CS21966

# Point Layout: A Guide to Model Based Quality Control

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### Learning Objectives

- Learn APL workflows
- Learn how to implement at the project level
- Learn about the right tools for your organization
- Discuss how to measure success

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## Description

This class will dive into how PCL uses Point Layout software and BIM 360 Layout to enhance self-perform activities, as well as QA/QC efforts.  We will explore why we chose BIM 360 layout, examine our workflows surrounding model-based QC and profile a project.

## Your AU Expert(s)

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## Project Overview

**Citi Tower – Orlando, FL**
Citi Tower is a $60 Million residential high rise in downtown Orlando. It contains one level of retail, 6 levels of parking and 25 levels of residential units. PCL is self-performing the concrete portion of this project and the team is using a combination of the engineer's structural models and our internal concrete models to assist in a model based layout of formwork, sleeves, block outs and embeds.

## Self Perform Concrete

PCL has always tried to self perform our concrete work. It gives us the ability to drive the schedule, set expectations and control the project. We have pretty refined processes for our model creation and lift drawings already so it was a perfect fit on where to start our model based QC initiative.



*CITI TOWER*

## Process

Now, on to the good stuff!  This will walk you through our process of how we get to the layout and QC portion of a self-perform project.  It is important to realize that QC starts from the very beginning of your process.  It is easy to think of QC as a finishing activity or check but we like to think of it as part of the entire process from receiving design models to as-built.

### Receiving the Design Model

This where we do a "model validation".  Compare the contract documents to the model.  Does it have the specified LOD?  What is the naming convention of the families?  Is all of the geometry present?  Really dive into exactly what you are getting from your engineer.  It will set the tone for whether you need to create your own models to build from or if the design models are usable.

### Create Parts (If needed)

Next we create parts for all of the concrete in the model.  This does a few things, it allows us to work inside a linked model and never have to touch or alter the designer's model.  It also allows us to rapidly digest design changes in that we don't have to redo work when the design changes.  Since we have created parts from a linked model we can update those parts automatically.  This used to be a cumbersome process but thanks to a Revit add-in called "PCL PartsLab" it has become a very key piece of our workflow.  If you haven't checked out PCL PartsLab I would highly recommend doing so.  It can truly alter the way you consume design models and best of all it's free! https://partslab.pcl.com/

### Add points through APL

This is the simplest part of the process yet probably the most cumbersome.  Here is where we add the location points to our model.  It is simple enough to add points to whatever we want to layout or QC.  The problems have come in that we now have so many points that visualization has become ineffective at best.

### Upload to 360 Glue/Layout

Majority of our projects are using Glue in some way shape or form nowadays so this isn't a huge stretch for the project teams but keep in mind that it can be helpful to have limited entry points for your layout data.  By entry points I mean, one or two people that are responsible for uploading your layout points and content to the cloud.  We operate this side of Glue as our "Live Model" so anything that gets posted can be used by the field.  ie,  make sure it's accurate!

### Layout

Finally, the model has been verified, we've added our pour breaks and embeds, uploaded to the Glue server and now…. It's time for layout!  Our engineer, in this case Matt Dodge, will sync his iPad and layout files then head out to the field to layout the desired components.  We'll take a peek into Matt's day and how long it takes him to layout in a little bit.

### Install

Let's pour some concrete!

### QC/Asbuilt

After we've poured we head back out to the field to back check or "QC" the install.  We typically check embeds, blockouts, sleeves, column locations and any other critical components.  These are "round tripped into the models and we then do one of two things.  First we decide if we are in tolerance, if we are we move on.  If not, we revisit the area and take action from there.  It is important to note that you can set variances to automatically tell you if you are out of tolerance.

We do this on occasion but mostly we visually check through the model and the asbuilt points. Also, depending on your contract and scope you may need to update your model accordingly.

## APL Process

The software we use for creating and placing points is Autodesk Point Layout.  It was formerly a product called Get The Point, GTP.  This is where I'll walk through some of the steps we take to insure our model points are ready for layout and QC.

### Isolate Parts

When we start to create the points we need for layout it quickly becomes apparent that there will be A LOT of points in your model and they start to add up quickly.  One thing I always do is isolate the model by scope.  So if I am working on slabs I will dim or hide everything except for the slabs.  Same with columns and so on.  We haven't yet found a decent way to isolate and hide points while working so narrowing down to specific scopes helps to keep it simple.

### Create Views

Another trick we use is to create specific views for point placement.  The same as before we will hide and dim certain scopes to make it easier to locate what we are trying point.  We will create a series of 3d views, plan views and elevations to aid in the placement of points.  I know this seems pretty basic but it is a key point to set these up.

### Identifying Point Types

One of the more frustrating things in APL is the lack of point descriptions.  Right now there are descriptions for things like Walls, duct hangers and sleeves but it would be very nice to have things like Columns, Framing, and actual slab/floor points.  As of now the majority of the points we end up using are actually "wall points".  Simply because they seem to be the most versatile. We set the naming convention to match the family type of the original object.  That is a bit risky since we are relying on the naming from the designer but anymore those names tend to be pretty self-explanatory and we can figure out what they are.

### Place points

Next we will actually place the points.  There are a few different ways to do this.  The most basic way is to place your points manually.  You can basically snap points to work planes and edges. Setting the elevation of these ca get a bit tricky so pay attention to where your points are locating elevation wise.  You can also pick more points with a bit of automation.  If you select the wall tool you can select    walls and it will automatically place the points on the wall.  There are a few variables you can tweak like place points on the finish, track or center.  You can also specify whether you want the points on the top, bottom or both.  There is also a "part" point tool which is what we use most of the time.  This allows you to automatically create points on parts. It will basically give you a point on every corner which is usually exactly what we need.  This is one more benefit of using parts for this process.

### Upload/Export

In the years previous, after we pointed our model we then had to make sure the numbering was correct, export a .csv file with multiple lines of Northing's and Easting's, send them to our surveyor, he typically would create his own CAD file to work with then we could layout.  Now we simply upload to Glue and the points are in the cloud available for our engineer to layout or check.

## 360 Layout Process

We use 360 Layout for laying out points and round tripping them back.  Again, the reason we chose this platform is A) we already own it in our Enterprise Agreement and B) it is a simple visualize interface rather than lines of code.  It's actually a very simple process from this point and we'll walk through the steps here.

### Link the Robot

We have gone through multiple connection options with our system from Wifi, to Bluetooth to Long Range Bluetooth all of which have had connection issues but we finally have settled on Long Range Bluetooth as our solution for now.  To connect the iPad is pretty simple, just make sure connection you are connected to your robot through the wifi or Bluetooth settings on your iPad then go to the app and your instrument will be connected.

### Filtering Points

Again, there will most likely be a ton of points in your model depending on how you choose to break them up.  360 Layout gives you the option to filter and sort points which can be helpful when dealing with multiple points.  We typically use the visual and pinch/zoom to locate our points.  Tapping on an actual point will bring up the same options as selecting from the list.

### Laying Out Points

After the point is selected it is now tied to your robot and it will guide you in to locate the prism. Locate to your tolerance and mark it up. Like I said, It's a pretty simple process.

### Install

Let's form it and pour it!

### Point "Round Tripping"

This is the point where most people think of QC but remember, QC actually started way back in the initial phase.  This is just the culmination of the QC effort.  Is it installed correctly?  The process for as-builting or round tripping your points is very similar to layouying out the points except you are logging a point rather than laying it out.  You can use the stick and prism to collect your points or use reflector less collection which is pointing the laser to your install point directly from the unit.  Reflectorless is much faster but is not as accurate.  Use your judgment on what is best for certain scopes of work.

## Why Citi Tower?

Citi Tower is not only using model based layout and robotic total stations but also daily laser scanning, heat maps for floor levelness, Revit parts, drones and a few other technologies that are ion the development stage.  So why did we choose this project to develop, test and deploy a significant amount of our technologies?

### Utilizing the right team

For any organization you have to have the right team in place to truly get a diagnosis on whether the technology is providing value or not.

#### Citi Tower staff

Citi Tower has a project manager, Robert Gosnell, and Superintendent, Seamus Turnbull, who truly believe that technology can and will build them a better project.  This sets the tone from the top down on site and absolutely can't be overlooked.  Engineers are also a key element to deploying a new technology.  You have to choose a project that has a team that is forward thinking and able to deal with the mishaps that will come up throughout the initial deployment.

### Towers are made for this stuff

Towers are the best projects to test due to repetitive elements, larger scale, are typically keystone type projects.

#### Repetitive elements

Automation is where we typically find the biggest bang for our buck. Tower projects which usually have typical floors going up are a breeding ground for repetitive tasks.  If you can hone in on those tasks you can usually find a way to automate and save time.

#### Metrics

Metrics can be difficult to come by in our industry simply because projects vary in scope and size so much.  With a tower project you may have 15-20 levels of the exact same work.  This allows you to compare and evaluate the exact same data during the life of a project and is typically easier to compare to other tower type projects.

## Strategy

PCL's strategy is to utilize our engineering staff for as much of the BIM related work as we can. We still have VC specialists doing project setup and often have a VC specialist on a project site but our philosophy is to put the right tools in the right hands to get the project done. Our goal is to find technology and develop it to the point that it is digestible enough for our operations staff to use without the help of a technology or VC specialist.

### Benefits

The benefits that PCL sees

#### Reduced man hours

This is exactly what technology is supposed to do. Reduce the time it takes to do your task so you can focus on other things or (imagine this) go home and spend time with your family.

#### Improved quality

We've found that having our operations staff use the technology we are getting better quality. In short, if you have a VC specialist working on three or four different projects his mind is focused on 4 projects rather than one. The project engineers conversely are in the drawings everday, understand all the RFI's, know the schedule and are basically more in tune with the project which gives them the edge on project knowledge.

#### Empowering your staff

Convince your guys that just because they will learn how to operate an Autodesk product doesn't mean that they will be a CAD jockey for the rest of their career. We convey these tools no different than a tape measure or hammer. This is a tool for them to do their job more effectively. You will notice that they will start to take more ownership in their work product as well. Ask yourself, does your organization want more VC specialists or to put tech in the hand so the guys that are building the project? There isn't a right or wrong answer and both have benefits.

Our BIM hiring craze was about 8-10 years ago. That is when I was hired at PCL as well. So we did like everyone else and started throwing BIM guys onto every project because it was an owner requirement or because we needed lift drawings or 3D coordination. But what we started to realize is that we now have a 5-6 year gap of engineers who have never done a lift drawing or coordinated a job. Which to PCL is a key skillset in being able to build a quality project. This is why putting technology like 360 Layout in hands of our operations staff is a key strategy at PCL.

## A typical layout day

This is walkthrough of a typical day laying out columns on the deck.

**7:00am**
PCL begins pouring the deck

**11:00am**
Finish pouring the deck

**2:30pm**
Concrete is cured enough to walk on

**3:00pm**
Matt sets control points on the deck from nearby rooftop prisms

**3:30pm**
Matt starts to layout column corners

**4:00pm**
Column crew starts to layout chalk lines from column corners

**4:30pm**
Matt and column crew finished with layout

**5:00pm**
Take it to the house!

You can see here that Matt (our Project Engineer) and the formwork crew spend about 1.5 hours to layout the columns. This is for 10,000SF pour that has roughly 13 columns per pour. Our staff estimates that using control lines and tape measures the layout would be about 6 hours and less accurate.

## Winning!  (Successes)

Here are some of the success we have had on the Citi Tower Project.

### Setup

We have found that setup can be a time and money eater, especially when transferring from deck to deck.  We brought out Stan Lawrence with Datum tech solutions to help devise a plan to speed the process up.  The team came up with the idea to mount prisms on nearby buildings to use as control.  So each setup for the robot locates these three prisms, an in turn, locates itself.  This has been a hug time saver for the team and seems to be working flawlessly so far.

### Revit Parts

Especially for our concrete operations using parts has opened many doors for us.  One of which is the ability consume design model changes almost instantaneously through PartsLab which gives us a bigger window to operate between a design change and the actual concrete pour.  The other is the "parts" command inside of Autodesk Point Layout.  This is typically a one button push for us that creates every point we need for a desired component.  APL reads parts very well actually and since parts are already a vital piece of our concrete workflow it fits perfectly and is quite a lean process.

### True "Model Based Layout"

This is what we were after.  Think back to the first section of this handout where we described our strategy as "wanting to put tools in the hand of our engineers".  We have been exporting points from models for a few years now.  But that always required our survey team to take an export, usually a .csv file, then load it into a total station all while recreating a CAD file for him to use.  That requires a specific numbering scheme, up to the minute exports, a surveyor and someone to export the points from the model as needed.  Now we can load these into 360 Layout and were off.  No surveyor, no export, no .csv file.  The biggest key to getting our engineers doing the layout is the visual interface.  They can now navigate to a point, select it and lay it out within seconds.  That's what we were hoping for initially, and that's what we are getting.

PRISM LOCATIONS

## Losing  (Hurdles)

Here are some of the speedbumps we have had on the Citi Tower Project.

### App Crashes

Sorry Autodesk, but your app crashes sometimes.  It is usually not a catastrophic collapse and we can typically pick up where we left off but it is frustrating.  I'm sure this will get better with future releases but for now it is the reality.  In full disclosure we did have a month long issue where the robot wasn't locating itself properly.  This was determined to be a 360 Layout issue and was ultimately resolved in the next update.

### iPad temperatures

This project is in Florida and if you have never been on a deck of formwork in a downtown environment at 98 degrees and 100% humidity with no wind I highly suggest you stop by our project so you can see that working in snow might not actually be that bad.  That being said, iPads do not work well in extreme temperatures.  I'm sure you have all seen the temperature warning on your iPad and this was a daily occurrence during summer in Florida.  I have also been told that extreme cold tends to lock the iPad as well.  We have noticed that the new iPad pro handles temperatures significantly better so we have equipped our engineers doing layout with new devices.

### Lost connections

We have bounced from wifi connections, to Bluetooth, to long range Bluetooth all of which have connection problems from the iPad to our total stations.  We aren't exactly sure what is the best solution or what causes the issues but we have settled, for now, on the long range Bluetooth connection and our operations staff seem to be pretty happy with it.
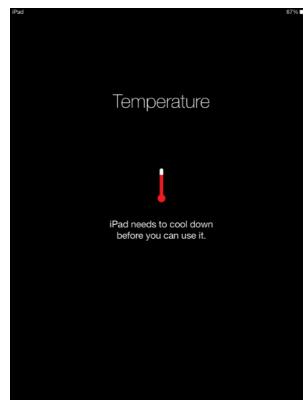


*IPAD TEMPERATURE WARNING*

It is important to note that setbacks and even failures are part of testing a new technology or process.  What is important is that you recognize why setbacks have happened and move forward with solutions.