

PROFESSIONAL

SURVEYOR

Magazine

April 2010 Vol. 30 No. 4



OPPORTUNITIES

in Machine Control



AMG Opportunities

An in-depth look at how two surveyors started a machine control firm reveals an abundance of opportunities in the business, if you can adapt to changing technology.



▲ At the Lyndhurst Recreation Complex in Lyndhurst, NJ, a machine operator from MACTEC Development Corporation watches his in-cab automated machine guidance display while grading ball fields.

By Joseph Priestner

Historically, stakeout for mass earthwork and large-scale construction has represented a significant revenue source for the typical land surveying firm. Many practitioners today see the advent of automated machine guidance (AMG) systems as a “threat to the profession,” leading to vitriol at any gathering attended by two or more surveyors.

Is this technology a true threat to the core of the profession? No. Does AMG infringe on the ancillary services often undertaken by land surveyors simply because we have the tools, knowledge, and experience to accomplish them?

Yes. It represents a threat to the business of surveying more than the profession itself. Businesses adapt if they intend to survive changes in technology that render their current services worthless. Is there a niche for the land surveyor in this high-tech AMG world? Unequivocally, yes.

Tom Frawley, PLS and I started LandMarker Geospatial in 2005 with the initial aim of providing support services to contractors who wanted to take advantage of the productivity gains offered by AMG systems but lacked the technical ability to effectively implement, operate, and maintain them. We began with a single client who wanted two dozers equipped with indicate-only systems for a landfill closure project. We configured

and installed two custom guidance systems, and immediately they wanted two more. They also required control surveys, data preparation, progress topographs, as-built surveys, miscellaneous layout, settlement monitoring, etc. Work begets work—a lot of work. And we happily relinquished all revenue for placing grade stakes. Our little three-person company wasn't even two months old, and already our range of services was expanding beyond our initial, somewhat naive, business model, bringing us closer to a traditional surveying firm.

Over the past four years, LandMarker Geospatial has grown in both size and range of services while maintaining a focus on construction-related positioning. We've added twelve more employees including a third partner, Rob Heitzer, PLS, to manage our second office in Bethlehem, Pennsylvania. Leica Geosystems recognized our interest and expertise in AMG and invited us to become a dealer for their machine control and construction products, turning LandMarker Geospatial into a rare hybrid organization. We sell, service, and support Leica hardware and have four licensed land surveyors on staff, all with four-year degrees in land surveying from Penn State and New Jersey's Science & Technology University. This unique pairing of products and professional service allows us to credibly offer complete turnkey solutions for all the positioning, mapping, and data-collection needs of the contractor on any construction site.

Significant Opportunity

I relate our experience simply to make a point. AMG represents a significant opportunity if the surveyor eschews a bleak attitude towards all things predicted to replace traditional methods. Embracing this technology and becoming an expert at its implementation and use can offset a portion of any potential revenue lost when a client switches to AMG for their grading operations. Most surveyors can take advantage of the oppor-

tunity presented by AMG today simply by capitalizing on the skill set inherent in the surveying profession and making a conscious effort to get involved on their first machine control project. This includes:

- performing extensive research regarding AMG systems,
- partaking in training on the various hardware and software components,
- establishing relationships with AMG vendors, and
- talking to your clients about assisting with AMG rollout and support.

Several individual areas of the AMG process exist where we as surveyors can add value. This list of services replicates those offered by our fledgling firm from a singlewide construction trailer on a landfill project more than four years ago.

Equipment Selection and Consulting

A contractor new to AMG will often be overwhelmed by the numerous options and buzzwords touted by vendors when they shop for a guidance system. The surveyor, especially if he or she has established a prior working relationship with the contractor, is in a unique position to provide valuable advice during the acquisition process. The surveyor must be comfortable with the notion that these systems may replace a crew or two on the project, but if you provide sound advice and are perceived as facilitating the adoption of this technology, you likely will be invited to participate in the implementation and support of the AMG systems.

We talked our first client into using machine control by demonstrating the potential cost savings and increase in productivity likely to be realized on a large-scale project. Subsequently, we were given all responsibility for the installation and overall operation of the system because we were perceived as the experts.

System Installation

The AMG dealer often initially installs a guidance system. New pieces of heavy equipment or “yellow iron” can now be ordered with a guidance system installed right from the factory. However, many aftermarket AMG systems are placed on rented equipment or moved from machine to machine as the contractor’s needs change. Further, most AMG dealers do not develop custom systems for applications outside the normal dozer/excavator/grader range of equipment. As surveyors become more advanced, they will be primarily responsible for installing custom guidance systems they design themselves and adapt to fit their client’s unique application.

The best way to get comfortable performing an install is to work side by side with a trained installer on a couple of machines, even if you have to do it for free in the beginning. The software vendor assisted us on our first two dozers, giving us the confidence to take on the work ourselves from then on. Most of the hard work is figuring out where

to run the wires to make the installation look neat and professional. For systems involving modifications to the machine’s hydraulic system, we subcontract that portion to qualified hydraulic technicians. Newer machines that use electric over hydraulic controls can be interfaced right at the electrical connectors on the joysticks, eliminating any changes to the hydraulic system.

The surveyor familiar with running RTK GPS already has a good grasp on setting up a GPS base station and establishing an RTK link. This is often the



▲ Robert Heitzer, PLS (left) trains a machine operator from MACTEC Development Corporation in the basics of AMG use at the Lyndhurst Recreation Complex.

most complicated part of the configuration process. Calibration of the machine to establish the relationship between the GPS antenna (or prism in some cases) and the working edge of the blade will also come naturally to a surveyor. These measurements are especially critical on an excavator where numerous geometric relationships and tilt values must be observed and entered into the calibration. If the surveyor becomes familiar with installing and calibrating the contractor’s chosen AMG systems, the contractor has one more reason to keep the surveyor involved in the project.

Site Localization

The GPS receiver typically incorporated into an automated machine guidance system outputs precise latitude, longitude, and ellipsoid height based on the chosen reference ellipsoid. Planar coordinates must be computed from the latitude and longitude by applying a standard projection. Ellipsoid heights must be converted to estimated ortho-



Brian McDermott, a student in the surveying program at NJIT, checks AMG grading progress at the Kingsland Landfill in Lyndhurst, NJ.

metric heights via an accepted geoid model. It is then common to perform a 3D transformation between the computed planar coordinates and orthometric heights and the local survey control to achieve a tight correlation such that all positions reported by the AMG system are relative to the on-site survey control used by others involved in the project.

This represents a simplified explanation of a complicated process typically called site localization or site calibration. The surveyor is by far the most qualified person to understand the complexities and nuances involved in accomplishing this task.

For example, I was performing a site localization on a project using coordinate and elevation values supplied by the contractor. I tied into five or six control points spread around the project. The horizontal and vertical values were held fixed by default as I performed the site localization, and my residuals were okay. Not great, but okay. Education and experience as a surveyor have taught me that the site localization can warp your data enough to fit bad survey control. As a check, I edited the localization to hold only a single point fixed, performing a quick, minimally constrained adjustment. Now I had over a foot of vertical residual on the control points along the one side of the project. I asked the contractor to check his numbers, and, after a couple of days, the answer came back. They were bad. I would never have caught that error if I did not understand the process.

The surveyor can also provide protection for the contractor by performing independent calibration checks of their guidance systems periodically during construction. For one contractor, we visited each of their AMG-equipped machines once a week and documented on a pre-printed form the position reported by the AMG system versus our survey grade GPS, which was checked on the site survey control each time. This gave the project team confidence their machines were working properly and the little things, like blade wear, were being accounted for. In a dispute over quantities or grades, that data, backed up by an independent licensed professional, would have been worth many times what they paid for it. No one but a surveyor can credibly perform that service.

Data Preparation

A machine with a properly installed and calibrated AMG system knows precisely where it is, but it has no idea where to go until various digital files representing the proposed design are loaded onto its computer. The process by which the requisite digital design files are generated is typically referred to as “data preparation.” It is important to note that it is not called “data loading” or “data transferring.” Today, there is a significant amount of preparation involved to ensure that the digital files placed on the machine accurately represent the intent of the design professional as expressed on the official signed and sealed, released-for-construction documents. Attention must also be given to the intended construction methodology to be used by the contractor.

Often, the experience and tools necessary to accurately generate alignments, templates, and surfaces from 2D plans or CAD files are not available in-house for many small contractors. Surveyors are ideally suited to take responsibility for this essential data preparation task. It is a process quite familiar to most surveyors performing modern construction layout using a data collector or field computer. A surveyor who has staked grades using a DTM on his or her data collector has likely worked through all the steps necessary for preparing files to load into an AMG system.

While opportunity abounds today for the surveyor in data preparation, a caveat exists. Do not expect to retire performing data prep for your clients. As civil engineers get more comfortable performing site design in true 3D, as they recognize the fact they can charge a premium for “machine-ready files,” and as insurance companies finally wrap their collective heads around insuring the accuracy of a digital file, the bulk of the data prep work will not be necessary. The gross checks and the minor tweaks to the model files necessary for the selected construction methodology will remain. When we started Land-Marker Geospatial, we estimated we had



▲ At the Avon Landfill in Lyndhurst, Stephen Stafniak, PLS replaces a dual-axis tilt sensor mounted on the blade of a bulldozer.

ten years of performing comprehensive data preparation for our clients before the civil engineering profession fully embraced 3D design and significantly reduced the magnitude of data preparation required. That was four years ago. The window of opportunity for the surveyor remains open, but the pace of technology is forcing it closed every day.

Operator Training

Machine operators require training in the use of AMG systems to take full advantage of their capabilities. An operator can be trained quickly in the basic use of a guidance system, but the more advanced functions or detailed grading tasks require additional time and practice. It takes about ten minutes to show an operator how to grade out a large flat area using an AMG system. It's almost as simple as “Fill means blade up, cut means blade down. Give her a whirl.” That same approach with an operator trying to grade a narrow berm will result in chunks of earth being carved up followed by a long and creative string of epithets. The operator in the second case needs to be taught about break lines, how to switch his grade reference point on the blade, and how to use the hold slope function.

As surveyors, we understand the intricacies of grading and can easily relate that knowledge to the AMG earthmoving process. The surveyor can stay involved in a project using AMG by taking the time to learn the capabilities of the contractor's guidance systems and being available to train new operators and offer advice to operators struggling to use the system.

Progress Reporting

Up-to-date progress reporting becomes critical on a site using AMG for grading. In the past, a forest of stakes was set on the site, and all parties involved could see the proposed grades. The stakes served multiple purposes. The grade foreman used them to direct fill material to the correct location and locate where cut material was going to come from. Project managers and site superintendents could walk the project and get a feel for progress being made.

Adopting AMG eliminates this ready source of information, often throwing the supervision of grading operations into chaos. Without accurate progress reporting, the only people on site who truly have a grasp of the grading progress

ers and provided weekly updates of the grading maps to support fill-placement logistics as well as payment requests by the contractor.

More recently, our clients have allowed their operators to log progress data on the machines themselves, which they send to us to generate updated maps. We politely explain to them that operators aren't always the most careful data collectors and that a licensed land surveyor will never sign maps containing client-supplied data, but we are happy to provide the service. For the most part, it makes no difference to the contractor for simple interim progress reporting and allows them to receive more frequent updates at less cost. Thus we remain a critical part of the project team

to remove this work from the surveyor's purview. This can represent a significant expense for the contractor, but there are no options.

We often work with the contractor to devise methods for performing as-built measurements as efficiently as possible, but our survey crews are still out there performing the work. AMG has only affected the speed at which as-built documentation is required. As grading productivity increases, the required turnaround time for as-built documentation shrinks. When the subgrade is complete, the operator simply hits a button, and he or she is ready to start spreading final grade. There is no wait for layout; all they wait on is approval of the subgrade as-built. The surveyor can shine by recognizing how AMG has affected the productivity and scheduling of grading operations and increasing their level of service to match.

My goal in writing this article is to demonstrate by first-hand experience that the motivated surveyor can remain an integral team member on projects that turn to automated machine guidance for grade control. At LandMarker Geospatial, we made AMG support and service the cornerstone of our firm because we felt it was an interesting application and represented a natural technological extension of the surveying profession. Every day as I return home, I get a stark reminder of what happens to a business overrun by technology. The shuttered Fotomat kiosk sits weathered and abandoned in the parking lot at a local shopping center. As a business owner, the place gives me

the creeps and provides all the impetus I need to continue looking for better ways to keep our services relevant for our clients. ↓

JOSEPH PRIESTNER, PLS, PE is a partner at LandMarker Geospatial in Jefferson Township, New Jersey. He holds a B.S. in Surveying Engineering Technology from the New Jersey Institute of Technology and a B.S. in Civil Engineering from The Citadel and is licensed as a surveyor in NJ, NY, NC, and SC and an engineer in NJ and SC.



▲ A machine operator from Edgeboro International installs gas collection piping using an excavator-mounted AMG system at the Kingsland Landfill.

are the operators in the seats. Supervisor systems exist that can be installed in pickups or on ATVs to provide an identical display, but these are expensive and limit the availability of the information to those who have the systems installed in their vehicles.

The surveyor is best suited to periodically collect topographic data during construction and generate updated cut/fill maps to assist with planning and managing grading operations. At LandMarker Geospatial, we have run quads equipped with GPS behind the doz-

and available when other surveying and mapping tasks are required.

As-Built Documentation

Familiar to all surveyors, generating as-built documentation is similar to progress reporting with one major difference. The maps produced represent the final in-place product and will be used by the owner to judge and approve the fitness of the contractor's work. These maps are almost always signed and sealed by a licensed professional land surveyor. As such, there is no way