A Point in the World: Robotic Total Station in a Design-Build Environment
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CR2328 There are many ways to create a coordinate point, but how do you use that data in the field to make the construction process more efficient? This class explores the benefits and items to consider when using point data on the jobsite. Learn where to start, what to do, and what to avoid, in order to realize a more effective project layout workflow. We discuss real-world examples that will assist you in visualizing how your company can use this information to its advantage. Our case studies focus on design-build projects in which Haskell provided self-perform concrete services as well as steel fabrication, including an aviation complex and a biomass facility.

Learning Objectives

At the end of this class, you will be able to:

- Learn how to leverage design models and integrate subcontractor fabrication models for point creation
- Learn best practices for checking model accuracy for point creation
- Learn how to utilize as-built data from the field for verification and real-time coordination
- Learn how to develop a custom workflow for point creation and layout in your organization
John Hall, BIM Integration Specialist, Haskell

John is a BIM Integration Specialist for Haskell, a multidiscipline Design-Build firm based in Jacksonville, FL. He facilitates the development, coordination, and management of Building Information Models for construction and field use during all phases of a project. He is responsible for integrating trades during construction, as well as, leveraging the power of building information models in the field to increase productivity and reduce errors. Since graduating from ITT Technical Institute, he has worked in many building sectors including Architectural and Electrical design and construction coordination. John has actively participated in multiple presentations for local USGBC and AIA conferences and is a Revit Certified Professional.

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Ryan Camer, BIM Integration Manager, Haskell

Ryan Camer received his bachelor’s degree in computer graphics technology from Purdue University and is the BIM Integration Manager for Haskell, a design-build firm headquartered in Jacksonville, FL. He is a co-author of the firm’s BIM Subcontract Attachment and provides BIM implementation strategies and services, including self-perform concrete layout technologies. Ryan has served as guest speaker at ASPE chapters and AIA Continuing Education Programs throughout Florida. He is a Revit® Architecture Certified Professional and is also proficient with Revit® Structure, Revit® MEP, Autodesk® Navisworks®, AutoCAD® MEP, Trimble® Point Creator, Get the Point® software, and more.

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About Haskell Design-Build

Locations

Founded in 1965, our corporate headquarters is in Jacksonville, FL, with over 780+ employees throughout all of our regional offices:

- Atlanta, GA
- Beloit, WI
- Columbus, OH
- Dallas, TX
- Jacksonville, FL
- Livermore, CA
- Mexico City, MX

Services

We are an integrated mid-sized design-build firm with the following services:

- Architecture
- Engineering
  - Structural
  - Mechanical
  - Plumbing
  - Electrical
  - Process Systems
  - Material Handling & Distribution
  - Packaging
  - Civil
- Construction
- Landscape Architecture
- Interiors
- Sustainability

Along with construction management services, Haskell has a steel shop fabrication unit and self-performs concrete work on most of our projects. We have a team of over 109 LEED® accredited professionals along with a sustainable project portfolio over $1.1 billion.

Market Sectors

Haskell annual revenue is $590+ million with 70% of our work through repeat clients, in the following market sectors:

- Consumer Products
- Food and Beverage
- Manufacturing
- Distribution
- Energy
- Government
• Water & Wastewater
• Aviation
• Education
• Healthcare
• Commercial

**Haskell Construction BIM Group**

Since 2007 the Haskell Construction BIM Group has been leveraging BIM for the following construction applications:
• Clash Detection
• Quantity Takeoffs / Estimating
• Construction Sequencing / Scheduling
• Facility Management
• Mobile Technologies
• Self-perform Concrete Layout via Robotic Total Station (RTS)
Section I. Robotic Total Station (RTS) Overview

Layout Equipment Overview

Layout Technology Differences:

- *Transit and/or Builders Level*

- *Total Station*

- *Robotic Total Station (RTS)*

- *GPS*

**RTS vs. GPS**

*RTS*

- Ideal for Concrete/Steel/MEP Contractors
- Requires line of sight
- More accurate than GPS (~3mm, .118”, or 3/32”)*
GPS

- Ideal for Civil/Site Contractors
- Does not require line of sight
- Less accurate than RTS (~8mm, .314”, or 5/16”)

Why Haskell is Using RTS

Haskell procured Trimble® RTS 633 equipment since the bulk of its use is for concrete self-perform work which requires tighter accuracy than GPS system for setting anchor bolts and embeds.

Trimble® RTS 633 Specifications:
- Accuracy greater than 3mm 3/32”
- Measurement Distance up to 2,500m (8,200 ft)
- Direct Reflect up to 800m (2,600 ft)
- Robot Radio up to 700m (2,300 ft)

The robot allows for one-man operation in lieu of two-man operation so less field personnel required, along with faster layout, and greater accuracy than our traditional layout methods.

In our case the data collector communicates with the robot via radio frequency when necessary to re-locate if auto-tracking communication with the prism pole is lost.

Configuration Options

Prism Pole Options

The prism pole configurations can be customized, including attaching the prism to the bottom of the pole for greater accuracy when setting anchor bolts.

Data Collector / Tablet Options

There are many data collector options including tablet PCs with larger display sizes and greater processing speeds and RAM which is necessary on complex projects with several thousand layout points.

IMPORTANT NOTE:
We recommend getting a tablet with 2 GB+ RAM for complex jobs.
Section II. Point Creation Overview

What to Create From

Contract Drawings

Manual Entry from PDFs:

This may include entering Site Monuments from Civil Drawings, or Building Tie-Ins from Architectural/Structural, etc.

Digital Extraction from 2D Drawing Files (and/or 3D Conversion):

This may include a 2D CAD file obtained from a Structural Engineer drawing file for locating foundation corners, pipe sleeve locations from Mechanical Engineer drawing file, etc.

Digital Extraction from 3D Models:

This may include a 3D model from the Structural Engineer for locating XY and Z coordinates of foundation elements, etc.
**Shop Drawings**

**Manual Entry from PDFs:**

This may include coordinates shown on shop drawings for tie-in points, etc.

**Digital Extraction from 2D Drawing Files (and/or 3D Conversion):**

This may include a 2D CAD file of precast foundations for locating anchors, pins, formwork panels, etc.

**Digital Extraction from 3D Models:**

This may include a 3D model from the steel fabricator, formwork supplier, equipment vendor, MEP subcontractor for rough-in layout, etc.

**IMPORTANT NOTE:**

In all cases, quality checking “scrubs” of digital files are required to ensure the information is accurate for point creation and matching printed documents. Examples of quality checks will be covered in further detail in the Lessons Learned section.
What Software to Use

**Revit® Plug-Ins**

**Autodesk® Point Layout® (formerly GetThePoint® / GTP)**

Autodesk Point Layout is our preferred plug-in for point creation via Revit®.

**Trimble® Point Creator (TPC)**

Trimble® Point Creator (TPC) was our first trial software for point creation via Revit®, and while it worked for all intensive purposes for point creation, there were too many bugs and limitations in our opinion. We believe Autodesk Point Layout is the most advanced point creation software available for Revit® at this time.

**Excitech®**

This tool is free and used by our AE staff for XYZ coordinate schedule population on Contract Drawings in Revit®. This tool is not as robust on the point creation automation side, but a great free tool to use in some cases.

**Alternatives**

**Navisworks®**

The Autodesk Point Layout add-in for Navisworks is great for creating points on highly detailed equipment vendor models, for example Inventor files, that may be too complex to bring into a Revit® model for point creation.
Civil3D®

Civil3D offers built-in point creation for populating coordinate schedules on Contract Drawings.

AutoCAD®

Both Autodesk Point Layout and TPC offer AutoCAD plug-ins as well for point creation on 2D or 3D CAD files.

Tekla®

Tekla includes built-in point creation tools, ideal for steel fabricators or concrete contractors already working in this software.

Notepad / WordPad / Excel

Great for basic manual entry, point data searching, etc.

**What the Field Requires**

Be sure to discuss point creation in detail with your field personnel prior to creating points. Too many or too few points for layout can be detrimental to the process. The field team may not always require XY and Z points for example. Also understand what additional offsets may be required in certain cases, for example for mud mats, bolt template alignment, etc.

It may also help speed up the data collector and point retrieval if these points are grouped by area or sequence of work, as well as prefixes relating to the work sequence, for example **IFB123 = Isolated Footing Bottom point, ABT999 = Anchor Bolt Top point, EBC456 = Embed Center, etc.**

We found that our team was more productive when given points that included a three-letter prefix with the third letter indicating elevation: **T** for **Top** and **B** for **Bottom**, **C** for **Center**, etc.

See Point Prefix List Handout, for all of the Haskell standard abbreviations for your reference, that you may want to tailor similarly to the needs of your organization.
How to Transmit to the Field

Cloud Storage

We recommend using a cloud storage account (Ex: Box®, DropBox®, SugarSync®, Egnyte®, etc.) This has proven to be the quickest and easiest method for us and includes version control, syncing capabilities, and email notifications on uploads/downloads.

Alternatives

- Network Drive
- Flash Drive
- Email
Section III. Lessons Learned from Past Projects

How We Use RTS

Self-Perform Concrete Layout

As an integrated design-builder with steel fabrication in-house, all of our Structural Design is done in 3D using Autodesk® Revit® and steel detailing in 3D using Tekla® Structures®. These models are directly leveraged for self-perform concrete layout.

As-Built Verification

We also as-built verify every anchor bolt and embed and relay this information from the field to the office team for steel fabricator adjustments if necessary.

Additional QC Checks

We also perform Quality Control (QC) checks on various subcontractor scopes’ of work, including site utilities, MEP systems, wall layout, etc.

Combined Case Study

Food Manufacturing Plant in Northeast

- $115 MM (Building Only)
- 370,000 SF
- 7,000+ Layout Points

This was our pilot project using Trimble® RTS 633 layout equipment technology.

We generated points through Revit® using Trimble® Point Creator (TPC) plug-in software and distributed these to the field layout team through a Box® cloud storage account.

Layout Elements:
- Isolated, Continuous, and Step Footings
- Concrete Pedestals
- Stem Walls
- Tilt-Up Wall Panels
- Sloped Slabs
- Precast Columns
- Precast Anchors and Pins
- Structural Steel Anchor Bolts and Embed Plates

**Aviation Complex in Mid-Atlantic**

- $130 MM
- 610,000 SF
- 50-Acre Site
- 10,000+ Layout Points

We generated points through Revit® using Trimble® Point Creator (TPC) plug-in software for this project and distributed these to the field layout team through a Box® cloud storage account.

Layout Elements:
- Piles and Pile Caps
- Isolated, Continuous, and Step Footings
- Concrete Pedestals
- Elevator Pits
- Tilt-Up Wall Panels
- Sloped Slabs
- Equipment Pads
- Trench Drains (2.5 miles of sloped concrete)
- Formwork Corners
- Pipe Sleeves
- Precast Columns
- Precast Anchors and Pins
- Structural Steel Anchor Bolts and Embed Plates
- Structural Steel Truss Alignment Points
Bio-Mass Plants in Southeast

- $250 MM
- 150 Acres Combined
- 25,000+ Layout Points

We generated points through Revit® using GetThePoint® (GTP) software (now Autodesk® Point Layout®) for this project and distributed these to the field layout team through a Box® cloud storage account.

Layout Elements:
- Site Utilization: Construction Compound, Batch Plant, Temp. Power, Laydown, etc.
- Isolated, Continuous, and Step Footings
- Concrete Pedestals
- Elevator and Sump Pits
- Concrete Walls
- Tilt-Up Wall Panels
- Sloped Slabs
- Equipment Pads
- MEP Stub-Ups and Sleeves
- Structural Steel Anchor Bolts and Embed Plates

Model Accuracy

Annotation Overrides

Throughout our past experiences, we have discovered that the digital files received externally and internally have contained discrepancies between printed documents and digital information. We discovered columns and foundations that used annotation overrides that did not coincide with the geometry of the modeled object, step footings not modeled per details, anchor bolts not modeled to the correct projection etc.

Object Overlaps

After our pilot RTS project, we changed our internal Revit® modeling standards companywide for overlapping objects to be modeled true to the construction details in the Structural Engineer design
models. For example, we previously had overlapping objects at step footings and stem wall/pedestal intersections which affected the ability to create points at object intersections.

Units Precision and Dimension Rounding

Design-Discipline Coordination

Shared Coordinates

Frequency of Exchange

Grid Lines and Building Corners

Design Readiness and Phasing Discussions

Subcontractor Modeling Requirements

Shared Coordinates
Vendor Working Points

Level of Development / Detail (LOD)

File Type Interoperability

Shop Drawing Verification and Coordination Meetings
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Point Data Exchange between Parties

Coordinate Prisms and Radio Frequencies

Communication Workflows

Design Team Communication

Steel Shop Communication

Field Communication

Expanded Uses

As-Built Quality Checks

- Anchor Bolts
- Truss Alignment
- Panel Alignment
- Floor Flatness

Site Utilization Layout
Section IV. Haskell Layout Approach

Point Creation Overview

Define Project Team Goals

Getting Started with Point Creation

Point Creation Workflow

- Site Control
- Site Utilization Elements
- Excavation Layout
- Top of Foundation Layout
- Column and Wall Layout
- Anchor Bolt Layout
- MEP Rough-In Layout
- Tilt-Up Wall Panel Layout