Profile: The American Surveyor

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ABSTRACT: As an artist, scientist, and a legal practitioner, the American surveyor has had a profile that uniquely addressed the challenges of the era, the technological advances at the time, and the educational requirements for the era. The colonial surveyor handled matters concerning land grants and political boundaries with traditional equipment such as a magnetic compass for angles and the Gunter’s chain for distances. The geodetic surveyor accomplished the task of spatial framework going from coast to coast with primitive equipment over rugged terrain. The present day modern surveyor is challenged with the need to keep up with technological advances and having the know-how to keep the profession alive. Some would argue a gloom and doom to the present day surveyor while others would advocate an opportunity to enter a better, more developed stage of the profession. The surveyor did not evolve for the better or worse, rather he adapted with the times and the responsibilities that he was born into. This paper chronicles the evolving profile of the American surveyor as a result of advancing technology and educational needs.

Introduction

Much has yet to change in surveying. A horizon still closes at 360° and an acre still has an area of 43,560 ft². Surveying principles have remained relatively constant throughout the last few centuries. Surveying methods, however, have significantly changed with the advance of technology and knowledge. From the shot heard around the world to the shot taken by pressing a GNSS receiver button, surveying has evolved immensely from the colonial times to the present. Surveyors of today fit a different profile and are unlikely candidates for a 1798 boundary survey. Could it be that surveyors are less of a profession today? How did surveyors progress from pulling chain and worrying about the magnetic declination of a compass to cutting brush above the GNSS receiver? As this paper explores the varying of a surveyor over the years, we will be enlightened of how skillful one had to be in order to practice surveying, and develop an appreciation for the challenges facing the profession as technology replaces many of the mundane tasks that previous surveyors have come a custom to.

Profile: The Colonial Surveyor

The early populating of the New World called upon the colonial surveyor for his technical skills and professional expertise. If the original patent is not lost of destroyed, any deed researcher can scrupulously follow the chain of title until it is found. Chances are likely that the original patent was laid out by the colonial surveyor. The British, French, and Spanish men that set sail over the ocean blue to the New World were lured by foretold gold and riches. Ironically, they found the greatest value in the most fundamental resource of all, the land. Original claim to this land was
vital for European nations to express an interest on the land. By 1750, North America was inhabited by Native Americans, British, French, Spanish, and Dutch colonies. “The continent is not wide enough for us both,” proclaimed a Boston clergyman as the French and Indian War began in 1754 (National Humanities Center, 2013). On a smaller scale, individuals migrating themselves in the New World had a need to establish themselves. Political boundaries and original patents were the demands of the time. The surveyor in this period was presented with the task of a developing nation.

Before Thomas Jefferson established the Public Land Survey System as part of the Land Ordinance of 1785, settlements within the colonies had a method of populating within their boundaries by land grants. William Penn had a vision to populate his colony with cities and farms for agricultural purposes. Penn’s vision for Pennsylvania was different than other colonies that were sparsely inhabited with no central trade market in cities.

In order to populate Penn’s Pennsylvania and the rest of the developing nation, the surveyor sometimes acted as the locator for the desired land of colonists. Locators, also known as land locators, were often surveyors who recruited settlers to new settlements in the 1700’s. George Washington and Daniel Boone were early colonial explorers who would gain $¼ to $½ royalties to land under the King for locating tracts of warrant holders (Erickson, 2013). How did the process of issuing warrants work? The grantee, here the colonist, applied to the Land Office of their respective colony and if accepted by the Land Office, the Secretary of the Land Office issued a warrant, as shown in Figure 1, to the Surveyor General. The Surveyor General further directed the Deputy Surveyor to survey the land he/she wished to possess. A deputy surveyor was asked to furnish a record plat of the tract of land the applicant wished to inhabit (Love, 2000). After this process, the applicant received the original patent. Sounds simple, however much of the legal aspects of the survey created an extra job item as a legal consultant; often handling the painstaking elements regarding a newly created boundary. Much like today, the courts relied on the surveyor’s best professional judgment for establishing boundaries. The surveyor in colonial times was required to prepare legal documents in land transfer as well as interpret legal records involving land transfers.

The colonial surveyor was also known to have a great wealth of information. Not only was he was an expert technician for the methodical tasks of the times but he was a professional, with the responsibility to preserve the safety, health, and welfare of public. Communication with society
regarding prosperous land, exploring uncharted territory, representing the land owner, and aiding him in legal matters were some of the responsibilities of the colonial surveyor. Running the parallels of latitude for the northern and southern boundary proved challenging for the few, sufficiently competent surveyors of the age. Celestial observations were necessary procedure for running long boundary lines. Knowledge of astronomy and spherical geometry were essential to the colonial surveyor. One may question how a surveyor got educated in a newly populated frontier. Some, such as Jeremiah Dixon, Charles Mason, and Thomas Jefferson studied in college, while many of the surveyors of this era learned and became proficient by way of apprenticeship. Their education was contrary to today. Surveyors relied on surveying practice manuals and a good teacher to apprentice and educate him into the methods to competency. The tools of the trade were passed down from the elder surveyors. Since modern considerations such as geodesy and mapping projections were not major considerations in their daily activities, learning on the job was the method in which a surveyor became proficient.

The distinction between a professional and a non-professional surveyor of the colonial times can help to understand what a professional profile would be for the present times. Licensing boards were not developed until the early to middle 1900’s. So how can one proclaim to be a professional without holding a professional title? Only the sophisticated, the intellectual, and the great communicators were thought of as “professional” (Love, 2000). Society as a whole indirectly recognized an individual’s ability as a professional. If modern surveyors are unable to profess a wealth of knowledge that promotes the general health, wealth, welfare of a society, one may argue that surveyors are merely a tradesmen rather than professionals.

The land has always been the greatest asset since the original settlers came to the New World. The use of land for nations, states, municipalities, and private individuals required the colonial surveyor provide accurate measurement and good judgment. Political and personal interests demanded boundaries and documentation for these original patents. To this day, boundary surveyors sometimes need to trace these original patents to accurately reset or confirm an existing property corner. The next time surveyors perform their due diligence as to “following the footsteps of the original surveyor,” a surveyor can admire the first American surveyor as to his impact on a developing nation.

Profile: The Geodetic Surveyor

From the Atlantic to the Pacific, the United States relied on the geodetic surveyor to bring commonality to a common measuring system, provide accurate maps of the east coast, and aid in western expansion. The profile of the geodetic surveyor commences in the early 1800’s when as the United States was 19 years young. The Survey of the Coast, today known as the National Geodetic Survey, was created by Congress in 1807, under the Presidency of Thomas Jefferson to implement triangulation networks in order to address these issues. The French and British
initiated success with triangulation networks in approximately year 1670 and 1784, respectively (National Geodetic Survey, 2013). To promote expansion and development, the United States imitated this method of surveying. Thus, the nation’s geodetic surveyor was born. The Survey of the Coast’s first Superintendent, Ferdinand Hassler, was the first to implement triangulation networks in the United States. Triangulation networks were employed as a large scale propagation of points by measuring angles at either end of a fixed baseline.

The main problem in the year of 1807 was a poorly mapped coast that caused shipwrecks. Since people and goods moved by passage of the Atlantic Ocean, mapping the east coast was a key responsibility of the geodetic surveyor to promote safe navigation and American commerce. These first surveys commenced in 1816 consisting of 11 points near New York City. Prior to 1836, observations were made using a 24 in. theodolite. Geodesy from 1807 to 1843 was completely dominated by Hassler. Hassler proudly used a 30 in. theodolite called the Great Theodolite from 1836 until his death in 1843 (Dracup, 2013).

From 1843 until the turn of the century, many individuals influenced the networks. Up until 1871, the Bureau’s work was limited to the coast. As Congress saw a necessity to have transcontinental networks, the limitation was lifted under Superintendent Benjamin Peirce. The Survey of the Coast proceeded to run triangulation and leveling networks inland. In 1878, Congress changed the name to U.S. Coast and Geodetic Survey. As shown in Figure 3, geodetic networks extended from Maine to Louisiana and from New Jersey to California by the turn of the century.

How does the work of the 19th and early 20th centuries compare with the advancement of surveying equipment of today? The saying, “Good enough for government work” is misinterpreted as a seemingly low standard of work. Prior to the electronic age of surveying, it was not uncommon for personnel with the Coast and Geodetic Survey to achieve accuracies of 1 part in 1 million, with the most accurate recorded as 1 part in 5.5 million (Dracup 2013). These pioneers displayed the technical ability to accomplish the daunting task of surveying the mountains, plains, deserts, and the shores of a developing nation. The reconnaissance phase of the triangulation process is also important and requires considerable skill, experience, and judgment. In addition to these qualifications, surveyors of this time must have displayed much faith, perseverance, and courage. They sought to lay the reference framework for the future civil works and political boundaries of the United States.
The early Survey of the Coast employed few, but very qualified engineering experts that worked in field crews. However, average field personnel during the western expansion years did not possess a great deal of education to be proficient for the task at hand. These men mostly came from the communities in which the Coast & Geodetic Survey team passed through. They were hired as a temporary employee, typically working for 9 months. Jasper Bilby was extremely influential for the triangulation network of his time. He is credited for building the “Bilby Steel Tower.” (See Figure 4) This was a steel tower that was portable in such a way that it could be disassembled and reassembled at triangulation stations. Prior to his invention, towers were erected using wood and then abandoned after observations were complete. This was such a substantial waste of materials that, during the Great Depression, the Bilby Tower saved the National Government a total of about $3,072,000 over a five-year period. The most interesting fact about Bilby was that he never graduated from high school, only completing the 8th grade. His time and dedication to the Coast & Geodetic Survey spanned 53 years and will be admirable to generations to come.

From sea to shining sea, the spatial framework that was constructed across America was the success of the geodetic surveyor. The dawn of the 19th century welcomed in a national bureau that organized and developed the spatial framework through the process of triangulation. This bureau, today known as the National Geodetic Survey, went through a variety of name changes, however its purpose relatively stayed the same. The United States implemented the process of turning repeat angles over long distances inspired by the French and British’s prior development of the process. Triangulation was successful for providing the reference framework for political and personal property boundaries, infrastructure, and many other measuring purposes.

Profile: The Modern Surveyor

Newfound technology has produced a new profile of an American surveyor. Since the 1950’s, surveying has undergone a technical renaissance. There are two key phases to the technology revolution that changed the surveying profession as we know it. The first phase of modern technology was the development of photogrammetry, remote sensing, and Electronic Distance Measurement Instrument, which is more commonly known as the Electromagnetic Distance Measurement (EDM). Embracing this technology, geodetic surveyors completed highly precise surveys while increasing efficiency of otherwise labor-intensive observations. EDMs were later mounted on a theodolite and ultimately combined to create a distance and angle combination instrument, otherwise known as the total station, which is shown in Figure 5. The second phase started decades ago when the United States and Russia launched satellites into space in
preparation of nuclear warfare. Although originally created for the use of military operations, civilian applications of GPS, GLONASS, and other systems have been very profitable for surveying firms everywhere. GNSS has not been a total takeover of the surveying industry, but has certainly changed the profile of a typical, modern surveyor. Other modern industries such as LiDAR and laser scanning also belong in this category. Together these technologies have provided new methods of completing tasks quickly that in the past would have taken much longer, even years to complete.

The first phase of the modern era, introduced photogrammetry and remote sensing, which was known as photo interpretation, during the World War II. These technologies where required to map the terrain prior to troop movements and identified hidden enemy fortifications. While photogrammetry has been used since the Civil War, it wasn’t until War World II that extensive accurate mapping of the ground from aerial photos occurred. In the 1950’s, the early EDM’s were often stand-alone instruments capable of measuring long distances. Erik Bergstrand of Sweden used light to measure distances. This technology took a foothold in the American geodetic networks but was not commonly used in surveying as a whole. EDMs became commonplace with the advent of the miniaturization of computer technology, and became even more so when combined with a digital theodolite. This combination of computer technology and digital angle and distance measurement produced an extremely efficient way of measuring combined distances and directions. Today laser scanning and LiDAR can replace much of the tasks required of a field technician by measuring angles and distances at a rate much higher than was believed only 10 years ago. Physics and electronics are now relevant to the practice.

The second phase of the revolution of our industry commenced with satellites orbiting the earth thousands of kilometers in space. Before the advent of the TRANSIT system followed by GPS, it was not possible to connect continents with a common coordinate system. Additionally, with internal sensors and scanners, space craft have provided mankind with a view of the world that would have awed Galileo. These modern technologies have provided accuracies that the world of surveying never thought possible before.

So how can a professional be an expert at pressing a “measure” button on the machine’s interface? Has surveying become a trade industry; requiring only skilled labor with little professional expertise? Work is more efficient and measurements can be made on the fly without much concern for wasted time. Data is easier to obtain, however the knowledge needed to utilize GNSS for accurate surveying practices involves post-processing and receiver know-how that a surveyor must be proficient at in order to justify surveying grade accuracies.
Apprenticing to become a GPS technician for surveying grade work may not be difficult for the average person. With today’s broad spectrum of technology, interfaces of the hardware and software are learned in a training session and require moderate skill. Like other profiles, there is a clear distinction between a professional and non-professional in the field. Only surveyors with college education or intense self-exploration of the measuring system can be efficient with a receiver in his/her hands. Likewise, the automated, easy-to-use technology does not degrade the surveyor’s ability. Data collection is only one integral part of the surveyor’s job. Interpreting the data and the legal application to the data collected are what defines a professional surveyor. The surveyor’s value in this profile clearly goes beyond the pole he carries.

The technology of the middle to late 20th century changed the profession and respective professional’s way of practice. Physics, properties of electromagnetic waves, internal and external electronics, and understanding the “invisible” properties of measurement for both EDM and GNSS are all avenues that the professional surveyor entered during the modern era. Measurement, otherwise labor intensive, was simplified in the field and allowed the surveyor to achieve surveying accuracies more efficiently and cost-effectively.

**Profile: Tomorrow’s Surveyor**

Abraham Lincoln once stated, “The best thing about the future is that it comes one day at a time.” It is difficult to foresee the profiles of the surveyor 5, 10, 25, or even 100 years from now. However, trends are a good indication of predicted happenings. Technology has revolutionized the way a survey is conducted in the field as well as in the office. Human knowledge and advancement only promises more of the same moving forward. The success of the surveyor of tomorrow will be directly related to his ability to adapt to new methodology.

Data sets are being obtained through new technology such as laser scanning, remote sensing, unmanned aerial systems, and other advancements. The possibilities are seemingly endless for a graduating student in surveying or geomatics. With the rapid increases of efficiency in the field, one may argue that the surveyor of tomorrow will be a data manager like never before; collecting and storing accurate information in readily accessible programs and digital files. The knowledge base of tomorrow’s surveyor may sustain his reputation as a professional even in this age of automation. Data is everywhere and producible by anyone. There will be a correlation between tomorrow’s surveyor and the surveyor of old. The technicians will still be responsible for collecting the data in a timely and orderly fashion while, conclusions and processing of the same
data will be the professional’s forte. In this perspective, the surveyor’s ultimate job description will not change.

With technology, there is a 180° perspective of the profile of tomorrow’s surveyor. The looming fear of the surveyor being labeled as a tradesmen, where the trained know how to utilize the technologies, is ever present. Tomorrow’s surveyor will be asked to preserve the “profession” that sustained the surveyor since the beginning. Working smarter as opposed to harder is the origin of each item of newfound technology. The younger generation has found technology to be of second nature to their existence. Young graduates that enter into the profession perhaps have the greatest need for guidance from older, more experienced surveyors than ever. Naturally, newfound surveyors must be tech savvy. College curricula are loaded with opportunities to utilize software and equipment that make them efficient and, in turn, considerably profitable for a company. These same students will need to be skilled young professionals as they breakthrough into the job field. The principles that guided the generations that came before the present day will need to be instilled. If you don’t know where you came from, how will you ever know where you are going? The preservation of the profession as we know it will be in the hands of the graduating classes, crafted by the mentors who choose to instill their values into them.

Methods, equipment, and knowledge needed to be a proficient surveyor are rapidly changing. Fortunately for those associated with the profession, the application of foresight in such issues can put the surveyor in pace with the technology. The profession will need to choose to proclaim the exclusive rights to measurement for a variety of new technologies. Without the principles of expert measurement and professional responsibility instilled in the next generation, surveying may not be the profession as we know it in the future. The Registration Act, mentorship of the younger generation, and personal responsibility are all tools in which the profession may use in order to sustain a prosperous and historically rich profession.

**Conclusion**

Mathematical principles have not changed since the days of the colonial Surveyor. Although the theory has remained constant, the methods and equipment used for data collection has evolved significantly since colonial times. Each American surveyor profile possessed a skillset tailored for his era. Upon reflection of each profile, we are made aware of the skills each possessed, have a deep appreciation of where we came from, and challenge the present day surveyor to continue to advocate the future preservation of the profession.
References


