Perspectives on the Future of the Surveying Profession

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A reexamination of the role of surveyors in society

In order to truly appreciate the changes that are afoot in the surveying profession one must first be certain that they understand the fundamental role that surveyor's play in society. If you were to ask most land surveyors what it is that they do, they are likely to give an answer such as: We render opinions on where boundary lines are, or that they assure society that their boundaries lines are mapped properly and when marked on the ground they are marked in the "right" place. Another important role that surveyors fulfill is as expert land measurers, and some might also describe surveyors first as cartographers or map makers. All of these are true when you look at the role from the point of view of the surveyor, with differences of opinion mostly limited to how these functions are prioritized.

Another way one could ask the above question might be: Out of what need of society did the profession of surveying develop? When looked at in this historical way, the boundary surveying aspect moves front and center. Some might still say that society needed land measurers and mapmakers, however these skills were developed subsequent to, and in response to the basic need of boundary location. Specifically surveyors were anointed by society as the stewards of their boundaries and to meet society's need for certainty in boundary location. This is a slightly different perspective on what we do when compared to how we as surveyors view our role. We often see our role as getting boundaries in the "right" place while society, in a more

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fundamental sense is really just concerned with certainty of location, or even more basically, making sure boundaries don't move. In Brown's *Boundary Control and Legal Principles* the authors state it thus: "Once a boundary or boundaries were established and identified, they would be of no value if society could not assure them a degree of certainty" (Robillard, Wilson and Brown 2009, pg. 4). The entire evolution of the surveying craft has been centered on this idea of certainty of location, from "beating of the bounds" to the planting of monuments to our current system of monuments, measurements and interpretive laws. In fact, our entire system of land tenure rests firmly on the fundamental premise that boundaries, once established shouldn't, can't or don't move.

As our system of surveying has evolved we have developed a hierarchical ranking for interpreting boundary evidence such as monuments, deeds, measurements, etc. which has caused "getting a boundary in the right location" and "having boundaries that don't move" to become synonymous in our professional minds.. The entire legal system of boundary determination (getting boundaries right) has developed as society's best chance of getting what they really want (boundaries that don't move).

Some will counter that society really does care about getting it right and that mere lack of movement is not the central goal. To this argument I would counter with a couple of hypotheticals drawn from practice. If a prospective land owner is shown the monuments at all their boundary corners immediately prior to buying a parcel of land, and if during their term of ownership, be it six (6) weeks or six (6) decades, no one ever came to them and said their corners were in the wrong place, they will be happy. Of course, when a corner is found to be in the "wrong" place and a new marker is placed in the correct location a land owner has a theoretical 50-50 chance that the change might "benefit" them as it relates to proximity of their

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improvements near the effected lines, but generally society does not expect or want their boundaries to change. On balance, the (non) movement of corners is more important to society than a legal system's definition of "right". Another hypothetical drawn from surveying practice is to think about the homeowner who buys a rectangular lot and is shown all four corners when they purchase. That homeowner would much rather that an error in the original staking of three (3) inches go undetected during their entire term of ownership than have a neighbor's surveyor come out and tell them their corners moved the three (3) inches.

To summarize, what society REALLY wants is "Consistency of Location", and it would naturally follow from this that what society REALLY wants from us is to provide that in the most professional way possible. In fact, for society, legally right is really secondary and the more pragmatic need for boundaries to not move is primary. So what is the real role of surveyors in society? I would argue it is two-fold. The first is as "Society's Stewards of the Consistency of Boundary Locations" and second as "Society's Expert Land Measurers and Mappers".

An examination of a number of state statute definitions of the practice of surveying bear this out. Most if not all identify, boundary location, land measurement and mapping as within the definition of land surveying or the definition of the practice of land surveying. In Massachusetts, for example, the definition of the practice of surveying includes references to boundaries, measurement and mapping (emphasis added):

> "Practice of land surveying", any service or work, the adequate performance of which involves the application of special knowledge of the principles of mathematics, the related physical and applied sciences, and the relevant requirements of law for adequate evidence to the act of **measuring** and locating lines, angles, elevations, natural and manmade features in the air, on the surface of the earth, within underground workings, and on the beds of bodies of water for the purpose of determining areas and volumes, for the monumenting of **property boundaries**, for

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> locating or relocating any of the fixed works embraced within the practice of civil engineering, and for the **platting**, and layout of lands and subdivisions thereof, including the topography, alignment and grades of streets, and for the **preparation and perpetuation of maps, record plats**, field note records and property descriptions that represent these surveys. (MGL Chapter 112, Section 81D)

The same theme can be found in the National Council of Examiner's in Engineering and Surveying's (NCEES) model law (Emphasis added):

> Practice of Surveying—The term "Practice of Surveying," as used in this Act, shall mean providing, or offering to provide, professional services using such sciences as mathematics, geodesy, and photogrammetry, and involving both (1) the making of geometric **measurements** and gathering related information pertaining to the physical or legal features of the earth, improvements on the earth, the space above, on, or below the earth and (2) providing, utilizing, or developing the same into survey products such as graphics, data, **maps, plans**, reports, descriptions, or projects. Professional services include acts of consultation, investigation, testimony evaluation, expert technical testimony, planning, **mapping**, assembling, and interpreting gathered **measurements** and information related to any one or more of the following:
>
> a. Determining by **measurement** the configuration or contour of the earth's surface or the position of fixed objects thereon
>
> b. Determining by performing geodetic surveys the size and shape of the earth or the position of any point on the earth
>
> c. Locating, relocating, establishing, reestablishing, or retracing **property lines or boundaries** of any tract of land, road, right of way, or easement
>
> d. Making any survey for the division, subdivision, or consolidation of any tract(s) of land
>
> e. Locating or laying out alignments, positions, or elevations for the construction of fixed works
>
> f. Determining, by the use of principles of surveying, the position for any survey monument (**boundary** or non-boundary) or

> reference point; establishing or replacing any such monument or reference point
>
> g. Creating, preparing, or modifying electronic or computerized or other data, relative to the performance of the activities in items a–f above (NCEES 2010)

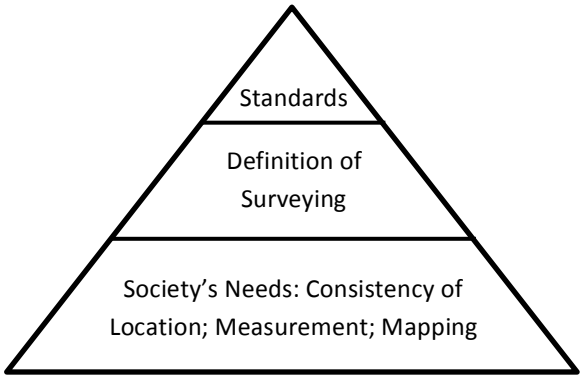
In most states these definitions are further parsed into specific products or types of surveys generally provided and standards for their performance in the form of administrative rules promulgated by the Board of Licensure. In Massachusetts these can be found in the Massachusetts Code of Regulations (CMR) 250, Sections 6.01 thru 6.05 as follows:

> 6.01: Cadastral, Original and Retracement Surveys
>
> 6.02: Data Accumulation Surveys (Topographic-Photogrammetric-Utilities-Site-Hydrographic)
>
> 6.03: Construction Layout Surveys
>
> 6.04: Title Insurance Surveys
>
> 6.05: Mortgage Loan Inspections

Each of these sections identifies a specific category of survey, the premise being that all surveys encompassed within the definition of the practice of surveying fits into one or more of these categories, but nothing lies without.

Figure 1 depicts a way to visualize how the products we are most familiar with in the providing our services to the public are related to the surveyor's role in society as described above.

Figure 1. Graphical representation of the relationship between society's needs and the regulated categories of practice.



To a large extent, the standards, or at least the categories of deliverables that are often found in state specific technical standards are market driven. Categories and standards are developed by boards of licensure as they see fit in order to fulfill their mission of protecting the public. For example, standards for the annual measurement of a surveyor's compass declination have all but disappeared, whereas many states have adopted standards for GPS surveys. Focusing on the five (5) Massachusetts categories, above, these can be further consolidated to three (3) when you take into account that Title Insurance Surveys and Mortgage Loan Inspections are really just specialized products developed to serve specific needs of the banking/title industry and are hybrid combinations of Cadastral Surveys and Data Accumulation Surveys. For the purpose of analyzing trends in the surveying the five (5) categories defined in CMR 250 Section 6 will be consolidated into the three general categories below:

- Cadastral, Original and Retracement Surveys (aka boundary surveys);
- Data Accumulation Surveys (Topographic-Photogrammetric-Utilities-Site-Hydrographic);
- Construction Layout Surveys;

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This analysis will include a discussion of the current state of the profession's interaction with society on each of these types of surveys and will be followed by a summary of the future viability of each of these areas as practice profit centers.

Construction Layout Surveys

This was formerly the sole domain of surveyors. Surveyors were the only individuals with both the equipment and the knowledge to provide this service to the construction industry. Today however, most construction companies have their own total stations, data collectors and cad software. Though licensed land surveyors are often brought in for high liability or high precision components of a site construction project, the routine layout is done by the construction company's own personnel.

GPS technologies in the form of Real Time Kinematic (RTK) surveys and machine control applications are also being more widely used by construction company personnel. The proliferation of traditional terrestrial surveying technology and even GPS/Machine Control technology in the construction field is, at least partially, a result of construction personnel being better educated, particularly in surveying. It is not uncommon to find that graduates from Construction Management and/or Civil Engineering Technology degree programs, individuals who often gravitate toward construction related careers, take as much, or more, field surveying than many boards of licensure set as the minimum requirement for licensure as a land surveyor.

So what does this mean? I believe it means that Construction Layout will be a continually shrinking profit center for most surveying firms and there is little hope that it will

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rebound for practitioners who want to do this work with the same tools and skill sets that many construction companies now have in house.

Data Accumulation Surveys (Topographic-Photogrammetric-Utilities-Site-Hydrographic)

One obvious change in this area is that Hydrographic surveying has become a unique field unto itself which utilizes specialized methods and equipment very different from what is employed in a traditional terrestrial mapping firm. Though some surveyors might do the occasional measurement using hydrographic techniques, most underwater mapping projects are beyond the scope and expertise of a traditional terrestrial surveyor.

Traditional terrestrial surveying is becoming a secondary method of gathering site detail and topographic information. High resolution photogrammetric products can provide richer site detail and in a format (photograph) that is very easy for non-mapping professionals and decision makers to understand and assimilate information from. Satellite platforms can also provide high resolution imagery, and this aspect of remote sensing science is currently in a phase of growth and expansion (ASPRS 2004). Topographic mapping once the sole domain of the surveyor is no longer. Stereoscopic photogrammetric mapping is the work horse of the topographic mapper today with LiDAR mapping coming to replace photogrammetric mapping for many applications. Much research in the remote sensing (analysis) and electrical engineering (sensor) fields is helping to not only make LiDAR data more reliable but is focused on automating the creation of mapping products and the removal of uncertainty from such products. Advances in both traditional photogrammetric mapping and LiDAR mapping have given us digital elevation models (DEM's) that are becoming more accurate, more precise and produced in a greatly

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enhanced automated environment thereby lowering the cost of production significantly (Jensen 2005). The computer processing of raw imagery to develop orthophotographs and mapping from these products has also been streamlined to the extent that much less ground control is needed (USACE 2002).

LiDAR technology in the form of terrestrial laser scanners has also been introduced as a way to collect intricate detail for such things as mapping to support bridge rehabilitation, building historical preservation or complex facility mapping. Geodetic surveying is now synonymous with GPS. NGS height modernization efforts will bring nearly the same accuracy to vertical measurement with GPS that we have come to expect from our horizontal surveys. Utility surveying is for all intents and purposes a photogrammetric/GPS/GIS endeavor. Gone are the days when Utility companies employed armies of surveyors to map their infrastructure on the ground.

There are two other observations related to data accumulation surveys that warrant a mention. First, society has a growing fascination with spatial data and mapping. Google Maps, and MapQuest have awoken society to the value of spatial data in decision making. Navigation grade GPS has also proved its value in decision making as it is rare to see a car on the road today without a GPS unit on the dashboard. Society has finally figured out what we as surveyors have known all along: You can make better decisions when you integrate the spatial component of a data set into your decision process.

So what is the future of Data Accumulation surveys for surveyors? I would posit that these new technologies will continue to reduce the amount of site detail and topographic mapping that will be done using traditional terrestrial surveying techniques, and as a result this type of mapping will continue to represent a shrinking profit center for traditional surveying

firms. In August of 2010 the New England Section of ACSM held a Summit at the University of New Hampshire on Real Time Networks. It was remarked there, in the context of how Real Time Networks can aid productivity in Data Accumulation surveys, that there is probably more mapping going on in the United States right now than in any other time in our nation's history. The vast majority of this mapping is being accomplished with photogrammetric, LiDAR and other remote sensing systems and the digital mapping products that result are being created, managed and used, for the most part, in GIS environments with traditional surveying firms, much less licensees rarely, if at all, involved.

The Sacred Cow: Cadastral, Original and Retracement Surveys (aka Boundary Surveys)

Although most definitions of surveying and state licensing laws that govern the practice of surveying include measurement science and mapping, only the most naïve practitioner would still believe that licensed land surveyors are the only professionals providing many of these services to the public. In contrast, the notion that licensed land surveyors are the only professionals who can render opinions as to the location of a boundary in nearly universally accepted. At the same time that other professions and trades have made significant inroads on the definition of surveying over the last several decades the sacred cow has always been the boundary work. Within the definition of surveying, the boundary determination facet has always been distinguishable from measurement science and mapping because it is the one area that is particularly unique and requires a very narrow and specialized knowledge that does not overlap other disciplines or their knowledge base. Other professions, for whatever reason, were not

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interested enough in learning the legal side of boundary determination necessary to get boundaries in the right place.

The Paradigm Shift

However, when you look at the impact of new technologies on society's most basic desire in having boundaries that do not move the paradigm shift that is underway today begins to present itself. The current wave of technology is fundamentally different in what it can deliver in the way of a boundary location solution. All previous technological advances seen throughout our entire history have provided the surveying profession with tools that have helped them do their perceived job, (getting boundaries right), better. Angle measurement advances from compasses to transits to theodolites to total stations helped surveyors better retrace old boundaries. Distance measurement advances from our rods to chains to tapes to EDM's did the same thing. The fundamental act has always remained combining our (better) measurements with written evidence to ascertain the right location of a boundary point or line as the best way to reposition a lost or obliterated corner marker or to verify that a found marker has remained in the same location on the face of the earth.

Today's technological combination of GIS and GPS can provide society with a solution to the "consistency of location" problem that surpasses the traditional surveyor/boundary law model in terms of accuracy, versatility, simplicity and cost. Standard practice today is for surveyors to combine the information about their control monuments, field measurements and written boundary evidence in a Cartesian plane based CAD file which represents their measurements and their boundary opinions in a single model. they then download this model in the form of coordinates to a data collector and in combination with their total station and control monuments on the ground transfer information from the model to the ground and visa versa.

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First it must be understood that no fundamental difference exists between today's CAD-Data Collector-total Station measurement system and a GIS-Controller-GPS (RTK) system. The GIS serves as the coordinate repository and modeling environment instead of the CAD file and the GPS is the positioning tool no different than the Total Station in function. Going one step further, with the growth being seen in Real Time Networks for kinematic GPS, surveyors are able to achieve nearly instantaneous single receiver, centimeter level map to field consistency of location without the need to personally maintain project or local control monuments. With RTN/GPS and its connection to the datum through the permanent broadcasting stations (CORS stations) the lack of necessity of local monuments is at the crux of the paradigm shift. This idea of combining RTN GPS and GIS coordinates has been a theoretical possibility since the inception of commercial GPS, but today it is commercially available and functional in many markets at the centimeter or better level. What this means that with the flick of a switch on a GPS receiver you can record a coordinate or navigate to a coordinate at centimeter or sub-centimeter levels of accuracy with a single receiver nearly instantaneously Of course the natural question for surveyors to ask is in regards to the accuracy of the coordinates in the GIS that is employed, and the answer is quite simple and familiar. The coordinates in a GIS are only as good as the measurements that they are derived from and quality of the adjustment of those measurements used to derive the coordinates. This is no different than the answer to the same question if asked in relation to the coordinates in a data collector derived from total station measurements and adjusted in a CAD environment. We all know the axiom "Garbage in, Garbage out", and we also know that if what goes in is of an appropriate high quality, what comes out will be of a high quality.

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As GIS parcel mapping becomes more widespread surveyors will continue to develop georeferenced parcel coordinates that are "boundary survey grade". As Real Time Networks become more prevalent and densified, the combination of survey grade GIS and these RTN's will become a way for society to get their certainty of location without engaging the land surveyor's system of monuments, measurements and documents. For the first time in our profession's history, society can get consistency of location without the system of surveying we have developed over centuries. Of course the development and ultimately the legal authority of the coordinates must evolve from the existing legal framework, but once the coordinates are migrated to a georeferenced platform the future reproduction of those coordinates are readily accessible with the RTN (Brown, 2011). THIS is the paradigm shift that the surveying profession needs to face and will impact our profession and our practices more profoundly than any other change that has come along since someone hung the first young boy up by his ankles at a boundary mark and beat him into remembering the place it occurred (Robillard, Wilson and Brown 2009). For those that might argue that even if public sector parcel layers lack authority I would simply point to the numerous examples in site detail mapping, topographic mapping and construction layout that are regularly done by those other than surveyors as demonstrative of the fact that society may not perceive a problem if their land boundary locations were provided by others. Society certainly understands our importance because of our mastery of the legal boundary determination process, but if society can get what they want (boundaries that don't move) without that process I am not sure they will not jump at the chance. Of course the question of the correctness of such coordinates is also often brought up as a problem associated with the combination of public sector GIS coordinates and RTN. However, if society's primary interest is in boundaries that don't move and correctness only as the historical means to that end,

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a paradigm shift that might provide the former without the focus on the latter might be palatable, especially if it comes at a lower cost in both dollars and time. I think we as a profession need to face the likelihood that if society is given the choice between living with corner locations which might be "wrong" (but close) but that will never move, and can be reproduced nearly instantaneously at a very low cost or a surveyor's opinion that is "right" (but might change if another surveyor's opinion is found to be more right), and requires both the time and cost of what we know as a traditional survey, I think society will make the choice that meets their most basic need the most economically: They'll take the RTN-GIS location". One need only look at the proliferation of mortgage loan inspections as a substitute for a proper boundary survey when one makes the most important purchase of their life if you are still wondering whether society won't trade cost savings and expediency for accuracy. There will always be a need for surveyors to address the odd problem, errors, ambiguities, or the situation where the precision needed out strips the GIS-GPS technology. Once all the easy parcels have been georeferenced and their coordinates are captured in a GIS traditional retracement surveys will only be needed occasionally.

Admittedly, when you combine the impact of this loss of traditional boundary surveying work with the previously articulated losses of data accumulation and construction layout the future of surveying might look mighty bleak. This is not uncommon when a profound paradigm shift looms, however the question that I hope appears obvious is that before such an RTN-GIS system can be operational the parcel information has to get properly georeferenced and into the GIS, and once in, someone [Read: properly educated modern surveyor] needs to fastidiously manage the parcel data and be professionally responsible for how that data is used in high liability applications such as real estate transfer, engineering design, and construction. This is

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the light at the end of the tunnel, or the silver lining to the cloud, depending on whether you are a subterranean or atmospheric thinker.

Before we can begin to discuss "the way out" of this quagmire, we need to dismiss a few misconceptions about our relationship to society. First is that society needs us. I think this is true as long as consistency of location and the "right" location are synonymous, but traditional boundary determination becomes obsolete once consistency of location can be accomplished using a RTN/GPS/GIS georeferenced coordinate model. Another misconception is that licensure protects us from obsolescence. No profession's past value insures their future value to society. Licensure was instituted by society to protect society. If society decides that something is not a threat expressed abolition or the irrelevance of licensure will result. I refer again to the fact that most boards of licensure are loath to enforce the limiting of land measurement or construction layout to those licensed as land surveyors against other professions when the statutes could not be clearer on the subject. I suspect that once we all have centimeter level GPS in our phones (and we will) and GIS maps with survey grade parcel data on these same phones, licensure will not be able to be invoked to stop people from determining their parcels position on the face of the earth for many applications.

So now what?

With such a bleak outlook what is it that the surveying profession needs to do? The answer is much easier to articulate than to implement, but I think that for those who endeavor to do this there will be significant financial rewards. What I suggest is that surveyors need to become engaged in GIS and position themselves as the custodians of the GIS parcel data and become the profession responsible for the integrity of that data. Engineering firms, construction companies, real estate related industries, consulting firms, geospatial data specialists have all

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figured out that if you develop expertise in storing and managing spatial data you are in a unique position to provide value to a growing clientele. If you can also be responsible for the integrity and accuracy of that data you can provide a critical service to your clients that they will pay well for. Many large multi-discipline engineering firms that 20-30 years ago shed their surveying departments because they did not see surveying as profitable are now building large GIS or geospatial services groups to position themselves as the managers of their client's spatial data. The consequence of this growth of spatial data management in the non-surveying sectors has of course been at the expense, in terms of market share, of the surveying profession. We have enjoyed a strong historical bond with the Civil Engineering profession, and indeed our common roots are a sense of pride for both professions, but in the same way that civil engineers are working for the betterment of their profession we need to focus on the betterment of ours, and that includes recognizing when our goals may be at cross-purposes at times. The surveying profession's romantic attachment with traditional boundary surveying has us so distracted that the most profitable sectors of our work in terms of data accumulation surveys and construction layout has been going out the back door in the hands of our colleagues in allied professions or the trades, for years. If you asked a surveyor to divide their work for a given year into a series of categories and then assign the percent each represents of the company effort and profits, I think you would find that for most surveyors the category noted as "surveying old, interesting, complex boundaries" might represent 10% of the work they do each year and a negative 5% of their profit! Complex boundary problems represent the work we love. For most of us, it is the reason we chose surveying as our vocation. Unfortunately, there isn't as much of it as we would like and for any number of reasons it is difficult to keep these sorts of projects profitable. If it is not too late already, we should be more vigilant as a profession and not let our colleagues in

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allied professions cherry pick from the work within our domain that is the most profitable. Saying this and acting on this are two very different things. There is implicit in a decision to assert sole dominion over all or a segment of that encompassed with in the definition of surveying a commitment to leveraging all available technology to that end. We can't have it both ways in saying we want to control a certain segment of work on the one hand, but on the other hand we will only do it the "old fashion way".

I would suggest there are a number of things that need to be done to address this situation. Some of these changes need to be made at the profession level, while others need to be made at the practice or personal level. These changes need to be strategic in nature; that is they are changes over time in how our profession, our businesses and individual practitioners interact with the external environment (Rajagopalan and Spreitzer 1997). The key to a strategic change is that it is not a change that is made instantly nor are its effects felt immediately. Strategic changes take time so they require perseverance and patience if their implementation is to have the desired effect. Most surveying organizations and the practitioners within them should be thinking about overhauling how they interact with their clients, public authorities and the land that they survey; starting now. The good news is that these changes do not need to be made instantaneously but rather the planning as to which changes to implement and when is what needs to start now.

Strategic Changes Needed For Our Profession

First, we must acknowledge that there is a real problem. This requires that we look beyond the current economic climate. The economy will improve. No one knows when this will happen but signs of improvement have been appearing sporadically and this has been a sign in

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the past that we have at least hit bottom. There have been a number of technological changes since the current economic downturn started, and as the economy improves clients will want to integrate those into their projects. Notable among these is that clients will likely want some or all of their deliverables georeferenced,, at some level of accuracy, so that the information you provide them can be integrated into the various GIS systems. For example there are many places in land development project's life cycle, from inception to management of the finally constructed facility where integration with GIS is possible and might soon be mandated by clients or other development team members.

We must also acknowledge that the paradigm shift that is coming, where survey grade parcel data in a GIS is combined with Real Time Kinematic GPS, is real and represents a significant change in how society will define it's need for and interaction with the surveying profession. We will also have to come to terms with the fact that we are not indispensible in society's eyes and that these technical advance will cause society to reassess our value to them.

We must also address the perception that many types of surveying and mapping work that we have traditionally viewed as "ours" and performed in a specific manner to provide society with a specific deliverable are now being provided to society by others, and arguably better. This is not because they are better than us at traditional terrestrial surveying, but rather others are leveraging technologies that we are not leveraging. This indicates another area where strategic change needs to be made in our profession. Namely we need to address the knowledge gap (abyss) that exists between what the profession knows and what it needs to know.

Our profession needs to get (back?) in the game in a number of technology areas. We need to embrace the value photogrammetric mapping and other remotely sensed data can bring to

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our clients. Imagery should be part of every project and deliverable we provide our clients. Topographic mapping derived from digital elevation models should be considered and in some cases replace other methods of topographic mapping. We should acknowledge that eventually we will need to work on a georeferenced platform and that the sooner we start migrating to such a platform (GIS) the sooner we can derive the benefits that come with working with georeferenced data. This should not be viewed as a negative, but rather as both an opportunity to better serve our clients and as the way for the surveying profession to remain relevant. Going hand in hand with this is the need to continue to exploit GPS technology to accomplish as much of what we do as possible. Strategically we should be looking ahead to the day when our primary measurement tool will be our GPS and we will rely on our total station/data collector system as the specialized tool for special circumstances. This evolution is no different than the evolution from Tape to EDM. When the EDM first came on the scene the tape remained the primary measuring tool but the EDM was brought out for the special situations. Today the transition is complete and it is the other way around. The EDM is the profession's workhorse and the steel tape is only brought out for special applications when the EDM can't be used for one reason or another. We should be innovative in our practices to find ways to migrate our field methods to using the GPS more and the total station less. Of course this requires us to improve our knowledge and comfort with principals of geodesy, horizontal and vertical datums and map projections. Again, rather than view this as an arduous chore we should be looking it as an opportunity to develop a competency, when combine with our existing spatial measurement and analysis skills, will allow us to provide real value to our clients. The earth isn't flat anymore and GPS is a round earth tool. Harnessing the knowledge that allows one to comfortably work on a

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round earth will be instrumental in the preservation of the relevance of our profession in the future.

We are also just beginning to understand the value that terrestrial laser scanning can bring to the collection of complex detail. Though some early adopters are finding innovative applications for this technology, many practitioners still see no way for this technology to enhance what they do. That is OK. What is important to understand about strategic change is that the change can be gradual and can accelerate or decelerate depending on the external environment. For example a strategic goal articulated as: "Actively monitor the development of laser scanning technology and to implement it when it is economically feasible", is much more appropriate than an institutional decision that the technology is irrelevant or to ignore if for now with the intention of possibly looking at it later. A predisposition towards irrelevance will necessarily cause opportunities to be missed, whereas active engagement with the development of the technology will allow for acquisition planning and timing. This is the essence of strategic change.

In the same way that an understanding of geodesy is essential to development of competencies in GIS and GPS, least squares adjustment methods are being built into the back end of many instrumentation and mapping systems. The compass rule was a viable method for adjusting plane surveys of limited extent in the days before desktop least squares adjustment software when trading off positional accuracy for computational ease provided immense time savings, but in today's world, where there is more computing power in many of our phones than was carried on the first lunar mission, compromising accuracy in order to avoid learning the proper way to do something is not how our profession should behave.

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As a profession we need to acknowledge that the future will be different than the past. We need to keep a healthy perspective on what is in the past and what is in the future. We must also recognize that the interests of the surveying profession and the interests of allied professions may not be the same and that, in fact, historical alliances may need to change and new alliances may need to be formed. We also need to prioritize the reshaping of the future. We can either reshape our future strategically around the opportunities that the above noted paradigm shift presents or our future will be reshaped by external forces bearing down on our profession and our relationship with society. This engagement with our future needs to be proactive and not reactive. This does not come easy to surveyors whose world view stands in contrast to the design professionals we work with. Surveyor's concern themselves with what "is" and what "exists". We map existing conditions, whereas engineers and architects concern themselves with what can be. We need to step outside this type of world view that focuses on seeing what is there and try very hard to look over the horizon to try and define what can be. This requires honest communication on what we know, what we don't know and the implications these represent.

We need to strengthen our local and national professional associations. These will be the primary vehicle for bringing about strategic profession wide change. At the time of this writing, The American Congress on Surveying and Mapping (ACSM) and its member organizations are in the midst of a complex conversation about the future of the surveying profession that has at its heart: Who do we want to be. Though as difficult, wearying and sometime contentious these conversations can be. They are a healthy part of the evolution of a profession and could not come at a more crucial time as the herein described paradigm shift looms.

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The single most important instrument of strategic change is education and there are three fronts on which this needs to be addressed. First is in educating society on the profession's changing role and how we are rising to meet society's modern needs, assuming we so choose. Second, we must create continuing education opportunities that actually help practicing professionals and their businesses develop new competencies (Vannozzi 2006, Vannozzi 2009). And third, we need to prioritize educating the next generation of surveyors in these new competencies so they can have long and productive careers. Though many graduates of the surveying degree granting programs around the country seek licensure, their education is much broader than boundary surveying in nature. Today's graduate is being prepared for a world where boundary surveyors, geodesists and GIS practitioners are not occupants of separate professional silos but rather labels that apply to a stack of hats they must wear at varying times in their career….or on a given workday.

Strategic Changes Needed For Our Practices

There is much overlap between the strategic changes need by the profession generally, as discussed above, but in terms of individual practitioners these are best expressed in terms of action items at the personal or practice level. Presenting these as a bulleted list makes more sense in light of the more detailed explanation provide above.

- Keep abreast of all changes in technology that appear on the scene, even if the initial reaction is that they are irrelevant or inapplicable to your practice;
- Develop competencies in new technologies. This does not mean you necessarily need to learn a specific skill set yourself, but may include hiring in expertise you personally lack;

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- Embrace change, do not ignore it. Consider the opportunities that change can present;
- Consider your strategic plans when you are deciding what to allocate resources towards;
- Deciding what education and training you will engage in (or require of your staff) should be a strategic decision. Using educational opportunities to advance your strategic agenda in competency development can provide immediate benefits in understanding and planning as well as having specific new competencies once a determination is made to integrate a new technology in your practice;
- Strategic planning should direct you decisions on what meeting and conferences you attend and what organizations you belong to and actively participate in.

Conclusion

Ultimately society will decide our value and our place. However, our profession's ability to remain relevant in their eyes depends on our commit to evolving into a profession that meets a modern need of society. Society is not looking to kick the surveying profession to the curb, but rather the opposite is more likely true. Society wants us to engage in the evolution of boundary and parcel mapping. They understand the importance of the expertise surveyors can bring to the conversation. Historically we have provided tremendous value to society, it is recognized, and it is appreciated. However, if we do not embrace this new paradigm brought about by the GIS-GPS revolution, our more geospatially aware society will find another way of getting what they want. We are valuable, we are important but we are not indispensible.

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