The Changing Role of the Surveyor

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ABSTRACT

Recent advancements in measurement technologies, the ease of transferring digital data via radios, the internet, and cellular phones have made it possible for anyone to obtain accurate positioning and design data in real time. This presentation will illustrate some of the applications where the non-traditional surveyor is using this easy access to accurate positioning data. This presentation will show how the apparent lack of the surveying function at a construction jobsite is only an illusion. However, it does mean that the role played by the surveyor, the work product that is delivered, the relationship between surveyor and client, and the measures for determining the success of a "survey project" all change. Understanding these changes and appropriately responding to them will be a significant contributor to the success of the surveying business of the twenty-first century.

BIOGRAPHIES

Bryn Fosburgh is Division Vice President of the Land Survey and Infrastructure Business Area of the Construction and Engineering Division of Trimble Navigation Ltd. In this position he is responsible for the financial and strategic direction of Trimble's land survey, infrastructure, marine, and civil engineering businesses. His previous assignments at Trimble have included various positions in the sales, marketing, and development areas. Prior to joining Trimble, Mr. Fosburgh worked as a civil engineer for the Wisconsin Department of Transportation where he was responsible for coordinating the planning, data acquisition, and data analysis for statewide GPS surveying projects in support of transportation improvement projects. He has also held various engineering, research, and operational positions for the U.S. Army Corps of Engineers and Defense Mapping Agency. Mr. Fosburgh received a Bachelor of Science from the University of Wisconsin (Green Bay) and a Masters of Science from Purdue University.

Joseph V. R. Paiva, is director of business development for the Engineering & Construction Division of Trimble Navigation Ltd. His previous assignments at Trimble have included senior scientist and technical advisor for Land Survey research and development and vice president and general manager of the Land Survey group. Previously, Paiva was vice president and a founder of Sokkia Technology, Inc., where he guided the development of GPS- and software-based products for surveying, mapping, measurement and positioning. He has also held senior technical management positions in The Lietz Co. and Sokkia Co. Ltd., of Tokyo, Japan. Dr. Paiva was also a professor of civil engineering at the University of Missouri-Columbia, and a partner is a surveying/civil engineering consulting firm. He is a Registered Professional Engineer (PE), Registered Land Surveyor (LS), and has more than 25 years experience working in civil engineering, surveying and mapping.

INTRODUCTION

Technology constantly changes the way surveyors work. The introduction of calculators with trigonometric and other scientific functions meant tremendous increases in the speed of work in the office and in the field and in the labor used to get results. Improvements in the accuracy of calculations were also see due to reduction of blunders and more accurate determination of trigonometric values. Computer aided drafting added blinding speed to the completion of the office work of a geomatics professional. Not only were the required lines drawn, but also the lettering by the amazing combination of the computer and the plotter. Even the computation of the lines themselves, whether to determine subdivision lots or rights of way could now be done effortlessly.

The advent of the EDM and then the electronic total station brought a level of labor and effort saving to the field that was unprecedented. Together with all the other modern appurtenances, surveyors could truly begin to speak of their activities as akin to navigation in real time on land. Finally, GPS brought an end to the dependence on lines of sight between one control point and another or a control point and the points being surveyed. Especially with RTK, the concept of navigation in real time was made several orders of magnitude faster.

For the first time, there is much less of a tendency for the new technologies, i.e. RTK GPS and robotic total stations to replace the older ones. Instead there is more thought being given to the integration of these technologies, especially the sensors, to enable efficient and effective use of the combinations. As the geomatics professional is a key member of the team responsible for construction or development activities, this integration has great opportunities for benefiting much more than the land surveyor's work.

THE CONSTRUCTION OR DEVELOPMENT CYCLE

The construction cycle involves many phases. While not limited to these, the typical phases found are:

- Reconnaissance
- Initial surveys
- Design
- Stakeout
- Build
- Quality control
- As-built
- Maintenance

The professionals involved in the cycle constantly battle inefficiencies and rework. Some of the reasons these problems have occurred are that

- The information used in the construction or development cycle was mostly paper-based
- Information generated by the parties was usually designed to be locally optimized
- Regulatory agencies are only now beginning to use technologies supporting digital data
- The construction and development industries haven't accepted the comprehensive use of digital data
- Design and build are generally kept separate
- Reviews occur frequently during the process
- Standardized information exchange is rare

Additionally the transmission of information across the construction elements is awkward and incomplete. The aspects of construction machine information management, business/operations management, design, site office management and the business of the actual construction in the field are managed in ways that make the transfer of critical information across these areas difficult.

Recently, however there have been improvements to facilitate better transfer of information. The single most significant of these is the public network, or the Internet. Combined with the ability of design professionals to produce three-dimensional design data in electronic form, built-in machine intelligence, availability of robust, augmented positioning on the machine and management and site management tools suited to electronic data creation and transfer, many of the above-mentioned problems can be alleviated. However, the advent of these advances requires that the future construction environment to be more tightly linked.

CONSTRUCTION TRENDS

Professional construction managers have long realized that the various aspects of a construction project are best managed as processes, with process control used to alter the parameters to produce the desired result. The construction site is only a part of the entire construction project that is composed of complex and interweaving components.

A loose federation of principals has traditionally run construction projects: owner, designer, surveyor, contractor, government, etc. These segments have been created by function. Increased benefit has been shown when a construction project was handled as a "design and build" project and even more as a "design, build and operate" project. The ability to have more process control in the latter styles of handling the project has been show to produce more efficiency and cost reduction.

GPS GRADE CONTROL

One of the new steps in process integration to be introduced recently is GPS grade control. By transferring the design in electronic form to the machine, it has been possible to eliminate many error sources inherent in a largely manual process. By using common data, the same data as that used by the designer and the surveyor, the machine operator is able to visualize the job and complete it better and faster. Removal of many of the steps of staking reduces error and cost as well. However it is a critical fact that sharing of information freely among the members of the "federation" is required. It is critical that all parties involved in the project adhere to the principle of transparency. In this context transparency means access to a common set of data used by all the participants. They take what is required from the data set to do their parts of the job. As they work, and updates are required either to show current status or to reflect re-engineering, all parties will have equal access to the updated information to enable the project to continue seamlessly. This principle eliminates the concept of ownership of data by a particular group of professionals. However it does not eliminate the responsibilities that each group has for the accuracy and relevance of the data it contributes to the data set.

THE SURVEYOR'S CHANGING ROLE

The principles of GPS grade control were born in the mining environment. In that environment, the search for productivity translates to pennies per ton of material removed. In optimizing GPS for grade control and ore removal, a similar process to that used in construction process evolved. As with a construction project, a design is first completed for the engineering or ore removal project. The design is then transferred the machine to execute the design. It was discovered that the mine surveyor's job changed from being at the choke point of setting stakes to being information managers. They were now responsible for monitoring the integrity of the entire surveying system in real time. This included monitoring of the base stations, radio links, and integrity monitors. It also involved periodic checks of the machines and checks of the work being done, but without halting the work unless it was clear that the work was progressing incorrectly. The surveyors found that this way of working made their jobs safer, cleaner but more challenging. The most challenging and critical part of the activity was managing accurate and timely data flows.

In a construction project, the surveyor used to be involved for the initial survey, site control survey, converting design data to stake out plans, transferring the design to the ground (staking and re-staking and re-re-staking . . .) and finally, quality control.

When GPS grade control is used on a construction site, it appears at first that the services of a surveyor are used less. This is not true. However the surveyor's services are used differently. The surveyor's role yesterday and today may be compared in tabular form.

Yesterday	**Today**
• Initial Survey	• Initial survey
• Site Control	• Site control
• Convert design to stake-out data	• Convert design data to a DTM
• Place stakes	• Supply digital data for machines
• Re-stake . . .	• Update for changes and re-supply data
• Quality control	• Quality control
• As-builts	• As-builts

NEW SURVEY SERVICES

In the construction site of the future, today's surveyor is already well-equipped to deal with the requirements for GPS grade controlled jobsite.

The site always needs control. With GPS and total stations, perhaps even robotic total stations, the surveyor is up to the task. This may include surveying in the reference station and monitoring its (their) performance.

GPS calibration is a task suited to surveying professionals. They have the tools to do it properly. They are trained to identify and resolve any problems that may arise including conflicts in existing control. The transfer of calibration information to the machine is a critical part of the GPS grade control process. With calibration, only the surveyor is ideally suited to understand how to manage the height information. The surveyor is also the right person to determine how much information and control surveying needs to be done for a job commensurate with its size. The concepts of geoid modeling to apply to the results of the GPS surveys and understanding the difference between ellipsoidal and orthometric heights are again easily within the purview of the surveyor.

With data conversion, the survey professional is again ideal. Accurate modeling requires an understanding of gridded DTMs or TINs. Road alignments, whether horizontal geometry, vertical geometry or cross-sections are best understood and handled by the surveyor. In addition, the data may come from many sources. Design packages have their idiosyncrasies that must be understood. Surveyors know how to handle these.

Whether the data is moved to the machine wirelessly or through data cards, the surveyor is the ultimate authority for determining that the correct calibrations have been used to "register" the machine on the site. The digital terrain model carried by the machine is the responsibility of the surveyor. During the construction, changes frequently happen to the design. It is the surveyor's job to understand these changes, identify where the impacts are, make the changes and update the DTM that is then re-transferred to the machine. This is no less important than re-staking. Because it is done "invisibly" it requires much more diligent monitoring.

Quality control of the construction operation often involved measuring grades and checking the positions of building. Today it can also mean periodically stopping the work of the construction machine so that in effect a backsight and benchmark check can be done. Quality control also involves designing methods to rapidly verify without stopping the machines, that the work is progressing correctly.

CONCLUSION

Managing and understanding data flow in GPS grade control environments is an opportunity for surveyors to re-emphasize their key role as information managers. They are responsible for converting spatial data from concept to completion. Embracing the new roles instead of regretting the loss of old ones is the watchword for progress of the profession.