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18 WAYS TO SCREW UP YOUR REALITY CAPTURE WORKFLOW — AND HOW YOU CAN AVOID THEM

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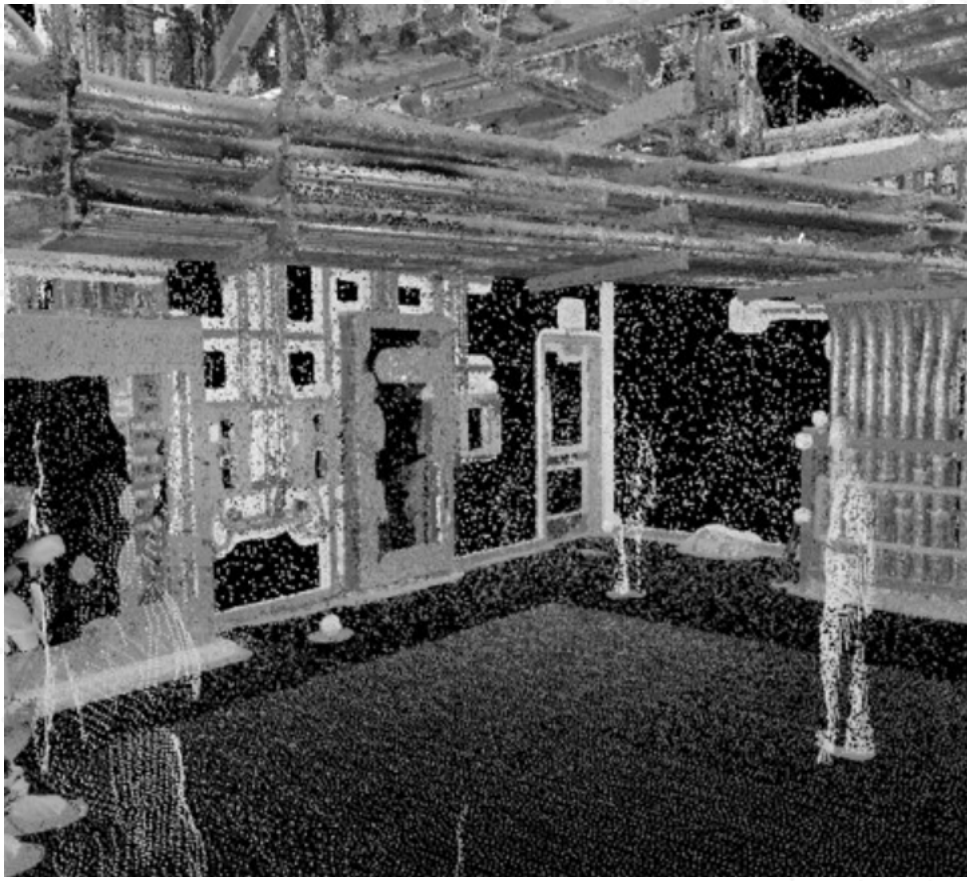


INTRODUCTION

The only thing better than learning from your own mistakes is learning from someone else's. ClearEdge3D recently assembled some of the reality capture industry's best and brightest to talk about their biggest screw-ups, gaffes, and blunders – and what they do now to avoid having history repeat itself.

We have divided the 18 reality capture mistakes into three categories based on where they typically occur in the workflow – fieldwork and scanning, registration, and modeling.

If there is a common theme running through this document – besides the fact that these mistakes all have solutions – it is that reality capture errors, even the small ones, have a funny habit of piling up and potentially turning into major problems by the end of a project. These often result in timely and expensive do-overs.

The bottom-line takeaway? Understand when and where these potential errors usually occur and figure out ahead of time how to avoid making them.

FIELDWORK AND SCANNING MISTAKES

MISTAKE #1 - FAILING TO CAPTURE SCAN DATA ABOVE 60 DEGREES

SITUATION

Greg Hale remembers the time he dispatched an experienced scan technician to an interior scanning project that was a three-hour drive from the HaleTIP office. The technician spent a full day onsite collecting scan data before returning. No problems had been encountered during the fieldwork.

The next day, however, when the modeling team uploaded the data and began processing it, they found there was no scan data for the upper 30 degrees of the interior structure. The scans didn't cover the upper ceiling space, which the client considered crucial for their applications.

A quick check of the scanner used in the project revealed its settings hadn't been changed from an earlier job. The only option was to drive back and rescan the site. Not only was this a budget buster, but the client had to undergo the additional inconvenience of adjusting activities to allow the scan technician back onsite.

SOLUTION

Two important lessons were learned from this situation. The first is to always check scanner settings before starting a new job. And the second is a no-brainer, according to Hale. Always check the quality and completeness of the entire data file before leaving the site and heading home.

FINAL WORD

"It's easier to stay overnight and do it again the next day than coming home and having to travel back to the job site, especially if there's a long distance involved."

- Greg Hale, HaleTIP

MISTAKE #2 - INCONSISTENT LEVELING DUE TO INCLINOMETER ERRORS

SITUATION

Scanning on survey control is a great idea, but it's not practical for all projects. Problems can arise with inconsistent leveling of the scanner when the internal inclinometer is relied upon, especially when the floor is uneven or not perfectly flat. The built-in device might not be accurate, or the scanner might get

bumped after it's set up. Either way, the scans can end up out of alignment, according to Ted Mort.

SOLUTION

To avoid this, his team at Zelus always takes a laser plane with them as secondary quality control. They shoot the lasers across the floor and set up black & white targets onsite, ensuring all are at the same elevation. This data can be used to double check the inclinometer measurements on site. And if leveling mistakes aren't caught until processing after the field work is done, they can use the laser plane and target data to correct errors and balance out the project.

FINAL WORD

"You don't have to buy a professional-grade laser plane. Pick up a consumer level for a few hundred bucks and it will save you a second trip to the site."

- Ted Mort, Zelus

MISTAKE #3 - LACKING CONTROL

SITUATION

"Control, you've got to have control," said Larry Kleinkemper. At least 10 years ago, he learned the hard way that multiple little errors can add up to one big error.

SOLUTION

Now his team at Lanmar Services takes three instruments with them to every large 3D scanning job site so they can eliminate the errors and improve overall accuracy. The three devices are a Disto, a Laser Scanner, and Total Station.

Typically, the total station yields the most accurate results, and the laser is second best. The least accurate is the Disto electronic tape measure. On each job, a technician measures between targets with each device. If two agree on a measurement number, and the third doesn't jibe, the tech knows which piece of equipment is not calibrated and proceeds accordingly to eliminate or account for the error.

FINAL WORD

"There's nothing like being 99% to 99.5% accurate and still being two to four feet off. On larger facilities, a triple check is a necessary step to maintain quality."

- Larry Kleinkemper, Lanmar Services

MISTAKE #4 - NOT KNOWING CONDITIONS ON THE JOB SITE

SITUATION

He laughs about it now, but Zoltan Ferenczy reminisced about a job that literally took place inside a 40-degree refrigerated warehouse. Not only did the technician get cold, but the scanner kept shutting down due to the temperature. After taking it outside a few times to warm up, the crew decided to come back the next day with a home-made jacket for the scanner to keep it functioning.

That wasn't the only environmental issue Zoltan has run into onsite. Over the course of his career, he has been without adequate electricity, encountered complete darkness inside a boarded-up structure, and even met up with squatters living in an abandoned building.

SOLUTION

Now he asks these questions before the start of every project:

- Will flashlights be needed?
- Is there electricity available to charge scanner batteries?
- Is the building secure?
- What's the climate like inside and outside?

FINAL WORD

"To avoid surprises, always ask the right questions before going to the job site."

- Zoltan Ferenczy, ClearEdge3D

MISTAKE #5 - TRUSTING CLIENT-SUPPLIED CONTROL POINTS

SITUATION

Kelly Cone had a client insist he use their control points for a huge project on a college campus. The only problem was – some of the points were off by 20 feet.

Cone had his team set up on the client's control points, as requested, and captured 400 scans. Back at the office, the registration just wasn't going right, and they wasted lots of time trying to pinpoint the error source, adding days to the processing portion of the job. Finally, they gave up on the control and used cloud-to-cloud registration, along with a handful of backup targets that had (thankfully) been set up. Ultimately, everything worked out, but the project took much longer than expected.

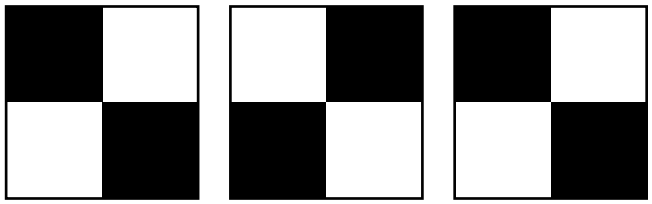
SOLUTION

Cone recommends using a combination of registration methods – survey control, cloud-to-cloud, and targets. If there is a failure with one of the techniques, the team always has fallback data to achieve high-quality results.

FINAL WORD

"Never trust client-supplied controls. It's OK to use them, just don't rely on them entirely."

- Kelly Cone, ClearEdge3D



MISTAKE #6 - MIS-REGISTERING CRITICAL SCANS

SITUATION

There are situations where it's impossible to use survey points, traverses or other types of control for scan registration, according to Greg Hale. Long narrow corridors are a good example of difficult-to-control areas. You will likely end up using scan-to-scan registration or targets, which is fine, but you have to capture more data than you think is needed in those areas. He suggests collecting three or four extra scans, depending on the size of the space.

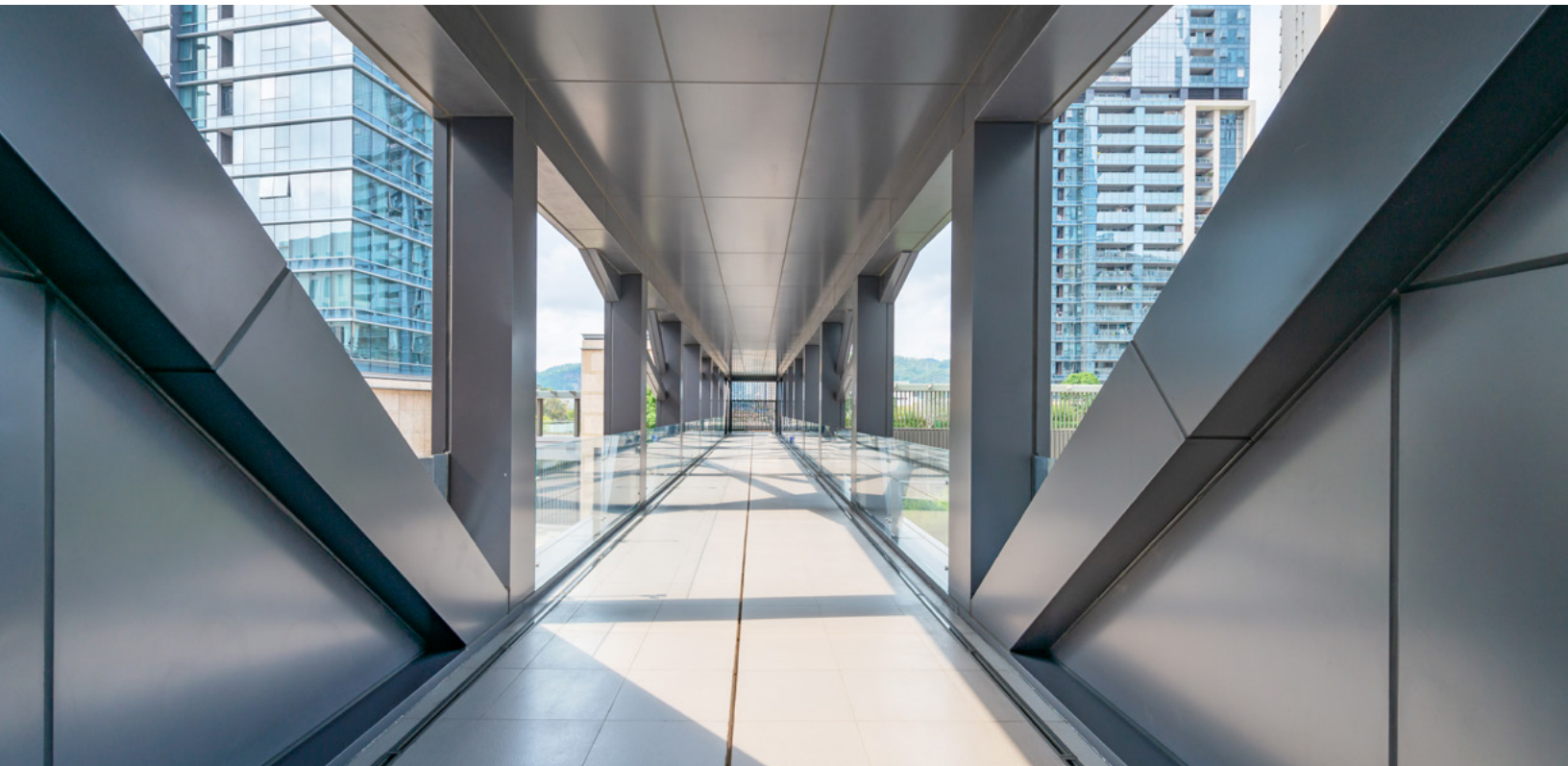
SOLUTION

For the scans in these critical areas, Hale recommends setting up multiple targets and spreading them out as wide as possible, so they appear in the edges of the scans. Don't bunch the targets together near the centers of the scans because they might rotate slightly, throwing off surrounding scans. Once the targets are spread out, take scans that cover a wide space.

FINAL WORD

"In real estate, it's location, location, location, but in scanning, it's rotation, rotation, rotation. Rotation errors compound over distance...so spread your targets out."

- Kelly Cone, ClearEdge3D



REGISTRATION WORKFLOW MISTAKES

MISTAKE #7 - HUGE MIS-REGISTRATION IN EXTREME REGULARITY AREAS

SITUATION

"People love cloud-to-cloud registration," observed Larry Kleinkemper, "but there are spaces where targets are an absolute must."

These are extreme regularity areas where the same structural geometry repeats itself. Examples of this are tight shafts and tunnels, and narrow stairways and vertical towers or long hallways, where cloud-to-cloud simply isn't practical. Those 20 scans you took will all get laid on top of each other and your tunnel or building will end up a lot smaller than it is in real life.

SOLUTION

Kleinkemper recommends using spheres and paper targets whenever you're working in extreme regularity spaces. His second tip is for the field technician to create a scanning map showing where each scan was acquired in the building. This is a lifesaver, especially for the registration technician at the office who wasn't onsite during the scanning. With a scanning map, the registration tech can determine which scan goes where, even if all 20 look identical.

FINAL WORD

"Draw a map to show where each scan exists keeps your registration easy, fast and accurate in extreme regularity areas."

- Larry Kleinkemper, Lanmar Services

MISTAKE #8 - LACKING COORDINATION & CONSISTENCY WHEN REGISTERING SCANS

SITUATION

"Communicating field conditions to the person doing the registering back at the office can create numerous problems in consistency if that technician wasn't involved in collecting the scans," explained Zoltan Ferenczy. "The ultimate goal is for a scanning contractor to generate the same results regardless of who performs the registration work. Unfortunately, this is not always the case."

SOLUTION

He recommends having a two-person field team for larger projects. One person sets up the scanner, and the other places the targets. If these technicians have worked with each other for a while, they will get a feel for how to work together so the scanner and targets are always in coordination with each other. When it comes time for registration, the scanner operator should do this work because he or she knows exactly where it was placed and why.

In some organizations, however, the scanner technician doesn't get involved with registration at the office. For those situations, the company should create a standardized template to record scan notes. These must contain detailed descriptions of where the scanner was located, how it was positioned and what order the scans were captured. The field technicians should fill out this template in a similar manner for each job and supply it to the registration person in the office.

FINAL WORD

"At the end of the project, regardless of who does the registration, the outcome should always be the same."

- Zoltan Ferenczy, ClearEdge3D

MISTAKE #9 - INCONSISTENCIES IN LONG RUNS OF SCANS

SITUATION

"Hallways can be the nightmare of interior laser scanning. You're going to accumulate errors in hallways and corridors," said Ted Mort. "It's going to happen. The traditional way to scan a long hallway, unless there is survey control on both ends, is to 'daisy chain' down the corridor with the scanner, tying one scan to the next."

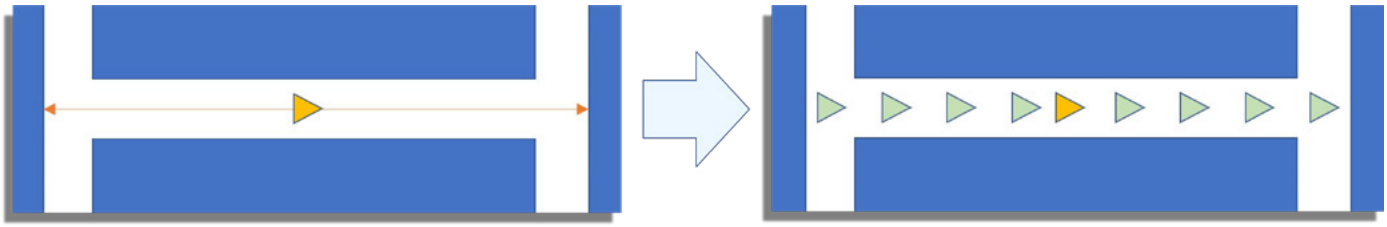
SOLUTION

Mort's team now uses a different approach during registration as a backup QA method. If possible, in a straight corridor, the scanning techs set up in the middle and take a high-resolution scan that captures both ends of the hallway. A few additional scans are then collected in the space. During registration, the processing techs use the first long-distance scan as a control and 'hand stitch' the others to it, making sure there are no deviations or curvatures to the hallway.

FINAL WORD

"I always tell new techs during training that boring, uninteresting spaces are usually the ones that require more scans for successful registration."

- Kelly Cone, ClearEdge3D



MISTAKE #10 - NOT ACCOUNTING FOR ALIGNMENT ISSUES (ESPECIALLY ON LARGER PROJECTS)

SITUATION

Greg Hale remembered a large manufacturing plant project where survey control existed, but there was a slight alignment issue that could have induced significant error in the registration during modeling. The key is to account for the alignment problem early in the project.

SOLUTION

"There are two ways to handle this," Hale explained. "You can either make sure scans are aligned perfectly in the registration software or export a temporary file in AutoCAD, Civil3D or Revit at the start of modeling." Gregg suggests slight rotations to get everything into alignment at the start because that results in greater accuracy than trying to rotate the entire model later. Figuring out if a slight rotation will work early in the project beats re-doing the model after you think it's complete.

FINAL WORD

"Do your QA/QC upfront. Even that small 0.01 degree error over a distance of 1000 feet in a building would be two inches, which is outside the tolerance of what most clients expect."

- Greg Hale, HaleTiP

MISTAKE #11 - STATE PLANE COORDINATES AND REVIT ESTIMATES

SITUATION

"Take note of how far your project is from the point of origin in a state plane coordinate project," warns, Larry Kleinkemper. "Conventional wisdom in the scanning business is that errors become induced at 20 miles from the origin. But the truth is that Revit only estimates an accurate geographic position of a point cloud captured 10 miles or less from the origin." That means your point cloud might bounce around, moving its location by as much as six inches during modeling.

SOLUTION

The fix is easy, according to Kleinkemper. The key to keeping a true coordinate system is to truncate the coordinates. Best done by a surveyor, the front end of the coordinates should be truncated as far as possible until you get to unique numbers and the coordinates become small. Additionally, modelers in America should know that Revit doesn't understand U.S. survey feet. It uses international feet, which differs slightly from U.S. measurements.

FINAL WORD

"Revit's ability to model large numbers on screen starts to fall apart. So if you're modeling based on what you see on the screen, you can get into trouble really fast."

- Kelly Cone, ClearEdge3D

MISTAKE #12 - ELEVATION BUSTS DURING CLOUD-TO-CLOUD REGISTRATION DUE TO TOP-VIEW REGISTRATION

SITUATION

Ted Mort predicts that cloud-to-cloud registration algorithms will continue to improve, but there are still issues that must be monitored in the workflow. One of these is an overemphasis in the workflow on the plan view, or top-down perspective, which can lead to inconsistencies in the elevations. Most cloud-to-cloud workflows don't offer the option to view the point cloud from a profile view where elevation issues are easier to spot.

SOLUTION

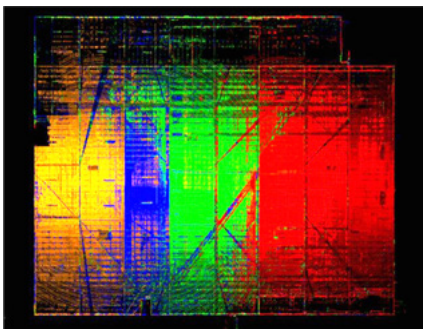
The remedy is to manually switch over to the profile view and look at a cross section of the point cloud during registration. This will enable you to make sure all the floor elevations stack up properly on each other.

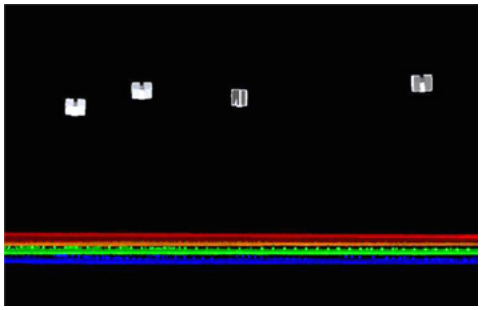
FINAL WORD

"Perform a cross section in each one of your axes to verify horizontal and vertical placement.

- Ted Mort, Zelus

Plan View





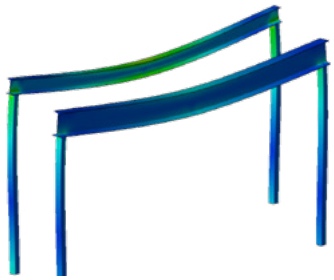
Profile View

MODELING WORKFLOW MISTAKES

MISTAKE #13 - NOT FULLY UNDERSTANDING CUSTOMER EXPECTATIONS

SITUATION

Greg Hale recalls a scanning project where his team submitted initial modeling results to the client but ended up having to model the pipe runs all over again after getting feedback. The problem was the horizontal pipes in a large interior space had been modeled perfectly straight. In reality, they weren't that way at all. As often happens with older piping, many of the longer runs sagged as much as four inches, which may not seem like a lot, but the client needed the model for clash detection in planning installation of new utility features.



The mistake that had been made was Hale's team hadn't asked the client upfront exactly how the model would be used. Clash detection, especially in tight spaces, requires a more highly accurate depiction of current feature conditions. Automated modeling software like EdgeWise captures reality, but it also allows users to straighten out features if they want. In this project, the modeling techs should have left the features in their actual shape and position.

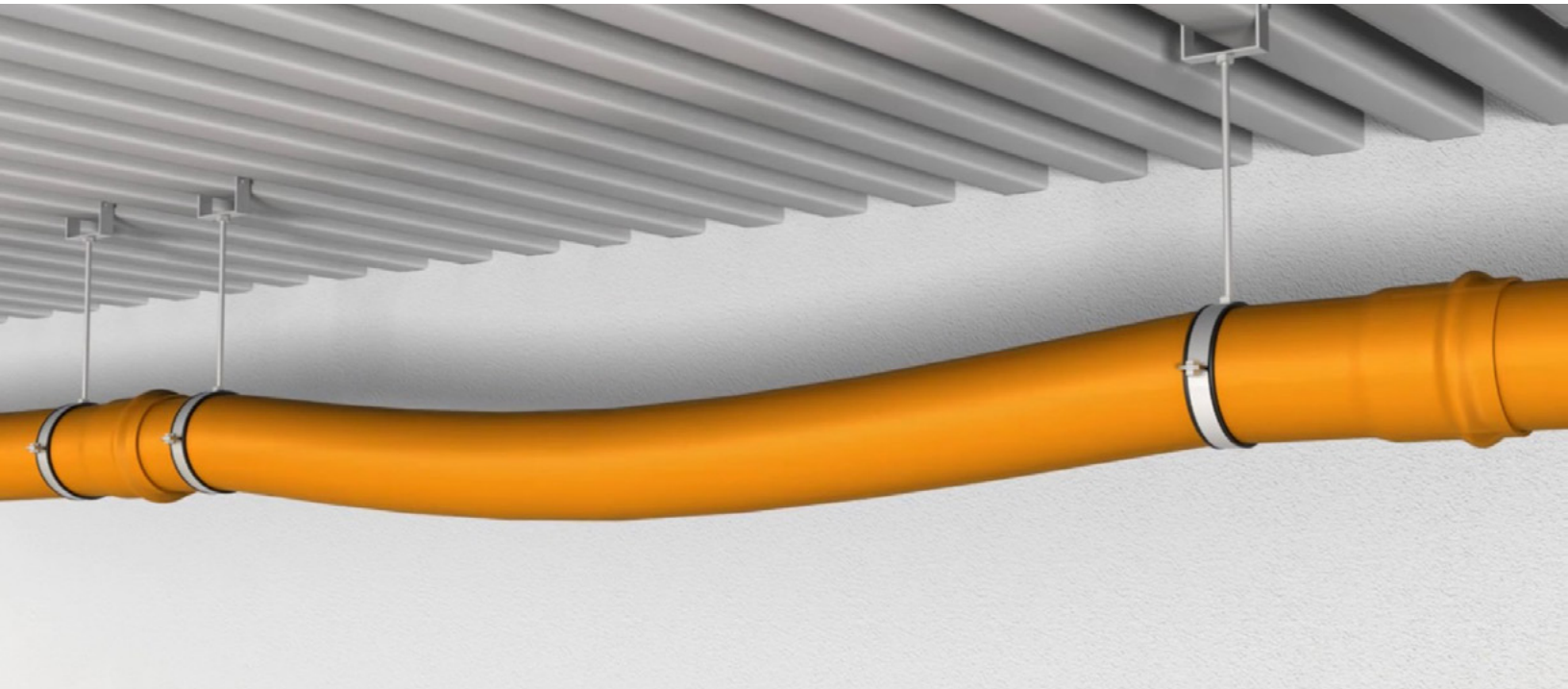
SOLUTION

Hale recommends having a thorough discussion with the potential client about how the deliverables will be used before the proposal is written. End use, as well as an understanding of the client's workflow, will impact what is delivered. And keep in mind, there may be several applications for the model. A critical question to ask is: What amount of tolerance is acceptable for features like steel beams and pipes?

FINAL WORD

"We like to see things nice and straight and orthogonal on our plans and design drawings. But in the real world, they really aren't that way."

- Greg Hale, HaleTiP



MISTAKE #14 - PIPES BOWING/BENDING THROUGHOUT RUN CAUSING MULTIPLE SEGMENTS

SITUATION

Elaborating on Mistake #13, Larry Kleinkemper reiterated you have to establish tolerances with clients up front, especially if that means modeling sagging pipes in their true condition. This becomes crucial when working in Revit because it naturally tries to straighten out modeled lines, which may be counterproductive in some projects.

SOLUTION

Kleinkemper recommends determining whether the model will be used for collision/clash detection, MEP connections, or architectural design. Your approach to scanning and modeling will be distinctly different for each one because of the following:

- Collision detection doesn't care about connectivity but needs sags modeled
- Architectural design doesn't care about connectivity or sags
- MEP doesn't care about sags but needs connectivity modeled

FINAL WORD

"If you know which of those three to focus on the most, you can save time, deliver to the client on schedule and on budget."

- Larry Kleinkemper, Lanmar Services

MISTAKE #15 - ERROR ACCUMULATION IN LARGE BUILDING SPACES

SITUATION

While this is not explicitly a modeling problem, error accumulation occurs during scanning – especially in large spaces. But the issues caused by it typically don't show up until modeling. "These errors can cause either an expansion or contraction with your modeling information," observed Ted Mort.

SOLUTION

For large building spaces, Mort recommends breaking the scans into three groups that will be registered separately. The first scans should be a loop around the exterior of the structure, even if the façade is not included in the scope of work. This creates a 'container' for the interior scan data you will collect. Next, find one or more long corridors that traverse long sections of the interior, the entire length of the building if possible. Finally, capture scans normally on the remaining interior space. This gives you three checks on each of these scan groups.

FINAL WORD

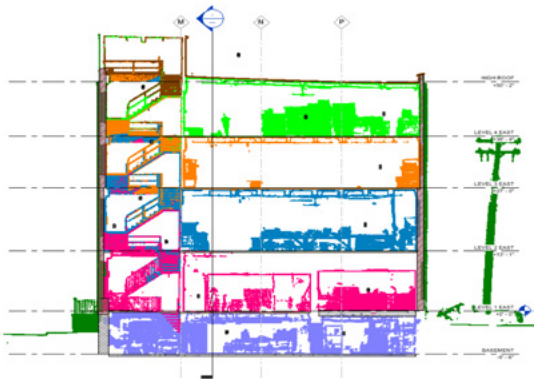
"Errors won't be obvious anywhere in the process until you get to the modeling phase. That's where they could have dramatic impacts when you're trying to fit everything together. They can grind you to a stop."

- Ted Mort, Zelus

MISTAKE #16 - HAVING TO REASSIGN MULTIPLE PROJECT ELEMENTS TO THE APPROPRIATE LEVEL

SITUATION

"Remember that in most buildings, especially older ones, the floors are not flat and the walls are not plomb. That makes it difficult to establish a good datum to build everything else upon," said. Greg Hale. "You don't want the datum to vary up and down too much. This means you have to be extremely careful setting up levels and grids."



SOLUTION

Hale recommends establishing the levels at stairwells, the way a surveyor would. Take spot elevations at the stairs and then establish the rest of the floor from there. Next, set the grids as average locations across all columns at a specific height. As you take these steps to establish the datum, try to understand what the original design intent of the structure was. Also be aware that different building materials – steel, drywall and masonry – have varying tolerances for straightness, levelness, and plombness.

FINAL WORD

"If you get too far into the project without the datum being correct and you have to switch something, it's going to screw up a whole lot of stuff."

- Greg Hale, HaleTiP

MISTAKE #17 - POINT CLOUD VISIBILITY ISSUES

SITUATION

Sometimes the challenge of modeling is just being able to accurately see what you're trying to model from – the point cloud. Larry Kleinkemper said he noticed early on that the background color of the computer screen can influence what you see in the point cloud, especially if you scanned in color instead of black and white intensity. B&W intensity shows up well on most screens, but white features will be lost in a white background and black elements will fade into a very dark background.

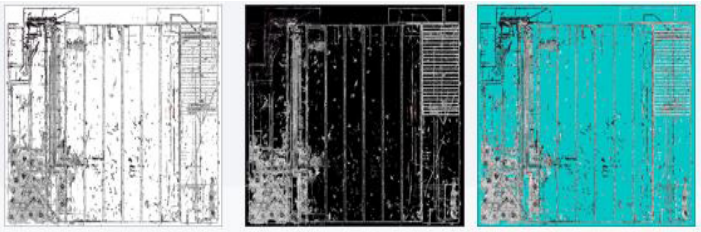
SOLUTION

The Lanmar modeling team now selects an unnatural color for their screen backgrounds, often a blue color that provides contrast and is easy on the eyes. That's where they do most of their modeling.

FINAL WORD

"Make it a point to change the screen background color before the project is completed and take a second look at your work to ensure you visualized everything in the point cloud."

- Larry Kleinkemper, Lanmar Services



MISTAKE #18 - POINT CLOUD DENSITY ISSUES SLOWING PROCESSING

SITUATION

Ted Mort noted that it's common procedure to collect lots of scans in very complicated sections of the space being modeled, like areas with numerous pipes, conduits, and equipment. But what invariably occurs is those extra scans also capture multiple data sets on background planar features such as doors, walls and floors. These extra points bog down the computer and software during modeling.

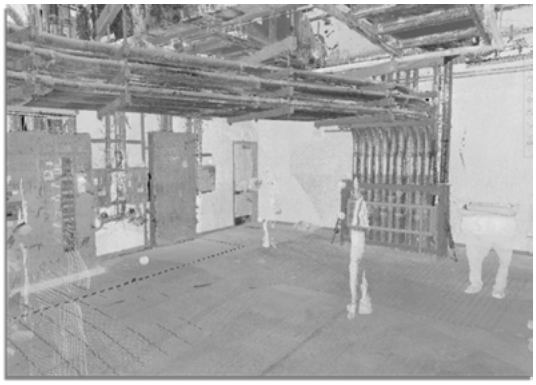
SOLUTION

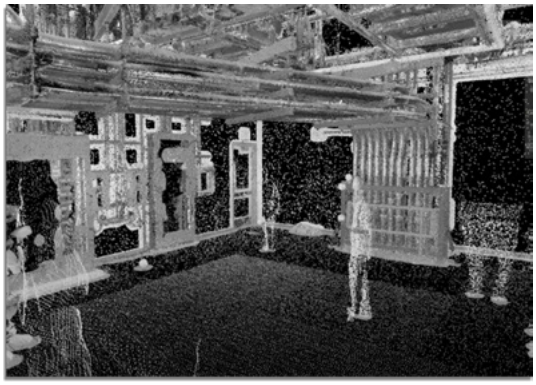
Mort's group wrote its own algorithm, which they call Z-Simplify, to filter out those redundant points during processing. But the algorithm is sophisticated enough to identify and retain the points that represent the complex geometric features or even the edges of the planar features, which are important. This makes a tremendous improvement in the modeling workflow.

FINAL WORD

"One way to handle this in EdgeWise is to isolate and segment out the points associated with specific feature groups so you work with just the points related to a given system. This makes things a lot easier on your computer by just showing the point you care about."

- Kelly Cone, ClearEdge3D





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