What Does the Geospatial Professional of the Future Look Like?

Introduction

The last few decades have brought great change to professions with very long histories. New professions have formed and are thriving, while others struggle to maintain a healthy membership and relevant role in society. In this article we will examine geospatial professionals in the recent past, the present, and the near future. As part of this examination we will briefly consider the following topics:

(1) The way geospatial professionals are trained and educated.
(2) The way these professions collaborate and interact with each other, with other professions and trades, and with the public.
(3) The way geospatial professionals execute their respective crafts or skills.
(4) How individual geospatial professionals and the organizations that employ them need to prepare for trends that will be shaping the geospatial industry in the near future.

Who are Geospatial Professionals?

The term "geospatial professional" could have many different meanings. Before we get into the thick of this article let's define the term for our purposes.

"Geospatial" is a word we will define as data with a spatial component that typically represents a feature or phenomenon on, above, or below the Earth's surface.

"Professional" is a term we will define as an individual engaged in the serious study and practice of a particular skill craft or endeavor and who possesses the following traits:

(1) A focus on improving their practice of the endeavor.
(2) A desire to improve the practice of the endeavor by fellow professionals.
(3) A duty to protect the health, safety and welfare of the public.
(4) A duty to protect the interests of their clients or organizations they serve.
(5) Adherence to a high moral and ethical standard in the practice of their endeavor.

With the an understanding of those two (2) words, we can then define a "geospatial professional" as any professional

that collects, creates, manages, manipulates, styles, or presents geospatial data.

Questions to Answer

This article will try to answer the following questions:

What will geospatial professionals of the future look like?

How will they be different from geospatial professionals of the past?

How have geospatial professionals been challenged by recent technology changes?

What technology trends have the potential to be the most disruptive to geospatial professionals as we move into the future?

What can you do as an organization to prepare for these changes and recruit the best talent?

What skills do you need to acquire as a geospatial professional to prepare for the future?

Changes in the Recent Past and Present

The last few decades have brought great changes to geospatial professionals. Many of these changes are part of larger ongoing trends that geospatial professionals are trying to adapt to. Let's consider the changes in the three (3) areas we mentioned previously:

(1)Education.
(2)Collaboration and Interaction with others.
(3)Execution of their trade or craft.

Changes in Education

We will begin with the changes to education. There has been a push to mandate education or to increase the educational requirements for geospatial professionals, especially for those professionals licensed and regulated by the government. This push has included changing state laws and creating new academic programs at colleges and universities.

While this push for more education is occurring, academic institutions are trying to adapt to many changes themselves. They are working to decide which of the old skill sets are no longer needed, which current skill sets should be the focus of their programs, and which should be the focus of their

programs in the future. They often struggle to "fit in" all the education needed to provide the broad and deep knowledge needed by the geospatial professionals they are training. At the same time rising tuition costs put the education they offer beyond the reach of more and more potential students. In response to these pressures, some colleges and universities are trying to make their instruction available remotely by means of the internet, and some even tailor their programs for working professionals.

Changes in Collaboration and Interaction

The internet has greatly increased the potential for collaboration among geospatial professionals. It has never been easier to connect individuals from around the world that share similar interests. In many cases these connections result in the formation of teams that come together to accomplish real work and solve challenging problems.

Despite this increased potential for collaboration, some of the traditional organizations that serve the interests of geospatial professionals struggle to remain relevant and maintain their membership rolls. The American Congress of Surveying and Mapping is an example of an organization that has seen its membership continuing to decrease over the last couple of decades. It remains a challenge for these traditional organizations to skillfully employ the internet to tap into resources offered by scattered individuals with an interest in their mission.

Other organizations, both non-profits and governments, are not prepared to take advantage of geospatial professionals that want to volunteer their skills. Oftentimes the more skilled the volunteer, the harder it is to find an organization that can fully utilize the volunteer's skills.

Changes in the Execution of Craft and Trade

The greatest changes have occurred in the way geospatial professionals execute their trade or craft. For the sake of simplicity, we will organize these changes into two (2) broad categories. In the first category we group advances in equipment and technology related to the acquisition of spatial data. In the second category we group advances in computing. We will discuss both categories.

Advances in the Equipment and Technology Used To Acquire Geospatial Data

A large industry has grown to support the high-tech business of providing geospatial professionals with tools to acquire or

collect geospatial data. This industry is no longer dominated by individual instrument makers practicing their craft in small shops. Instead global corporations with fingers in multiple aspects of geospatial data collection are the key players shaping the direction spatial data acquisition will take in the future.

The advances we've seen in the technology used to acquire geospatial data include the development of Global Navigation Satellite Systems (GNSS) and their related technologies. The premier GNSS is the Global Position System (GPS) funded and administered by the United States Federal Government. However, GNSS has proved so valuable and revolutionary that we now see other satellite systems like the Euorpean Union's Galileo, Russia's GLONASS, and China's Compass satellite systems becoming players in the GNSS arena. GNSS signals are being supplemented by supporting satellite systems like WAAS in the United States, Michibiki in Japan, India's GAGAN and even systems maintained by private companies, like John Deere's StarFire. More than any other single combination of technology, GNSS has made it possible to acquire the location of people and things cheaply and easily.

Advances in remote sensing have included new types of remotely sensed data, such as LIDAR. We've also seen the launch of powerful remote sensing satellites. The quality, resolution, frequency and types of data available from remote sensing have all improved. For example: The Fall 2010 Issue of Imaging Notes Magazine described the remote sensing satellite system operated by the company Rapid Eye. The five (5) satellites in this system have the capacity to capture 1.5 million square miles every day. That is an area equal to the land mass east of the Missouri River in the contiguous United States. The library of data from this system is already over one (1) billion square kilometers, or seven (7) times the land mass of Earth. It is now possible to acquire, for no charge or a very small fee, fairly current 3 foot resolution raster data for most of the Continental United States. In urban areas higher resolution raster data is often available in the public domain. I know of a small land surveying company that recently acquired 1 foot resolution aerial photography of an area covering several counties for just a few thousand dollars. This abundance of raster data is likely the second most powerful reason why it has become cheaper and easier to acquire geospatial data.

Advances have also come to the land surveying industry, allowing for more efficient collection of terrestrial land surveying data. The last (twenty) 20 years brought the use of GNSS in land surveying, elimination the need for line-of-sight in the execution of surveys. In just the last decade land surveying has seen the arrival of digital levels, reflectorless electronic distance meters that need no prism, robotic total stations, and terrestrial laser scanners.

These advances in GNSS, remote sensing, and terrestrial geospatial data acquisition have made it much less expensive to

obtain geospatial data. We will consider the impacts of this trend in later in the article.

Advances in Computing

In the second category of changes related to the way geospatial professionals execute their crafts or trades we group advances related to the computer.

The arrival of the computer as a platform for geospatial tasks has been a relatively recent development. The first successful high-level programming language arrived only a little over 60 years ago. Since its arrival, the computer has become smaller, more powerful, and cheaper. Programming languages have become easier to learn, easier to use, and programming language tools have become less expensive.

The computer has allowed a huge migration from paper records to digital records in the geospatial arena. For example: When was the last time you purchased a paper map of any type? We can now access high-quality street maps online, download filed surveying maps from our local County web site, access real property deeds from the local Clerk and Recorder's web site, and obtain digital USGS quadrangle maps from federal government GIS data portals, and view flood hazard maps online using tools from FEMA.

The software running on our computers have also impacted the geospatial industry. The power of personal computing has made it possible for organizations of all sizes to implement geographic information systems. These systems allow powerful spatial analysis and map-making on desktop computers. It is now possible to create and edit geospatial data in the field using your mobile phone. User friendly geographic software like Google Earth have increased public awareness of geospatial data and analysis. They have allowed the layman to easily view geospatial data.

Computers have increased the connectedness of our world. This connectedness makes it possible to gather geospatial data from real time sensor networks and to send geospatial data to land surveying field crews on the job site from the office. More and more devices, like are cars, our phones, and our home cooling systems, are connected to the internet and providing data about themselves. This data often includes the objects location or other geospatial information.

Trends That Will Continue To Impact Geospatial Professionals

What trends will impact geospatial professionals as we move into the future?

Trends in Computing

Continued advances in the equipment and technology involved used in the acquisition of geospatial data will drive down the cost of this data. In addition, the frequency, quality and availability of geospatial data will improve.

Computers will become smaller, faster, more ubiquitous, and more connected to one another. It will become easier and more affordable to use computers to collect, view, and analyze geospatial data.

Open source software and open technology standards will become more dominant. They've already begun to change the dynamics of the business world. Newsweek magazine recently commented on this change in an article on investment in start-up technology companies. It said:

"The reason any of this is possible is because in the last 10 years the price of starting a technology company has fallen dramatically. No longer do startups have to pay $60,000 for an Oracle database or shell out tens of thousands of dollars for a content-management system: free open-source software has taken care of that."

The benefits of the open source software development model will continue to drive down the cost of software while increasing its quality and effectiveness.

Demographic Changes in Attitudes Towards Infor-mation and Technology

There is an entire segment of our society that has grown up with a tremendous comfort with the internet and other technology. They easily adapt to advances in technology and integrate it into many parts of their life. As the "music should be free" generation ages and gains more control in our society, we will find the consumers, clients, students, and governments will require changes in the way organizations operate. "Business as usual" will no longer be acceptable. They will want data that is easily accessed and delivered on their terms. For example, they won't want to drive to a building to pick up a form; they will want that form online. They won't want to fill out a pile of paperwork to learn about the salaries of local government officials, they will demand this data posted on an easy to use web site. The concrete signs of these changes to our attitudes about data, including privacy, access, and transparency can be seen in the formation and activities of organizations like the Electronic Frontier Foundation and the Open Data Consortium. The Fall 2010 Issue of Imaging Notes Magazine commented on

the changing attitude about geospatial data in the scientific community. In an article summarizing the IEEE Geoscience and Remote Sensing Symposium St. Germain was quoted as saying:

"We are coming out of an era when scientists held tight their data and they owned that information. I don't think we are going to be living in that place anymore. Everyone will have access to the data and there will be no capital in holding onto it."

They will ask for software and hardware that is open and modular because this makes it easier to use, easier to customize, easier to maintain and more affordable. It will become more and more difficult to sell software licenses and media in digital form. Consumers will demand real value in their products and services. When was the last time you made a major purchase without reading review of the product online? Future consumers and customers will be better informed and more savvy than the consumers today. It will become more difficult for organizations to profit from them without delivering real value.

Consequences, Implications, and Ways to Adapt

What are the consequences and implications of the trends we have just described on geospatial professionals and the organizations that employ them? How do these professionals and organizations need to adapt? Let's consider the answers to these questions in the three (3) areas we discussed above, (1) education, (2) collaboration and interaction, and (3) the way geospatial professionals execute their craft or trade.

Consequences, Implications, and Ways to Adapt: Education

Our traditional system of higher education is extremely inefficient. We pay a teacher to provide instruction on the very same course year after year. In some larger schools, students will take low level courses with hundreds of other students, having little or no interaction with the course instructor. Students are often limited to the courses that are made available at local colleges or universities. They must schedule their life, including their employment, around their class schedules, instead of having education that fits their schedule.

Imagine instead, a higher education system in which a student can choose from a huge menu of courses. Each course follows the same basic format. It is a module that snaps together with other modules to form an academic program. Each course is designed by best experts and teachers available for the course subject. It doesn't matter what college or university teaches

each course. There is a single unified system for assigning credit, and a student can enjoy courses from any number of academic institutions. Instead of spending time in redundant lectures, the teacher of the course interacts directly with students, offering the needed acceptance and guidance.

In this system, the student can take advantage of instruction without having to travel to a brick and mortar facility. Instead, they consume education through the internet. Their lectures are delivered via online video; they interact with their fellow students and teacher through e-mail, online message boards, and social media. All of this action occurs on the student's schedule. The student learns when they have time. This allows the student to pursue their education while caring for their other important responsibilities.

Geospatial professionals would be much more engaged with their future peers in this type of educational system. They would work together with academic institutions to provide instruction, mentoring, and practical hands-on experience. Internships with local companies and volunteer projects with local professional organizations would provide students with real world experience in their chosen field of endeavor.

Consider for a moment the benefits that would come from this type of system for higher education. Education would become more flexible, more affordable, and of better quality. As a result, more people would choose to be educated. Because geographic limitations would be overcome, schools could compete for students around the nation instead of being limited to the local population. Students could pursue the education that really interested them, instead of being limited to the type of education locally available. Brick and mortar infrastructure required by colleges and universities could shrink, as would the costs associated with them. The close connection between students and working professionals would result in students that were better prepared for the work place and in-touch with the realities of their profession.

Consequences, Implications, and Ways to Adapt: Collaboration

The boundaries between different types of geospatial professionals are being blurred by technology. Our professional organizations should reflect this. They need to become more embracing, and less exclusive. Land surveyors and photogrammetrists should welcome cartographers and GIS practitioners into their halls. Geospatial professionals should reach out to individuals that practice on the “fringes” of our industry. These “fringe” practitioners include construction workers that do grade setting and layout on construction sites, school teachers and grocery clerks that map street networks for fun in their spare time, and museum workers that love historic

maps. Many of these individuals may not consider themselves to be professionals, or to be involved in the geospatial profession. However, they can make valuable contributions to our industry and benefit from the collaboration and learning that come with an active role in the profession.

The internet needs to be fully engaged as a tool for geospatial collaboration by geospatial professional organizations. This trend has started, but it needs to be accelerated. Future professionals will be more reluctant to engage in the traditional "face-to-face" meetings that these organizations have thrived on in the past. These meetings suffer from the same problems of location and schedule that our current higher education system does. The professionals of tomorrow will want to engage with their peers around the world, without the worries of time zone or travel. They will have the power to come together in teams that can solve difficult problems and challenges if given the platform and guidance needed to do so. Successful open source software development projects have provided a demonstration of what can be accomplished when these systems of collaboration are implemented and they provide a model for geospatial professionals to follow.

Consequences, Implications and Ways to Adapt: The Execution of Craft and Trade

The most critical consequences and implications for geospatial professionals affect not our education or collaboration, but the way we execute our respective crafts and trades.

The Commoditization of Geospatial Data

Geospatial data will become more abundant, of higher quality, and cheaper. How long will it be until mobile phones provide positions accurate to the nearest foot and low cost hand held GNSS receivers can provide locations accurate to the nearest hundredth of a foot? The march towards cheap and accurate geospatial data will continue far into the future. At some point, geospatial data will no longer be the product of a skilled professional, but a commodity like clean water, crude oil and sugar. This reality will have tragic results for geospatial professionals that produce spatial data and that fail to adapt to the future in which geospatial data has become a commodity.

In certain aspects, this reality has already started to impact land surveyors. They can now accomplish much more with much less. As a result, fewer surveyors are needed and there is a downward pressure on prices. Construction staking has given way to machine control, and it is quite possible in the next few decades that a land surveyor with traditional surveying

equipment will no longer be seen on a construction site. Low-cost and widely available geospatial data sets also reduce the need for traditional topographic and data collection. Data sharing and community mapping efforts may accelerate this trend and reduce the need for GIS mapping efforts as well.

How do geospatial professionals and the organizations that employ them adapt to this coming reality?

There will be money made during the commoditization of geospatial data. The companies that create the hardware and software enabling the commoditization will profit. However, it will become much harder to reap financial rewards through tight control of technology. The use of patents, proprietary file formats, digital rights management, hardware "dongles" and other forms of vendor lock in will become less and less acceptable to society. Although these techniques may provide an effective short term strategy for success, the companies that collaborate and benefit from more open development models will thrive in the long run.

As we move forward in time, most geospatial data will be provided by a few large companies. Their coverage will be broad, their products will be comparable, and their profit margins will be thin. Land surveyors and other small geospatial data providers will be pushed to the margins, providing specialized data collection services to just a few clients for whom the standard data products of the big players falls just a little short for their unique project needs. In this sense, the geospatial industry will become like the automotive industry. Most consumers buy their car or truck from a large corporation company that mass produces vehicles. Only a few consumers and organizations purchase specialized vehicles. (For example: A race car, military vehicle, or ambulance.)

The companies that do operate in the thin fringe of specialized geospatial data creation will deal with intense competition and small profits. There will be far fewer companies offering these services than there are now. There may be some small exceptions to this overall trend, such as boundary surveying. These exceptions will be in areas that still require great skill, local knowledge, and a tolerance for high liability. In any case, the overall market for geospatial data collection will be shrinking and becoming less profitable.

Opportunities from Geospatial Data Commoditization

The commoditization and proliferation of geospatial data will present advantages for geospatial professionals and organizations that recognize and prepare for the opportunities.

Why is Google such a successful company? Certainly one reason is their ability to allow users to quickly and easily find useful information in among the masses of data in the web. In a similar way, companies that can wring value from masses of geospatial data will also be successful. This value will come from analyzing and using geospatial data to solve real world problems. It will also come from effectively presenting geospatial data or the result of its analysis.

Geospatial professionals can learn a lot about effectively presenting geospatial data from graphic designers, information designers, web designers, and typographers. The book *Visual Language For Designers* has a power quote that touches on the problem of effectively presenting meaningful information from mountains of data. It says this in a section entitled "The Designer's Challenge":

"The never-ending flood of facts and data in our contemporary world has caused a paradigm shift in how we relate to information. Whereas at one time information was community based, slow to retrieve, and often in the domain of experts, information is now global, instantaneous, and in the public domain. We now want information on our own terms. We maintain an underlying belief that it is our fundamental right to have access to well-structured and organized information. As a result, information design is exploding as organizations and individuals scramble to manage an overwhelming quantity of content. Understanding the most effective way to inform is now a principal concern. According to professor of design Dino Karabeg, 'Informing can make the difference between the technologically advanced culture which wanders aimlessly and often destructively, and a culture with vision and direction.'"

Increased cooperation between geospatial professionals and graphic designers, information designers, web designers, and typographers, will no doubt improve our cartography and the way we present geospatial data to our clients and the public. A more clear presentation of the message encapsulated in geospatial data will greatly benefit human society.

We mentioned previously the use of geospatial data and analysis to solve real world problems. This will be a critical skill for effective geospatial professionals and organizations as we move into the future. We will need to transform from geospatial data producers to geospatial data managers. Our clients won't need help producing or creating raw geospatial data. Instead, they will need help finding and using it to overcome the challenges they face and to accomplish their mission. As geospatial data becomes cheaper and more abundant, GIS projects that were once cost-prohibitive will become feasible. This will increase the opportunity for geospatial professionals that implement and maintain GIS projects that deliver real value.

Successful companies will be able to explain to potential clients how geospatial data can help them. These companies will not wait for organizations to approach them with their geospatial data needs. They will be actively helping organizations understand what role geospatial data plays in their operations. At its essence, this is a question of skillful marketing. Companies that do well at delivering this message, and in teaching their clients, will do well in business.

Efficiency: A Critical Business Trait Obtained Through Custom Software

As profit margins shrink in the geospatial arena, and they will shrink, efficiency will become even more important. Efficient companies will thrive, inefficient companies will wither. One key to increased efficiency will be the ability to quickly move, transform, manipulate, analyze and present geospatial data. Your organization can't afford to have a human doing a task a computer can do. The computer will do it much faster, more effectively, and with less error. The sad reality is that most out-of-the-box geospatial software is ill-suited to meet the particular geospatial data management tasks of your organization. Open source software that can be maintained and tweaked by your organization is one thing that can help you overcome this limitation. Modular software is another. Even more important is the ability to implement home-grown software or to customize software using modern programming languages. The ability to write executable computer code in one language or another will be a critical skill for geospatial professionals and the organizations that employ them. This skill will allow companies to maximize efficiency and profits. Companies that learn to work together on their software under an open source development model will reap the many benefits that come from this form of cooperation. Programming languages supported by open standards, governed by communities and not single corporations, and supported by open source tools will prosper. Programming languages that suffer under tight corporate control will eventually fade into obsolescence.

Conclusion

Geospatial professionals have been impacted by major changes in the way they are educated; the way they collaborate and interact; and in the way they execute their craft or trade. Many of these changes are trends that will continue into the foreseeable future. Individual geospatial professionals and the organizations that employ them will need to adapt to these trends if they will survive and prosper. Of all the trends impacting geospatial professionals, the commoditization of geospatial data will be the most disruptive. To deal with this

trend geospatial professionals will need to become less focused on creating geospatial data, and will need to become more focused on helping organizations extract real value from geospatial data. As profits in the geospatial industry shrink, increased efficiency in the management of geospatial data will become more important. Open source software, open technology standards, and modular hardware can help organizations achieve the efficiency they will need to compete.

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