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The Integrated Construction Site
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Few will argue that construction is an industry of close tolerances, where precision and accuracy can make or break a contractor's bottom line.

At the same time, the pressures of a compressed schedule and tighter budget mean jobs must be completed faster and cheaper, while improving profitability. To ensure a smooth completion, all job parts need to be integrated — from design to project completion to confirmation. To achieve this, contractors are increasingly relying on cutting-edge technology at each phase of the construction process.

There are three phases of construction today that are being significantly impacted by the introduction of three-dimensional positioning technology and the ability to digitally and seamlessly move data from the office to the field and back to the office. They are design, grading and checking/confirming.

With the advent of digital design data, it is possible to move the same data seamlessly between each construction phase, without any loss or distortion of information — a tremendous quality control and productivity advantage.

Before an earthmoving machine cuts the surface, there is considerable planning, surveying and designing for creating the site design and project plan.

Civil engineers and designers work with a wide range of powerful design and computer aided design (CAD) packages, such as the Autodesk Land Desktop, Inroads, Geopak, MOSS, or the Trimble Terramodel® software.

The design emphasis is shifting from preparing printed plans to developing a three-dimensional surface model of the entire project and analyzing it in multiple ways prior to grading — heading off potential design problems. As a result, any point observed in the field can be instantly compared to the surface model, and grade can be established. Additionally, surface files can be transferred to automatic machine control systems, thereby reducing the need for construction staking.

The benefit of digital data is the ability to seamlessly connect the design engineer, surveyor and contractor into an integrated workflow. Delivering a sheaf of paper plans is becoming unacceptable. Instead, the same digital information created for the site design and project plan is being used for machine control to ensure accurate grading — and accurate site positioning during and after project completion.

During the grading phase, the earthmoving contractor converts the designer's electronic designs into reality. On the integrated construction site, design data is available to the machine operator and supervisors right in the cab of the machine or their vehicle.

With three-dimensional automatic grade control systems, contractors literally can put cutting-edge technology on their cutting edge — the blade of their earthmoving machine. This technology uses either the global positioning system (GPS) or an advanced tracking sensor (ATS) to control the actual position, elevation and cross-slope of a machine's blade or bucket relative to the site design displayed on the in-cab computer.

The three-dimensional system measures the blade's X, Y and Z coordinates. The in-cab display shows the desired elevation and cross slope for the current position from the preloaded digital terrain model. Using a machine guidance system, the operator moves the blade or bucket to the correct cut or fill position elevation and slope. If the machine is equipped with automatic grade control, the system will automatically respond and adjust the blade accordingly.

A GPS automatic grade control system provides up to 0.1-foot (20 millimeters to 30 millimeters) of accuracy. To achieve even greater accuracy, a total station is typically used, providing accuracies as tight as 0.02-ft (plus or minus 5 millimeters). Using three-dimensional grade control systems allows the operator to precisely grade complex site or road designs without string lines or grade stakes.

Placing grade information within the cab empowers the operator to make fast decisions. The operator knows where grade is, as well as the locations of design elements, and can work in dust, wind or darkness. In-field changes can be made quickly. New grade or pad elevation can be set right in the cab without waiting for grade stakes to be set or repositioned.

While the project is being worked on, there is the need to check and verify that finished grade and material thickness meets the design specifications — real-time verification.

On the integrated construction site, the grade checkers and supervisors take the digital site design into the field to measure material volumes, check grades and material thicknesses, and perform site measurement tasks, such as point, line and surface stakeout. To provide in-process checking and end-of-project confirmation, contractors are using solutions such as the Trimble SCS900 Site Controller System. The unit is designed to automate daily construction site tasks so that contractors can easily perform site positioning and make decisions in the field to keep machines running.

The integrated construction site is helping contractors to be more productive, thorough and precise. Digital data is now flowing seamlessly from the site designer's computer through the machine operator's controls and on to the accurate confirmation of a job well done.

The hard work of construction has become technologically sophisticated, yet simpler in many ways to complete. And throughout these three phases of construction, contractors are reaping benefits of improved safety, productivity, accuracy, and profits.

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