*GeoTec 2010 — Panel on*

# GIS in Higher Education:
## Issues, Opportunities, Concerns, Considerations and Future Directions


*Panelists*

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*Moderator*

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*The panel session discusses a variety of topics affecting GIS in higher education to include organizational structures, student types, instructional approaches, logistics/venue considerations and curricula content. The panel's members have over 100 years of combined experience from workplace settings, project design, development and implementation in industry applications to academic presentation of GIS concepts, procedures and practice in a wide variety of formats from workplace workshops, and certificate programs to introductory classes and intensive graduate courses. Audience interaction and extended discussion is anticipated and encouraged.*


**Further Information**: The following list includes selected online references the panelists have suggested a couple of related online references that they feel would be useful for the audience's further study.

– **http://www.innovativegis.com/basis/MapAnalysis/Topic4/Topic4.htm**, "Where is GIS education?" A series of Beyond Mapping columns appearing in GeoWorld magazine, Joseph K. Berry. Excerpt: *"Historically, maps focused on precise placement of physical features (material/tangible) primarily for navigation. As mapping evolved more non-physical information (logical/cognitive) found its way into map form. The step from digital map data to spatially distributed solutions involves a paradigm shift from descriptive "Where is What" mapping to prescriptive "Why, So What and What If" modeling. This transition in emphasis …suggests that spatial reasoning needed for the transition lies outside the usual knowledge, skill sets and experience of GIS'ers. However, most GIS curricula are designed to service the core community with minimal attention to reaching other disciplines."*

– **http://www.esri.com/news/arcnews/winter0506articles/defining1of2.html**, "Defining the Components of the Geospatial Workforce - Who Are We?" Published in ArcNews, Winter 2005/2006, Duane Marble. Excerpt: *"Presently, far too many academic programs concentrate on imparting only basic skills in the manipulation of existing GIS software to the near exclusion of problem identification and solving; mastery of analytic geospatial tools; and critical topics in the fields of computer science, mathematics and statistics, and information technology."*

– **http://www.informaworld.com/smpp/section?content=a915789602&fulltext=713240928**, "Roles for GIS within Higher Education." Published Journal of Geography in Higher Education, 2009, Diana Stuart Sinton. Excerpt: *"The use and awareness of GIS is steadily increasing… With this popular growth comes an opportunity to establish greater awareness of mapping, spatial reasoning and geography in general. There is no one-size-fits-all role for GIS within higher education, and that speaks to the versatility of geospatial technologies and the breadth of applications for spatial analyses."*

– **http://www.nature.com/nature/journal/v427/n6972/full/nj6972-376a.html**, "Mapping Opportunities." Published in Nature, January 2004, Virginia Gewin. Excerpt: *"Earlier this year, the US Department of Labor identified geotechnology as one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology. Job opportunities are growing and diversifying as geospatial technologies prove their value in ever more areas."*

**Questions Considered**: The discussion focuses on issues, opportunities, concerns, considerations and future directions in GIS higher education. *Included below are comments made by Joe Berry, jberry@innovativegis.com.*

1) *GISystems vs. GIScience?* How important are IT skills to a GIS professional? *Enterprise databases, database design, programming, web mapping, server administration, etc. are all skills that are commonly specified for a GIS specialist position,* **but are these beyond a typical university or college curriculum? Is it realistic to think that one institution or program can offer everything listed in the UCGIS Body of Knowledge? Is there a gap between what is found in a traditional GIS textbook and curriculum, and what employers actually want graduates to know?**

In short, Geographic (meaning relating to the surface of the earth), Information (referring to knowledge derived from study, experience, or instruction) can be viewed as 1) a System (interacting elements forming a complex whole) or as 2) a Science (explanation of phenomena). Following this logic, there obviously at least two "types" of GIS'ers and assuming that there is but "one curriculum" seems outrageous.

It is important to keep in mind that there is a continuum of GIS expertise that is needed for successful GIS implementation and use— 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* |

A "**GISystems**" perspective tends to focus more on the computer and it is imperative that these students have very sound IT skills. But even here there are differences in emphasis. A **Systems Manager** needs a deep keel in web mapping, server administration and database operations. An **Applications Developer** needs a strong foundation in programming, particularly with scripting and GIS macro languages.

**GIS Programmers**, the most misunderstood and least served lot of all GIS students, need extensive knowledge in systems development and formal programming languages, such as C-sharp, to develop our expanding suite of processing and analysis tools. This experience is well covered in the computer science side of campus but rarely do they expose students to the unique character of spatial data.

The "**GIScience**" (aside: I hate that "GI" introverted, dichotomous and overly cute abomination of a term for *Geotechnology*; sounds like research in digestive track problems) perspective tends to focus more on the application and while these students need to be comfortable with computers, IT is not a mainstay— rather it emphasizes the 'theory and practice behind how to solve spatial problems with computers." A **Data Provider** needs a strong background in mapping principles, as well as a comprehensive understanding of GPS and Remote Sensing systems and processing software. Just as important is an understanding of the information needed within his or her application field. The traditional **GIS Specialist** serves as an interface between users and the technologists. As such, he or she needs to be a generalist in all aspects of spatial information handling and processing as well as well versed in an application field suggesting a catamaran-like educational experience in GIS and an applied discipline (double-major or combined bachelors/masters degree programs).

The other group of woefully misunderstood and least served set of students involves **General Users**, primarily because they are not "officially" GIS students. However, as we move further beyond mapping and visualization toward complex applications, spatial problem solving becomes paramount. This suggests that spatial reasoning needed for the transition lies outside the usual knowledge, skill sets and experience of GISystems and GIScience professionals. Domain expertise that understands the capabilities of GIS is the needed catalyst but is rarely recognized in GIS curricula beyond simple digital mapping and visualization awareness.

Ok, enough background definitions and academic hyperbola …**are these (IT Skills) beyond a typical university or college curriculum?** …no, not at all; they are well represented throughout campus. The rub is that the skills are usually outside the traditional walls of disciplines involved in mapping, such as geography, natural resources.

**Is it realistic to think that one institution or program can offer everything listed in the UCGIS Body of Knowledge?** …no, not at all; but it requires interdisciplinary cooperation and university-level support that recognizes cross-discipline educational efforts.

Finally, **is there a gap between what is found in a traditional GIS textbook and curriculum, and what employers actually want graduates to know?** …yes, and thankfully that is as it should be. That is, in part, the distinction between "education" (acquisition of knowledge, communication and problem solving skills) and "training" (acquisition of skills necessary for a given job and its tasks). Higher education tends to excel in the former at the expense of the latter; certificate programs, on the other hand, tend to excel in the latter at the expense of the former. Following this logic, there obviously at least two more types of GIS students— "skill seekers" and "problem solvers"—to accompany the "of the computer" and "of the application" types.

So what is the "rosy future" of GIS education? Three things come to mind—

1) GIS educators need to design curricula with multiple "tracks" (an ugly, unspeakable word in academia) that, at a minimum, recognize different experiences needed for students "*of the computer*" and students "*of the application*" at two different levels—degree programs and certificate programs,

2) Departments need to cooperate in developing programs for cross-discipline courses and project experiences, and

3) University bureaucracy needs to instill policies that recognize and reward interdisciplinary instruction and advising.

A pipe dream? …probably; but it is what is needed for geotechnology to reach its full potential.

2) *The Spatial Triad recognizes the interdependence of remote sensing (RS), global positioning system (GPS) and geographic information systems (GIS).* **What is an optimal balance in a student's academic experience with these three fields? What additional fields might be added to the mix in the future (computer science, multimedia/webpage design, robotics, etc.)?**

All geotechnology professionals need a basic knowledge in all three components of the Spatial Triad—RS, GPS and GIS. My doctoral work was in Remote Sensing, but that was in the pre-Paleolithic period of the early 1970s before GIS and GPS even existed outside the dreams of a few innovative researchers. Adding GIS provides an encompassing digital environment for mapped data and advanced geo-query, visualization and analytical capabilities. Adding GPS provides real-time positioning and considerable precision to field collected data and delineation of spatial modeling results.

**What is an optimal balance of three spatial technologies** is in large part dependent on a student's interest and career objectives. What is certain, however, is that all three have to have some representation at least at an introductory level in a geotechnology student's portfolio. If for no other reason the triad forces students to confront different paradigms of spatial information. However, it is important to keep in mind that it is imperative for students to develop a deep keel of advanced skills in at least one of the spatial triad technologies…a demonstrative level of expertise that a prospective employer will readily perceive.

One paradigm difference involves alternative data structures and formats, such as the enduring "**vector versus raster**" intellectual partition. It is critical for students to experience the relative advantages and disadvantages of "squiggles" and "chunks" in conceptualizing, storing, processing and analyzing mapped data.

Another paradigm difference involves the distinction between "**precision and accuracy**." In GPS and vector GIS the focus is on precisely locating discrete spatial objects defined by point, line and polygon features. The attribute attached to the feature is usually assumed to be accurate. In Remote Sensing and grid-based GIS the precision is locked into the spatial resolution of the grid cell and the focus is on the accuracy of the classification. A project area is viewed as a continuous surface with varying conditions or characteristics throughout that have fluctuating accuracies.

Ok, the statement that "an optimal balance depends…" is a hedge toward being politically correct. Personally, I see large value in exposure to both GIS and Remote Sensing as they offer dramatically different perspectives and experiences in the expression of spatial information. GPS, on the other hand, seems more vocational and a tasking skill set—that is unless one pursues its deep, deep keel involving advanced mathematics and electrical engineering. It is sort of like knowing that your car has a turbocharger (awareness and appreciation) but not withholding your driver's license if you don't know the gas compression principles and forced induction theory.

Now that a good portion of the audience is outraged, attention can be turned to "**additional fields that might be added to the Spatial Triad mix**." In Precision Agriculture RS/, GPS, GIS combine with "**intelligent devices and implements (IDI)**." The Spatial Triad is used to assess the relationships among factors driving crop production, such as nutrient levels, pH, and seeding rates, and then derive prescription maps for site-specific management action. For example, a prescription map can be generated that identifies the right amount phosphorous, potassium and nitrogen for each ten-foot grid location in a field. The map is transferred to a flash card that is inserted into a controller that adjusts a bank of servos to deliver the precise mixture of P, K and N to each grid location as the fertilizer rig moves across the field.

In a similar fashion, a variable rate seeder can adjust the seeding rate to micro-terrain changes—more seeds in the depressions and less on the side and top slopes for low moisture areas; opposite for high moisture areas. The RS/GIS/GPS plus IDI approach can be extended to most applications requiring spatially depend variations in machinery for on-the-fly control.

A totally different kind of extension involves linking "**social science tools**," such as consensus building and conflict resolution software to calibrate and weight spatial models. For example, a model for routing an electric transmission line that considers engineering, environmental and development factors can be executed under a variety of scenarios that reflect different influences of the criteria map layers derived from different stakeholder groups. The result is infusion of collective interpretation and judgment required for effective cognitive mapping.

This linkage is in part the basis for the hot new term "*crowdsourcing*" that mashes the words "crowd" and "outsourcing" to describe *the act of taking tasks traditionally performed by a team of in-house specialists, and outsourcing the tasks to the community through an "open call" to a large group of people (the crowd) asking for their input* in calibrating and weighting the model.

However I believe the Spatial Triad extension that will have biggest impact in the next couple of decades will be the full integration of advanced "**data mining technology**", such as CART (Clustering and Regression Trees), induction models and neural network analysis for analyzing spatial patterns and relationships. This will require a rethinking of both the GIS and statistical communities—from paradigms of discrete spatial objects and random sampling to recognition of continuous spatial surfaces that account for and utilize spatial correlation and autocorrelation. But that's another story and beyond the scope of this forum ...involving the "dismal and unsettling" science of statistics.

3) *With corporate powerhouses like Microsoft and Google now firmly entrenched in the GIS realm,* **how do we accommodate the needs of these juggernauts in providing GIS savvy people?** *In addition, enterprises like Google are inherently changing the face of the commercial remote sensing industry, simply by satisfying their need for information processing and their business model for giving information away.* **How does this impact the subsequent changes we are seeing in the "GIS" industry, and the demand for GIS educated professionals?**

In many ways, the "*Multimedia Mapping*" expression of geotechnology is a spur of the discipline—an enormous and tremendously important spur, that today is effectively driving the technology. In essence it provides a ubiquitous vessel for organizing and viewing spatial information. The open nature of these systems foretells a radical change in instruction and educational experience from the current flagship GIS systems. To **accommodate the needs of these juggernauts** more emphasis needs to be on generic programming languages and computing environments—a big bump away from specialized GIS software and toolboxes toward more general computer science.

While the underlying spatial concepts of GIS remain the same, the working environment is different. This is both an a burden and an opportunity for academic programs. It will require revamping courses and developing a closer relationship with computer science and digital media studies. In turn, there could be connection to a pipeline of new "shared" students.

I suspect that Bing Maps and Google Earth will continue to focus on navigation and visualization for the masses that captures millions of eyeballs—their coin of the realm that feeds off "advertising clicks" that follow one's virtual tour of the globe. That leaves a lot of elbow room for boutique GIS solution companies to develop tailored applications that call for graduates with deep-keeled GIS system and map analysis skill sets. Overall there should be a surge of interest in GIS across campus provided the current GIS programs don't "circle the wagons" in defense of the status quo.

The business model of free access to spatial information of the multimedia mapping juggernauts has changed the GIS industry landscape, particularly for data providers. Of course this isn't the first tsunami of change for them. Twenty years ago the gold field was in data conversion that kept folks busy 24/7 digitizing the paper map legacy. Those days have played out. Similarly, last decade's hot new fields of website development and web mapping are on the downside of their run as most of the potential market has been brought online.

The commercial remote sensing industry is hard hit as well. Unless there is an overriding need for time sensitive or high spatial/spectral resolution, contract imagery is in a tailspin. LIDAR and terrain modeling is serving as a stopgap but most of the acquisitions are for governments and free distribution. Unless there a lot of Mt. Saint Helens in the future this to will play out.

So how does all this **impact the changes we are seeing in the "GIS" industry, and the demand for GIS educated professionals?** …in a word, "**value-added**." Data will become increasingly free and omnipresent. Gone will be the cadre of worker bees tending to a honeycomb of corporate caches of separate yet mostly redundant spatial data. Like the evolution from application-specific GIS packages to the GIS "Toolbox" environment we are transitioning to a GIS "Storage Box" environment.

The jobs and subsequently skill sets in demand will be in developing spatial reasoning skills that "mine" the communal storage box of data for context and custom spatial products—mapped data describing "where is what" to spatial information conveying "why, so what and what if" for decision-making. GIS education will lessen its emphasis on data warehousing and take on more of a problem-solving role.

4) *"Free or for fee" …this geospatial data debate has spanned over decades and touched every organization involved in geospatial data collection, maintenance and use. Many organizations however (mostly government) have recently decided to open their data vaults and (subject to legal restrictions) allow free use of data. This has opened a huge opportunity for individuals, community groups, private businesses, and academia to use the data for all kinds of applications. Many of these elements are concerns which data producers (especially in government) have during decision making process for data release.* **How is the open data environment changing directions in higher education? Would educational institutions attempt to teach more legal and/or regulatory subjects, statistics, programming techniques, communication tools, data management, and security?**

Open data environments are breaking the longstanding logjam of potential applications. Historically, the cost of data acquisition often outweighed the combined investments in storing, analyzing, managing and displaying spatial information. As baseline sets of mapped data become freely available, particularly in a "cloud computing" environment, these costs plummet. Combine this with Open Source GIS systems and GIS is within reach of more and more organizations in a wider variety of applications. That's good, right?

But it comes with "strings" attached that are **changing directions in higher education**. Open systems and free data certainly will cause restructuring of a lot of the technical aspects of contemporary academic programs—new software, procedure, hands-on exercises and, to some degree, new concepts and theory. "Open" in both data and software are education in themselves from three perspectives—1) the compliance specifications for interoperability force students to struggle with the details; 2) the systems allow students a peek "under the hood" of database and software design; and 3) provide an inexpensive environment for students to "duplicate" processes in alternate environments that reinforce fundamental concepts (theory) over platform mechanics (buttons).

One of the biggest changes would be the exchange of commercial GIS platforms with less controlled and supported **Open Source Software (OSS)** residing in the public domain. The new environment would be like the Internet itself— loosely organized and collaboratively driven by volunteers from around the world. In a sense, it would be more like the university ideal of freely exchanged ideas, joint efforts and mutual benefits …sort of a GIS equivalent to the Linux open source software collaboration resulting in a Wikipedia-*ization* of GIS.

But could the move from commercial to public domain software in GIS higher education really happen? …well, yes and no, and that is an important dichotomy. A growing segment of the world is turning to public domain GIS packages; particularly in the developing countries. Many countries in Africa, for example, explicitly require government funded projects to utilize open source software; and a large portion of cloud computing movers and shakers support OSS approaches. The bottom line is that Open Source Software is gaining greater presence and indeed a firm foothold outside the US and Canada.

Hence, academic GIS programs and students with an eye to serving non-profit and overseas organizations need to develop OSS skills and have practical experience opportunities. That suggests a new emphasis or minor in the general GIS curriculum for some schools (that's the "yes" in yes and no response). But open source software will not replace commercial software at most universities for three primary reasons: 1) existing course development investments, 2) aggressive marketing and support from commercial vendors, and 3) deep educational discounts for universities and students (that's the "no" in yes and no response). These factors, coupled with direct experience (training?) with commercial software students most likely will encounter in the North American workplace, insure that commercial software will continue as the mainstay at most US/Canada universities, at least in the near term.

But what will be the impact of **free (and open) data** on changing directions in higher education? It is a tsunami with its first and second waves already inundating academia. Two very important considerations dominate the debris: 1) how will GIS programs respond to the increased interest across campus, and 2) "who owns" the data, maintains it, verifies its authenticity, accuracy and precision— in short, "who is responsible" for the data?

I believe there will be two distinct responses to the increased interest in spatial information. Some GIS programs will "circle the wagons" and strongly defend their ownership (and student numbers/budgets) of all things geotechnical with minimal outreach. Other programs will have permeable walls with a free flow of students, faculty and ideas that encourage interdisciplinary efforts. In large part, the path taken will be influenced by university-level policies and budgeting that encourages or discourages disciplinary silos and programmatic fiefdoms.

On the ownership question, GIS programs need to take the lead in trumpeting the utility of spatial information, while at the same time tempering the enthusiasm with realities of data precision, accuracy and appropriate use. "All mapped data is not the same" should be the mantra of tailored seminars for applied disciplines that catch the geotechnology bug ...a professional responsibility we cannot avoid.

5) *Many academic programs express difficulty in balancing common principles (centralization/standards) with unique application considerations (use/utility).* **What role does standardization and certification play in GIS higher education? How important is it to innovate, adapt or follow standard GIS curriculum, such as the NCGIA Core Curriculum in GIScience?**

The US Department of Labor notes that the GIS job market is growing at an annual rate of thirty-five percent and touts geotechnology as one of the "mega-technologies" for the 21st Century, alongside biotechnology and nanotechnology. Our students need a multitude of skills— not only in basic subjects such as reading, mathematics, writing and problem solving, but also developing technical and computer skills in programming, database management, modeling, statistics, project management, as well practical experience through independent projects or internships.

Academia has responded with a plethora of courses, minors and majors, degree programs, professional and certificate training. So far most of this has happened with minimal standardization, which to some degree has confused students and potential employers alike. One might argue that if geotechnology is actually a "new discipline," there ought to be a set of fundamental concepts and principles, skills and capabilities, and exposures and experience s that are common to successful professionals in the field. To many it follows that **standardization and certification** are needed to define this common knowledge base.

This approach has been adopted by a multitude fields from real estate agents to jet mechanics to pediatricians and lawyers. It has the *advantages* of outlining an essential set of proficiencies, signaling to a prospective employer a basic skill set attained and even minimizing academic battles over curricula requirements—just teach to what the overseer says. The primary *disadvantage* is that the standard curricula might not align with each student's the interests, background, or intended career path— and same might be said for the faculty. Standardization also suggests accreditation which has its own administrative concerns.

My take is that there is a lot of daylight between the concepts of "standardization" and "certification." I suspect many GIS educators would agree on broad areas of expertise defining geotechnology, such as…

- **Geography and cartography**, *including map design and spatial relationships*
- **GIS technology**, *including software proficiency, data considerations and analysis*
- **Information technology**, *including database design and management*
- **Other essential skills**, *including mathematics, statistics and presentation*

…but disagree on the mix, relative emphasis and depth of experience in each of the areas, not to mention specific course content. *Certification* translates the broad list into "specific requirements" and in many cases, even develops tests to assure proficiency (analogous to a "planned" economy). *Standardization*, on the other hand, treats the broad areas more like "guidelines" that allow the faculty to assemble program requirements that they believe best meets student, employer and academic needs (analogous to a "market driven" economy).

For the most part, I believe the **standard GIS curriculum, such as the NCGIA Core Curriculum** and *The Geographers Craft* are best viewed as resources for helping educators design and develop their own curriculum, rather than as sets of materials defining a GIS program of study and individual course content—adapt rather than adopt. This enables institutions to be innovative in developing entirely new courses, as well as tailoring the curricula to groups of students with specific interests (such as non-profit or developing nations career aspirations) and utilizing unique faculty expertise and experience.

The bottom line is that the assumption that there is single program of study defining geotechnology is in itself, "certifiably silly." Now for my personal soapbox …I believe much of what we used to call GIS is moving to "commodity status" which means that more and more competition will come from individuals outside geotechnology who can perform basic tasks of data acquisition/collection, geo-query, internet mapping, spatial database management and visualization. However, the analytical capabilities of GIS likely will remain the domain of specialists who can translate complex spatial problems into effective spatial solutions. The most successful students will be able to contribute "new ways of doing business" to an organization that will likely involve map analysis skills over traditional mapping skills.

Capabilities for spatial inventory, analysis and display likely will revert to those with domain expertise which suggests that students need to develop a thorough understanding of an applied field—need to be able to "walk the walk and talk the talk" of an industry and its professionals. To do otherwise, will keep students and their geotechnology skills in a closet "down the hall and to the right" away from the real action in an organization.

6) *To date, most GIS education within the academic and commercial arenas has focused on teaching students GIS technical skills in support of understanding spatial data management and analysis concepts. For GIS to truly become a key technology, increased knowledge is required to understand "how to apply" these skills to meet social and business*

*requirements.* **How do we achieve this, and what is the role of academic versus corporate organizations in meeting this education requirement in the future?**

The translation of learned "principles and skills" into "effective solutions" is largely dependent on the experience and creativity of the student. Both of these factors are difficult to hone in academic environments—difficult but not impossible.

I believe **how we achieve this** is twofold: through practical examples in the classroom, and direct experience through projects and internships. As GIS in higher education continues to mature it seems the natural tendency is to add more and more "in-house electives" to an already burgeoning set of required courses.

Independent projects are an alternative but often start with minimal definition, tend to have a great deal of uncertainty and require considerable dedicated faculty interaction. Team or class projects that chase a defined spatial problem using existing datasets can be much more efficient and effective. The experience requires students to apply their grasp of spatial data and analysis concepts and employ skill sets within a practical context—in short, "problem-solving."

The **role of corporate/agency organizations** in this process is vital. Obviously they are a potential source for internships and independent projects. But just as important, they can provide interesting real-world project topics and help develop approaches and data sets for group projects. It is a win-win situation as students get practical experience and interaction with industry/agency and the organization gets to tap fresh minds and interact with potential new hires. In essence the university provides the setting, logistics, facilities and charge while the organization helps define and refine the project and its solution.

7) **How can we foster communication between instructors and employers to design and modify the curriculum over time to meet the needs of employers and society in general? How can we promote better linkages between educational institutions and employers?**

It seems to me that there are two critical impediments to collaboration that must be recognized and addressed before **we can foster useful communication between instructors and employers**— 1) the exchange cannot be viewed as "direct meddling" with curricula with a primary objective of meeting the needs of employers, as that easily can be misinterpreted as supplanting "education" with "training"— a sensitive hot button for academics, and 2) the exchange cannot be viewed as a "time tax" or distraction from their corporate mission but as a fully recognized, extensively promoted and heralded (public relations) event.

A "GIS Industry/University Summit" is a frontal assault forum which has had mixed success at some universities. It is most successful if it can be tied to another event, such as conference or regional business meeting (e.g, CSU, GIS in the Rockies Conference and Rocky Mountain Innovation Initiative (RMI2) for Northern Colorado Entrepreneurs).

A more "indirect" and lasting mechanism for **promoting better linkages between educational institutions and employers** is a weekly or biweekly seminar series—preferably an official light course with "mandatory" attendance and a light paper requirement. For example, a short course that meets weekly, 2 hours, 2 credits, 80% attendance, short paper or applied project addressing further investigation of two or more of the topics presented (e.g., DU, Topics in GIS course). To be effective it needs a faculty champion(s) with good industry contacts, general faculty commitment, curriculum canonization, and, of course, a small budget for free pizza.

The bottom line is that both the academics and industry activists must be vigorously engaged for the dialog to be effective and lasting. Also, the outreach to industry must be recognized, supported and enthusiastically sought by department, college and university administration.

A pipe dream? …possibly; but it is what is needed for effective and continuing relationship.

8) *More people live in cities than in rural areas. Urban sprawl touches not only the daily lives of families and individuals, but also government operations and service delivery. It looks like the constantly growing population and changing economic conditions make this process unstoppable. GIS plays a very important role in everything governments do. The City of Toronto has over 50 lines of business and 90% of them use geospatial data and technology to some extent and this is just the beginning. It is expected that GIS professionals who provide geospatial solutions to business problems understand every business problem. It is also expected that GIS professionals are IT savvy or in fact IT professionals as well.* **Should GIS educational programs be enhanced with more urban design, urban planning, social development, security issues, emergency services and database management, project management, computing infrastructure management, and communication infrastructure just to name a few? Is it**

**time to open more comprehensive Geo-technology Departments teaching subjects which are necessary to serve citizens with effective and efficient government services?**

Geotechnology, by its very nature, is an applied technology and can't survive in a pure disciplinary context unto itself. Its rapid rise from conceptual primeval goo in the 1960s to its present mega-technology stature is in large part due to extensive adoption by a myriad of other disciplines.

This widespread reach is both a plus and a minus in designing curriculum and course content. A diversity of applications helps students "see" fundamental concepts, principles and procedures from a variety of perspectives that reinforce practical utility. But at the same time, the spread of applications is well beyond the reach of finite GIS faculty numbers, expertise, interests and budgets. While we can see the ever expanding pile of application chips, it is dysfunctional to think we can get arms around it and sweep the pot to our side of the academic poker table.

The key is "outreach" to the other sides of campus. Rather than creating **a more comprehensive Geo-technology Department** by developing in-house courses in applied fields that **serve citizens with effective and efficient government services**, we need to partner with other departments in bringing GIS experiences into their offerings—either as formal courses or portions of existing courses. In part, this outreach is recognition of the student marketplace makeup with the applied discipline students happily housed in their current departments. Pulling them out of their program for a "related" course in another department is difficult; establishing a joint offering creates a recognized tap on that student pool.

Just as important is insuring that GIS students develop a "keel" of expertise in an applied discipline(s). This suggests that geotechnology education is more like the hull of an outrigger or catamaran, than an icebreaker. It encourages our students to develop a secondary disciplinary thrust that focus on spatial problem-solving instead of continued deeper dives into database compilation and software nuances. Particularly effective is developing "dual major" or "minor" relationships with other departments on campus. Also, this might help dispel the perception that GIS is a cluster of technical specialists "down the hall and to the right" nurturing mapped databases, but not really direct participants in the organization's mission.

The bottom line is that for us to move beyond a mapping support role we need to <u>fully engage "applied domain expertise" in GIS offerings and through partnered offerings and degree programs</u>. This means outreach across campus is as important (and arguably more important) than further honing courses for training core professionals.