

A&E Briefings

Structuring risk management solutions

“Machine Control” means change for surveyors and engineers

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In the movie “2001: A Space Odyssey,” it appeared that the machines were going to take over. The year 2001 has come and gone, and sometimes it seems that Stanley Kubrick’s classic film wasn’t science fiction – machines really are taking over.

If the phrase “machine control” makes you wonder who is in control, you are not alone. In the realm of civil engineering and surveying, machine control refers to the ability to operate earth-moving equipment via a satellite-based system such as GPS. Contractors are able to do this with on-board computer technologies tied into the hydraulics of construction equipment. Satellite control is established through individual base stations on a per-project basis, permanent bases able to “cover” multiple projects or, in some parts of the country, subscription-based private GPS networks.

Some of the benefits touted by major machine control system manufacturers include increased productivity, improved accuracy between hubs and at transition points, decreased material overages, a reduced need for staking and grading, elimination of mid-job surveys and ultimately, cost savings.

Yes, but...

However, machine control is inappropriate in a variety of situations.

- The accuracy of GPS depends on receiving signals from as many satellites as possible (seven is optimal). Urban areas with high rise buildings that block reception present a problem with the consistency of satellite signals.
- Machine control performs well in producing elevations and cross-slopes on long stretches of transportation projects, but not so

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well on tight sites where access and clearance are difficult. The human touch is still needed for intricate maneuvers such as trenching.

- Any site that is complicated by the proximity of underground utilities and unreliable as-builts can be problematic. Construction equipment guided by machine control doesn't “know” what it hit – whether it's a rock or a sewer pipe – and will keep pushing.
- The technology of machine control is not yet well developed enough for fine grading or paving. In “Design Guidance Memorandum Number 1-19,” dated July 6, 2007, the Delaware Department of Transportation (DelDOT) states: “Vertical control using Machine Control Technology is not yet sophisticated enough to meet highway construction specifications of ± 0.01 feet.”

- Correlatively, unusually sloped and steep grades where the vertical component takes importance over the horizontal component pose a difficult situation. Seasoned practitioners rely on machine control for flat work, but trust their own professional judgment and experience for vertical construction such as bridges or golf courses.

What about me?

So how does machine control affect engineers and surveyors? In a traditional example, the civil engineer prepares design documents (paper and digital files) that are appropriate for the bidding process and to receive permit approval. This data is eventually handed over to surveyors who manipulate it to serve their purposes for project layout and staking. Construction equipment operators then follow the stakes to cut and fill, establishing the finished grade.

With machine control, an extra layer of data preparation enters the process. The (mostly) two dimensional (2D) data prepared by civil engineers, usually in MicroStation, has to be converted into a three dimensional (3D) data model in AutoCAD detailed enough for machine control. It



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is a matter of taking data points and turning them into a surface file. Whether this translation process is done by engineers, surveyors, consultants or contractors, financial and legal liability for the use of machine control is an overall issue.

For engineers, typical civil drawings are akin to a performance specification. Plans may show existing and proposed elevations, leaving interim calculations to surveyors and contractors. Contractors are given general estimates of earthwork quantities for bidding purposes. Major variations from these estimates are handled on a unit price basis through change orders.

If design professionals are expected to produce data files to a higher level of completion for terrain models, this may raise owner expectations regarding the accuracy of these earthwork quantity estimates. By providing data files in bid documents, design professionals could take on liability for the cost of contractor change orders for quantity deviations.

Surveyors have customarily served as the liaison between the office and the field while also performing quality control and documenting finished as-built conditions. If surveyors provide machine control data files, they effectively remove themselves from day-to-day presence and interaction on the job site. This lack of participation during construction makes surveyors more vulnerable for liability for errors in the data files. Common wisdom says that an extra set of eyes at the project will catch an error sooner, and the sooner an error is caught and dealt with, the less the cost to fix it.

Machine control has bred a new type of “data prep professional” or “data conversion consultant.” These third-parties could be licensed surveying firms expanding their services, or they might be associated with the machine control technology manufacturers. Services provided may include machine control file preparation, site calibrations, quality control surveys, and even providing the GPS network. To what standard of care do they perform and to whom do they owe responsibility and liability? That depends on whom they are working for – the engineer or the contractor.

Contractors who undertake the use of machine control may not realize the effect that machine control has on scheduling. Whatever time is saved on the back end may have to be invested on the front end. It’s not called data prep for nothing – a lot of preparation time, along with math and surveying skills, are needed. The sophisticated technology is only as good as the people behind it.

Regulatory response

Government regulations usually lag behind technological advancements. This is the case with machine control. State agencies that regulate the engineering and surveying professions are addressing machine control indirectly. Rather than revising existing regulations, “position statements” are issued in an attempt to address current practices and give some guidance to professionals.

At issue is what functions fall under the responsible charge of a licensed professional surveyor.

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Is a construction contractor who uses machine control practicing surveying without a license? Is a professional licensed surveyor or civil engineer guilty of aiding a contractor in the practice of surveying without a license by handing over the data files needed for machine control? There is no one correct answer at this time; it is being resolved on a state-by-state basis.

Most states are exploring the use of machine control for survey staking and rough grading, but few have developed GPS-related specifications.

States that have addressed machine control place the responsibility and liability to comply with standards with the contractor. As an example, the Iowa Department of Transportation's “Developmental Specifications for Global Positioning System Machine Control Grading” contains the following clauses:

- The Contractor may use any type of GPS machine control equipment and systems that results in achieving the existing grading requirements. The Contractor shall convert the electronic data provided by the Contracting Authority into the format required by their system.
- No guarantee is made that the data systems used by the Engineer will be directly compatible with the systems used by the Contractor.

- The Contractor understands that any manipulation of the electronic data provided by the Contracting Authority shall be taken at their own risk.

Agencies are also treating data files as they would any electronic drawing file. The DelDOT “Release for Delivery of Documents in Electronic Form to a Contractor” must be completed prior to releasing any electronic files to the contractor for the use of GPS machine control. Some of this form's provisions are:

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- The ELECTRONIC DOCUMENTS are provided as a convenience to the CONTRACTOR in connection with the CONTRACTOR'S

responsibilities and obligations relating to the PROJECT. The DEPARTMENT shall not be construed to have performed any services in connection with the CONTRACTOR'S use of the ELECTRONIC FILES provided and shall have no liability for any aspect of their use, and has no contractual relationship with the CONTRACTOR in connection with their use, other than set forth in this Agreement.

- All parties agree that the ELECTRONIC DOCUMENTS are not, nor shall they be construed to be, a product or products. It is specifically agreed by the CONTRACTOR that there are no warranties of any kind in such ELECTRONIC DOCUMENTS or in the media in which they are contained, either expressed or implied, including any

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warranty of merchantability or warranty of fitness. Any warranty of merchantability or warranty of fitness is expressly waived by the CONTRACTOR.

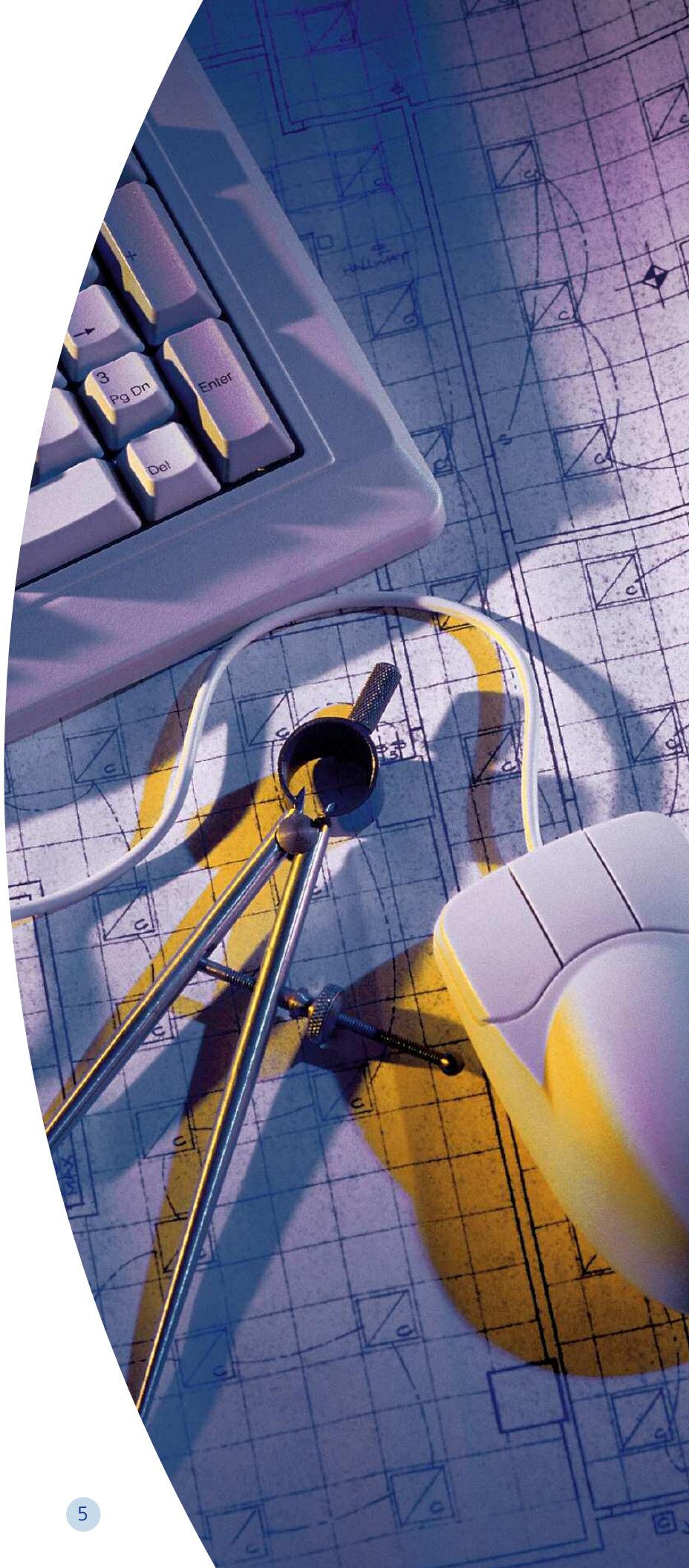
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Let's talk business

Computer technology has been changing the practice of engineering and architecture. So too machine control is changing the practice of surveying, and changing the ways that parties to a project interact.

Does machine control sound a death knell for surveyors? No, there will always be a need for professional licensed surveyors. Remember all the situations where machine control is inappropriate. And even where machine control is being used, satellite signals can be lost or base stations can go down, causing the job site to sit idle.

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Yes, surveyors’ business operations will be affected. For example, the Minnesota Department of Transportation found that contractors using machine control needed quicker inspection and approval of their work by field personnel, thereby requiring more survey staff but for shorter durations.

Yes, surveyors’ employment opportunities will be affected. Surveyors who are savvy in machine control may migrate away from engineering firms to work for consultants or contractors.

In the time it took to research and write this article, information regarding machine control changed. That’s how quickly this area of practice is evolving. Just knowing the existing professional code of practice may not be enough. Civil engineers and surveyors need to stay current with developments within their state and if appropriate, become involved in the political/regulatory process through professional societies.

Translation means change. There are liabilities in change, but there are also opportunities. Machine control can be looked upon as a new language, offering future benefits to anyone willing to learn this skill set.

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