enterprise systems through enhanced relational database management systems, middleware and database amalgamation software. How will GIS practitioners be affected by broader enterprise adoption and IT integration?

GIS used to be "down the hall and to the right"—isolated from the rest of IT and only called upon when a map was needed for the boardroom wall. This was the result of our paper map legacy of mapping and inventorying physical assets, conditions and characteristics primarily supporting field operations.

So what's different now? Knowing where is what (graphical inventories) is valuable data but not inherently information for decision-making … "can't see the forest for the trees." Broader adoption of geospatial technology hinges on processing techniques that weeds through and translates the tsunami of spatial data for useful information within a problem context. The basis of the integration isn't so much "mash-ups" that are graphical regurgitations of otherwise non-spatial databases (e.g., address geo-coding) but a fully integrated spatial bade interacting with all components of IT.

What GIS practitioners need to realize is that raw mapped data has to be refined into useful information within the context of a decision. For example, the Big Guy in the Boardroom doesn't want a Forest Parcel map as much as a Principle Net Worth map of the forest holdings that changes as different discount rates and mill requirements are simulated.

What IT folks need to realize is that location (X,Y,Z position) is a universal key for organizing and accessing information as robust as the traditional key of date/time. Geospatial data is a powerful new way to organize, access and analyze database records.

State of Innovation

Consumer-oriented Web mapping tools seem to add a new functionality every month. This pace is difficult to match on the geospatial platform tool side. What's the current state of geospatial technology innovation, and where are the frontiers with the greatest promise?

What I find interesting is that current geospatial innovation is being driven more and more by users. In the early years of GIS one would dream up a new spatial widget, code it, and then attempt to explain to people how they might use it …sounds like the proverbial "cart in front of the horse."

However, "user-driven innovation" is in part an oxymoron, as innovation (a creation (a new device or process) resulting from study and experimentation, Dictionary.com) is usually thought of as canonic advancements leading technology and not market-driven solutions following demand. At the moment, the over 500 billion dollar advertising market with a rapidly growing share in digital media is dominating attention and competition for eyeballs is directing innovation.

User-driven GIS innovation will become more and more schizophrenic with a growing gap between the two user communities…

"**Analysis**" *…impact measured by conceptual/application changes (models)*

|-- Experienced/Expert → Platform Tools

Users ------------| *<widening gap>*

|-- General user/Masses → Web Postings

"**Visualization**" *…impact measured by eyeballs/hits to websites (interpretation)*

Another interesting point is that "radical" innovation often comes from fields with minimal or no paper map legacy, such as agriculture and retail sales, because these fields do not have pre-conceived mapping applications that constrain spatial reasoning and innovation.

In the case of *Precision Agriculture*, geospatial technology (GIS/RS/GPS) is coupled with robotics for "on-the-fly" data collection and prescription application as tractors move throughout a field. In *Geo-business*, when you swipe your credit card an analytic process knows what you bought and where you live/work and can combine this information with lifestyle and demographic data through spatial data mining to derive "propensity to buy" maps for various products throughout a market area. In both cases, mapping and map analysis was non-existent a dozen years ago but millions of acres and billions of transactions are now part of the geospatial "stone soup" mix.

Who is GIS

Is the educational system turning out the right mix of skills to respond to industry's needs? Is there enough depth (e.g., basic skills like computer programming, stats, etc.) and breadth (understanding of applications)?

Wow!!! …a Socratic question like "what is beauty," what is justice," and "what course of life is best." Whoa, question like "Who is GIS" ought to be debated all night with free-flowing casks of wine.

In a large sense, "who we are" is a reflection of our professional and educational experiences. For the educational component, it can be divided into two groups—

"**Theory/Concepts**" *…of the computer and mapped data (GIS experts)*

|-- Education → programmers, GIS developers, system managers, data providers
"Who We Are" --|
|-- Vocation → GIS specialists, general users, masses

"**Skills/Practice**" *…of the application and access (Domain experts)*

The bottom line is that one academic shoe (program) does not fit all under the ever enlarging GIS tent. Historically, GIS was thought to be "owned" by Geography but, like statistics, the applied disciplines are claiming their own GIS turf on campuses and GIS courses in <*fill-in the blank*> (e.g., natural resources, agriculture, business, epidemiology, engineering, etc.) are increasingly prevalent on campuses.

Also, early on GIS was thought to be the domain of computer science, but with increasing computer literacy and access on campuses this aspect is diminishing. For example, at the University of Denver we are moving into our eighth year of requiring students to have a notebook computer and the entire campus has wired or wireless access—a very computer savvy student body.

Effective GIS solutions need folks that know the right questions (Breadth of the applications) and know the right tools (Depth of the GIS procedures). This combination is rarely embedded in a single individual and best addressed within a team environment. What seems to be missing from many GIS academic programs is team-based problem-solving and experience in clear/concise communication of spatial solutions.

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