

# THE ROLE OF LAYOUT IN DELIVERING EFFICIENT, SUCCESSFUL BUILDING PROJECTS

By Bryan Williams

**SITTING SOMEWHERE** between the point where structures are conceptualized and designed and when they're physically erected, lies a vital phase of project success – construction layout. It's where architect, engineer, and detailer ideas get translated to the real world. Reference and alignment from detailed drawings are transferred to the job site to facilitate construction and without them, work can't start, much less succeed.

## The Critical Role of Layout Professionals

When starting at bare dirt, surveyors or experienced general contractors will have established control points, usually beginning with a known point, such as a property corner. These indicators of key structural geometry placement are based on detailed architectural design models. They are established based on measurement and calculation of precise distances and elevations relative to the initial reference points. These control points are then used to transfer reference points to the actual structure that are used by the many contracted trades.

These measurements must be carefully documented and checked against contract documents to ensure easements, setbacks, and property boundaries are within specification. To be effective, these markers must be durable and appropriate for the length of the project, easy for contractors to understand, and most importantly, accurate.

## Potential Problems with Inaccurate Layout

Inaccurate layout points can lead to a wide range of problems. Just as a structure built on a weak or damaged foundation is bound to crumble, installation of a wall, pillar, or beam based on inaccurate layout points is likely to suffer one critical error after another.

In most cases, these errors are discovered when contractors attempt to install building components. In this case, the result is a Request for Information (RFI) or change order that typically requires input from a detailer, or even the architect. Depending on its severity, the error could be a quick fix or create delays that eat away at the project budget and a contractor's profit margin. When materials have been prefabricated based on erroneous measurements or calculations, the delay and cost of rework can escalate even further.

In some cases, layout errors might not be discovered during a project's initial erection phases and instead can impact the mechanical, electricals and plumbing (MEP) work, steel erection, or later phases of construction. In this case, rework is often more costly and time consuming as stakeholders scramble to make adjustments that accommodate



Robotic total stations have dramatically improved construction layout. structural components already in place. In a worst-case scenario, layout errors that are not identified or properly prioritized during construction weaken or otherwise compromise the finished structure, creating a serious safety hazard for occupants.

It's easy to see why accuracy is critically important. To do the job right, layout professionals must anticipate errors, rigorously check their work, understand design intent, communicate effectively with all stakeholders, and visualize the finished project.

## Modernizing Layout

Traditionally, layout was a completely manual process that required at least two or more people, depending on a project's size, and a host of tools including string, tape measures, levels, theodolite and leveling rods, plumb bobs, combination squares, and measuring wheels.

Advances in technology such as pocket calculators, laser levels and distance meters, and electronic theodolites enhanced the process to some degree, but there was still a high potential for human error. With the introduction of the first electronic total stations in the early '70s and advances in CAD for generating, verifying, and placing points, the industry took another step in the right direction, but there were more improvements on the horizon.

Today, steel and concrete layout professionals have an incredible array of tools and techniques at their disposal that professionals from the past would envy. These tools bring an unprecedented level of speed, efficiency, and accuracy to layout.

In recent years, Robotic Total Stations (RTS) have dramatically improved construction layout. Taking a natural step beyond the capabilities of the electronic total stations of previous decades, an RTS reduces the opportunity for human error and frees up layout professionals for other, high priority work. An RTS can be controlled remotely using a tablet or controller, so one person can handle even the most complex layout tasks.

In a head-to-head competition, one person using an RTS laid out 200 points in four hours, while two people working manually only laid out



Hardware and software tools can be used to integrate layout into the overall workflow.

97 points in the same amount of time. This efficiency and speed didn't come at the cost of accuracy. The RTS produced zero errors, while the team working manually had two RFIs, missing dimensions, and a serious layout bust for a mirrored "similar" floor plan.

Laser-based rapid positioning tools (RPT) and global navigation satellite system (GNSS) receivers are similar in function and benefit to the RTS and allow steel and concrete contractors to choose the features and tolerances required for a given project.

The most advanced RTS models not only handle the necessary measurements and calculations on the fly, they also provide powerful visualization options, such as photographic documentation and augmented reality-style overlays. They can also connect directly to powerful layout software solutions designed specifically for building contractors for true connectivity between the office and the field.

Combined with hardware, software can seamlessly integrate the layout process into the overall construction workflow and provide layout professionals with access to constructible 3D Building Information Models (BIM) created by designers and detailers along with all the corresponding metadata.

As layout progresses, information can be fed back into the model and updated in near real-time so all project stakeholders are kept informed. If changes need to be made, layout can adjust on-the-fly to avoid costly rework of their own. The resulting data gathered by connected equipment onsite can easily be viewed in context by all other stakeholders for purposes of clash detection, fabrication, and more. Once again, speed, efficiency, and accuracy are held to the highest standards as every phase of construction remains connected through powerful hardware and software solutions being used to complete the layout.

### Taking it to the Field

The benefits of these tools are far reaching and apply to numerous layout tasks, including:

**Footings, Foundations, and Stem Walls.** Check the placement of formwork, steps, block outs, and anchor bolts before, during, and after concrete is poured. Variations as slight as 1/8 of an inch can be instantly



New technologies are bringing speed, efficiency, and accuracy to the layout process.

identified and corrected while the concrete is still wet.

**Steel Erection.** Steel contractors not only need to layout their specific items, but also check concrete work to ensure attachment points are correct.

**Super Structure – Concrete Cores and Slabs.** Verify placement and alignment of all openings and components embedded in the concrete to avoid expensive rework and the potential for future, dangerous damage.

**Slabs on Grade (SOG) or Deck (SOD).** Ensure the flatness of slabs is within the tolerances needed for proper load bearing, flooring installation, precision usage, and resistance to damaging weather.

**Super Structure – Precast Concrete and Steel Fabricators.** Perform layout in the fabrication shop and carry the data directly to the site with no issues in translation. This ensures all project parties are clear on openings, attachments, embeds, anchors, pre- and post-pour camber for deck slabs, plumb, square and flatness, clips angles, bolt holes, stiffeners, complex assemblies and curves, pre-loaded camber and welding deformations.

### Looking Forward

We have seen that problems during layout can have a snowball effect on the rest of the build and lead to costly RFIs, rework and even worse, safety hazards. After all, layout can constitute as much as 25 percent of a contractor's costs.

It's no doubt that layout will continue to play a critical role in modern steel and concrete workflows. Moving beyond manual processes to leverage technology advances will help layout professionals meet the demands of increasingly complex projects, all while working faster, with unprecedented accuracy.

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