RUSTY STEEL: Morning, everybody. So we probably should wait another couple minutes for everybody. But I figure we can knock out the intro because we have a lot of information that we're trying to cram in. And what we really want to do is leave some space at the end so you guys can ask questions because I just have a feeling, with all of the LiDAR information and stuff, you guys are going to want to.

But to get through all the data, we're going to try and hustle. So if I could, I'm going to go ahead and jump in. And people can just get in past the intro. So my name is Rusty Steel. I'm from CEC Corporation. We're out of Oklahoma City, Oklahoma.

BARTLEY ESTES: Is your real name Rusty Steel?

RUSTY STEEL: That's my real name. Corroded metal is what they call me. Rusty Steel.

BARTLEY ESTES: Rusty Steel.

RUSTY STEEL: And honestly, we're excited about getting feedback from you guys. The whole reason we're doing this is we want to see where everyone else is at with this technology. So we want to talk with you. It would be awesome if, at the end, we exchange information and follow up on stuff. But on the presentation, if you don't mind, if we could shelf the questions just so we can hustle through it. So with that being said-- and this is my man, Bart, the LiDAR guru here.

So my background-- I'm a designer, ACI instructor for Civil 3D. So we're a full fledged design firm-- LiDAR collection firm. But we added an ATC a few years ago, partially to start doing stuff like this. One thing where we've been trying to focus on is don't just like-- so LiDAR is an example. We don't want to just deliver LiDAR to our client, set it down, and walk away, and assume they're going to know what they're doing with it.

We're trying to train people-- and good client relationships and stuff. So the reason I'm here is to talk to you about how we're using LiDAR that we're collecting with our LiDAR team in design, whether it be Civil 3D or other things in the Autodesk suite that you guys are probably familiar with. So the title, the BIM in Civil Design. I'm going to try and explain this over the next few slides.

This is a bunch of jumbo here. But to me, what it's about is-- like I said, we hope to teach you something new in LiDAR, if you're new to it. Or if you're advanced in it, maybe we can spark up more conversations going forward. But we want to talk about LiDAR. And basically, we want to talk about how it comes into the software-- different platform.

So the reason we threw BIM in there is-- it's just a word we're all using. And I know everybody's used to it in the facilities in the vertical stuff. But we're starting to say things like SIM or TIM in our transportation industry.

But to me, it's all about models. It's all about bringing multiple models in from different groups in real time, as much as you can. And that's the whole goal with BIM to me, a central model, intelligent, being updated from different ways.

I threw this together real quick. So that's a traditional workflow, how I see it. But I did the second one because I think this more fits what we're going to talk about today.

We're going to start with some existing stuff-- the point cloud. And we're going to talk about how linework's being generated because we all will come to agree that, right now, we got to continue to do 2D plans. We got to have that linework. We can't just work with a point cloud. But we're going to throw out some ideas on things we're trying, specifically on a job where we need to be efficient because of budgets and things like that. So some new ideas we're trying.

We're going to jump into things like InfraWorks. I'm not going to go nuts in InfraWorks. That's not what this class is for. But we're going to show you how LiDAR's coming into it, how we're using it, and then carry in to things like Civil 3D, building that AMG proposed model because, once again, we're trying to mesh models together, make sure they blend right. And the whole goal is virtually construct the project in the office to eliminate errors.

So over here, our facility friends. Right there. Blending multiple models. They're seeing clash detection. They're seeing other things. Same thing over here in our world.

We're not going to spend a lot of time talking about utilities clashing. But I think, ultimately that's where all this is headed. We're going to spend more time-- or I am specifically talking about blending existing surface models, be it from LiDAR, with LiDAR, proposed models, and meshing them all together and trying to build a good grade ready model, whether it's for earthwork or stringless paving or things like that.

So if you guys haven't seen this slide, it's a good one. What it means basically is the ability to affect the project as the project goes along is more challenging and more costly. That's what 1 and 2 are representing. And 3 is where we're at as an industry right now.

Basically, like I said earlier, we're doing our 2D planes. We're throwing them into the field. And the contractor is making it work the best he can. And a lot of RFIs. A lot of change orders.

So I think everybody's on board with we want to try and use this 3D software, and construct it, and find those busts in the office, and slide that bell curve over, and try and save everybody money. So that's a quick little intro. But once again, a reminder, what we're doing here is blending all the different models together.

So we got to start with LiDAR. That's a great tool for us. So Bart is going to give you guys some background on that.

BARTLEY ESTES: Thank you, Rusty. Like Rusty was saying, my main role and the whole reason I'm here is to talk about LiDAR specifically. I'm not a designer. I'm not an engineer. I work in the survey division.

And my area of expertise is LiDAR. So what I'm going to do is give you fundamental concepts, the basics. And we'll get into the weeds a little bit just on how LiDAR work. And then I'll feed it back to Rusty where he can talk about where that feeds into the workflow of BIM.

So before we get started, can I see a raise of hands of who is currently using LiDAR data, using point clouds, knows how it's in your workflow. So we have a few. That's good. Is there anybody who knows what point clouds are but are looking on how maybe they could fit it into their workflow-- not super comfortable. A few more.

Who has a very basic understanding and just knows that point clouds are called point clouds? We got one guy. Awesome. So we're going to start with just the very basic fundamentals. This is going to be a snoozer for a lot of people. But I'm going to go through it step by step and explain how LiDAR works. And we'll step through it so that we're all on the same level here.

RUSTY STEEL: Please, don't do that.

BARTLEY ESTES: I'm totally kidding, you guys. We're literally going to start with what is LiDAR. LiDAR is an acronym. It stands for Light Detection And Ranging. It's a survey technology, remote sensing technology.

That's just a fancy way to say it's survey technology. LiDAR works a lot like a total station on steroids. It's just putting out tons of shots every second.

It's using infrared lasers, infrared light, pulses of light to collect the points that it's collecting. You probably all know that the data set is known as a point cloud, commonly. Terms that get thrown around-- LiDAR, 3D laser scanning, point cloud data. It's all the same thing, just so we're all on the same page.

LiDAR sensors are typically putting out around sometimes a little bit more than a million pulses every second. So the point cloud is literally made up of survey points. So you're getting around a million survey points every second.

And each point, obviously, has a xyz coordinate, but also intensity. So the sensors are putting out pulses of light. It's actually illuminating the object that it's sensing, which is why, in the point cloud data, we can see things like striping. White concrete looks different than asphalt. And things like that.

Some fast facts that are kind of universal across all LiDAR applications and all why are platforms is data density. You're going to hear us talk a lot about density today. And there are varying levels of data density between LiDAR platforms. But please, keep in mind, no matter what platform you're using, when it comes to LiDAR, the data is very dense. You are getting a lot of points.

Accuracies range between sensors. There are GIS grade systems, all the way up to survey and engineering grade systems. That's what our expertise and our level of work is with. We're an engineering firm. So I have primarily only dealt with those survey grade type systems.

The data acquisition window-- a lot of people try to compare LiDAR with traditional photogrammetry or remote sensing. And there's a lot of things that limit photogrammetry, like time of day. You, obviously, need to fly during the day time.

You want to wait for leaf-off conditions. You want to wait towards the end of the year. With LiDAR, because we're not using images, we're actually using laser pulses that can penetrate things, like vegetation. You don't really have to worry about leaf-off conditions. You're going to get through the trees. You're going to get through the grass.

And like I said earlier, we're using pulses of light to collect that data. The lasers are illuminating the objects they're collecting. You can collect LiDAR data in complete darkness. We collect data at night all the time, specifically with our mobile system, which I'll talk about a little bit more later on. But we actually prefer to collect at 3:00 in the morning just because there's not as many cars on the road.

And many different platforms-- I kind of already have touched on a few. And we'll talk more about the more common ones here, in just a little bit. But LiDAR is just a overall technology. It's a sensing technology. It can be mounted on just about anything, an airplane, helicopter, a vehicle, a UAV-- which we'll talk a little bit about. But you can mount a LiDAR sensor on just about anything.

I'm not going to go through all of these. If you have questions on how all of the different components within a LiDAR system actually produces the data-- you and I talked a little bit about it before we got started here. But these are basically just the ingredients that go into the recipe for how LiDAR data is collected. If you have questions about it later on, please come down and I'll be happy to nerd out with you.

So the platforms. These are the more common platforms, aerial, mobile and terrestrial. They all kind of touch on a few-- make points about each of those.

So aerial LiDAR, in my opinion, is the most versatile, mainly because of project accessibility. If you can fly over it, you can collect LiDAR data. You don't have to worry about can the vehicle find a route there. Literally, if you can fly over it, you can collect data.

You can cover more ground, obviously. Aerial LiDAR is the way to go if you're trying to get a DM for an entire county. Aerial is probably the only way you can go about achieving that.

I put lower point densities, but I want to preface that with, remember, I'm talking in relation to other LiDAR platforms. The point density is still very, very high.

But just in relation to other platforms, aerial is your lowest. You're flying higher, you're flying faster, the amount of pulses are a little bit lower, right now. And so you're just not getting as many points on the ground. But here's an example of an aerial LiDAR dataset. That's still a ton of data. You can do a lot with that.

One of the negatives, I think, that comes along with areal LiDAR is higher operational costs. That kind of ties in stringent mission planning, as well. It's not as easy as jumping in the car and going and collecting data. You have to go through the rigmarole that it takes to get an airplane or a helicopter in the sky. So there is a little bit more planning that goes into a data collection for aerial.

RUSTY STEEL: Bart, can I jump in? We can go back.

BARTLEY ESTES: Sure.

RUSTY STEEL: And also, this is obvious, but if you wanted to collect under that bridge, he's obviously not doing it with aerial LiDAR. That's another thing to keep in mind.

BARTLEY ESTES: Correct.

RUSTY STEEL: But with this tool, he can.

AUDIENCE: Does accuracy change?

RUSTY STEEL: Does accuracy change?

BARTLEY ESTES: Yes. Very little. I will talk about it a little bit more as we get down the road. Whoever you are having collect your mobile LiDAR data or just LiDAR data in general, make sure you're getting an accuracy report. Make sure they're setting survey control because, at the end of the day, if you're utilizing survey control, it's all going to be survey grade. But there are companies out there that will fly survey grade data, and it's not.

RUSTY STEEL: So since he's talking about control, I want to take the opportunity to say, traditional survey-- boots on the ground-- in our opinion, is not going away. This is just an added tool to add to the bucket. A long time ago, we added total stations. Then the rovers came.

And now, this came-- you still have to have boots on the ground. Section work. Utilities being shot. We're not trying to imply that this is better than that, and that's going away, this is taking it over. They team up. We have traditional surveyors and always will. We need to do the control specifically--

BARTLEY ESTES: At the end of the day, LiDAR is just a survey tool, just like anything else. So the next thing I'm going to jump into is mobile LiDAR. This is my bread and butter.

This is what most of my experience is with. This is my baby over here, back home. I'm missing her dearly.

But mobile LiDAR is used for high density corridor surveying, typically roads, and bridges, highways, things like that. The mobile system, because we're driving slower than an airplane is flying, the system is actually putting out more pulses per second. Our data densities in mobile LiDAR are very high. And we'll see a example of that, I think, in this video that may or may not be hard to see.

I talked about setting control. Most mobile LiDAR systems-- there's a few of them out there that are GIS grade. But most mobile LiDAR systems are engineering or survey grade and achieving those accuracies.

The LiDAR system collects at posted speeds. So it's not like you're shutting down a lane of traffic and you're having to putt down the highway at 10 miles an hour. We've collected parking lot data at 5 miles an hour. We've done a cracking study on a airport runway at 80 miles an hour.

RUSTY STEEL: In between planes. Like, literally one touched down. He chased it at 80 miles an hour. They didn't shut anything down. He drove right behind at 80 mile an hour. And we did a cracking study from it.

BARTLEY ESTES: I'll tell that story very quickly just because it was the most exciting day of my life. It felt like I was in an action movie.

It was a municipal airport. They did not-- they wanted the survey done, but they said, we got tons of planes coming in. We cannot shut the runway down today to go out and shoot it. Said, OK.

We're sitting out on the edge of the runway in the taxiway with the radio with the air traffic control. And I said, you just let me know when I can go. He said, OK.

So we're sitting there. Airplane comes in. And I get on the radio. OK, you can proceed. So I pull out. And as soon as I'm pulling out, they come back on. They say, but you better hurry. I said, OK.

And so I hammer on the gas pedal. When we're flying down the highway. And I look at my rear-view mirror-- and this is straight out of an action movie. I look at my rear-view mirror and there's a plane coming in behind us as we're scanning the runway. But literally, from that data set, we did a cracking study when I was on and off of the runway in 2 and 1/2 minutes, which-- pretty incredible in my opinion.

So mobile LiDAR systems typically collect in 360 degrees. It's not just collecting what's around the vehicle. The sensors are set up in a way where it's collecting above the vehicle and below it. So you are collecting underneath bridges and power lines when you drive underneath them.

You're collecting the roadway underneath you and everything around you . The only thing I don't really like about this graphic is it makes it look like we're collecting data in this little globe around the vehicle. Lasers, or light, extends indefinitely.

How far out you can get a return varies. But it's typically 150 to 200 meters from the vehicle. So you're actually collecting data much further out than this. That's the only qualm I have with that graphic.

RUSTY STEEL: We have our own internal rules of how far away that shot can be to where we trust it. Anyway, sorry.

BARTLEY ESTES: Right. So terrestrial and static LiDAR--

RUSTY STEEL: Hey, Bart. Sorry. Will you go back? So talk about Google Earth-like imagery.

BARTLEY ESTES: Oh, yeah. I didn't finish.

RUSTY STEEL: You probably saw those RGB-- those colorized point clouds that are pretty neat. If you don't know how those happen, you wanna touch on that?

BARTLEY ESTES: Sure, yeah. I completely forgot to touch on these. The Google Earth-like imagery-- on most mobile LiDAR systems, it comes with georeferenced cameras that are calibrated with your LiDAR sensors. They're usually collecting an image a second, half of second, depending on what system you're using. But that's giving you that Google Earth-like drive-through imagery that we're all-- I mean, we all use Google Earth. Let's be honest.

But the difference is, it's calibrated to the LiDAR sensors themselves. So you can take those images and actually give each point in the point cloud a color value-- an RGB value from those cameras, which we don't do all the time. But sometimes it's nice to see.

And then the negative that I forgot to talk about. Mobile LiDAR is, obviously, project access. You can't drive it-- if the vehicle can't get there, then it's probably not the best tool to scan.

Some people have experimented with putting those systems on mules-- not real mules-- ATV mules, and four wheelers, and railroad cars, and everything else. But basically, if you can mount it on anything, you can put it on just about anything.

RUSTY STEEL: And one more thing on that note is if you like the RGB point cloud-- that's your goal, make sure you have your collector collect in daylight. Obviously, those pictures are pitch black.

You're not going to be able-- because it basically smears those photos over your point cloud. And that's how it comes to life. And so if the pictures are black--

[INTERPOSING VOICES]

BARTLEY ESTES: We've run into that too on projects. We had it set out in the scope of work-- collecting LiDAR data, we are not delivering the images because the client said they weren't interested. So to avoid traffic, we scanned at 3 o'clock in the morning.

After the fact, they said, hey, can you give us those images. I'm like-- well, I can. They're all pitch black. I can give you thousands of black photos.

So terrestrial and static LiDAR. That is what probably most of you are most familiar with. In the classes that I've attended here at AU, that's what most people are talking about-- the stationary on the tripod LiDAR scanner. They're the most common. So that's probably why.

Basically, it's acquisition from a fixed point. It's on a tripod. It's not moving. But it's also putting out a lot of data. It's in the same position. It's taking lots of measurements from that area. So you're getting very, very, very high point densities.

And it's also versatile, just like aerial LiDAR because we can do things like measure the equipment at the top of the cell phone tower from the ground and take those measurements that they need to take without having to climb the actual tower itself, but also, move it inside and do interior scanning inside of buildings.

And so I don't know if I have any MEP guys in here. But being able to scan inside a very tight, confined utility closet, and seeing all of your piping networks, and being able to pull that in to Revit-- and we'll talk about that later on too. But just having a interior survey that looks like that could be very beneficial.

So exterior and interior scanning is a big pro for terrestrial scanning. And it's the most common because it is the most affordable, obviously. Aerial LiDAR system in an airplane costs a lot more than a terrestrial LiDAR system and a tripod.

So it's easier to get a hold of the data. The data is cheaper to purchase. There's a lot more work that goes in. You have an 8 mile roadway project-- you don't want to leapfrog a terrestrial scanner all the way down the road and set up 40 times.

RUSTY STEEL: I've seen that. And that's unfortunate because then-- one of the great pros with mobile LiDAR is safety. You just drive right through.

Even if there's no shoulders, you're good to go. But I've seen plenty of datasets where you can see the circle where the static LiDAR was set up, if you guys have worked with point clouds at all. And they set up every 1,000 feet on a interstate

BARTLEY ESTES: For six miles down the road. And so with that, I'm not here to say one is better than the other. I'm really not. I'll just say, if you're starting to get into LiDAR data and you're looking to push it into your workflow, think about what kind of project you're doing and what makes the most sense.

Is it a wide area. Are you doing acres? Then you're probably going to want to use aerial LiDAR. If it's a roadway project that's six miles long, think about using mobile LiDAR. If it's a building-- a facade, use terrestrial LiDAR. So just keep in mind what's the goal of this project-- what is the point of the project, and then make a intelligent decision on which platform you want to employ.

RUSTY STEEL: Can I jump in, Bart?

BARTLEY ESTES: Sure.

RUSTY STEEL: So that's really what we're here to talk about today. We don't claim to be experts. A lot of you guys probably know a lot of this stuff as well as we do.

But I think we're kind of unique in the fact-- at least in our area-- where we're collecting it and we're using it. We're a design firm also. So really, we're just here to show you what we're going through, what we're seeing, how we're using it, little tricks that we have. So I want to just point that out.

BARTLEY ESTES: So I'm going to start talking about the applications on the civil side of things that we're employing LiDAR data on today. And like, Rusty said, we're not claiming to say we have it all figured out. We're just trying new stuff and are here to share it with you.

So I just threw up this image because I thought it was kind of cool. That was a huge, giant drainage structure that ran underneath the highway. And I thought, I think our vehicle can fit through that. And so we drove through it and picked up our local gang tags over here while we were at it.

RUSTY STEEL: He also picked up swallows' nests.

BARTLEY ESTES: Oh, yeah.

RUSTY STEEL: You guys [INAUDIBLE] on the planes. We have to show all that. And that's at night, pitch dark. And we can see-- we can count how many there are. We can quantify it.

BARTLEY ESTES: So our bread and butter is what we're using LiDAR for is topographic survey. We're an engineering firm. We got to have to survey.

So you can utilize a point cloud to go in and pull out those survey features. You're used to seeing brake lines, contours, triangles, your planimetric values-- where my signs, power poles, all my assets, and things like that.

And down the road, we're going to talk about how-- sorry, I clicked the wrong button. Well, that's fine-- talk about what level of-- how much of this stuff is really necessary to pull out because, when you really think about it-- I'm going to-- I know I have to hustle through this. But I'm going to step up on my soapbox. And this is what I get really excited about.

But we are always underneath the gun from engineers. How many engineers I got? Designers? I'm going take a step back because you guys are going to get mad at me.

But one thing we're constantly under, at least back home, is LiDAR's really cool, but I want to look like a conventional survey. I want it to look like the survey I've always gotten. I want it to look the same. I don't want to change the way I work.

And so literally, we are going in now and we're using this point cloud-- forget all the triangles and the lines. We have all of these points-- all are survey grade.

That's virtually your survey. And they're asking us to go in and trace this line. Trace this line. I want you to put a 2D block where my power poles are. And I bite my tongue. And I do it because the client is always right.

But it keeps me up at night because I'm like, you have all of this data, and you're asking me to go drop a 2D power pole where there's a power pole. And I can tell you where it is, how far it's leaning, how tall it is, what's on the power pole. You can see all of those different things. And it just--

RUSTY STEEL: Or better yet.

BARTLEY ESTES: Stepping off of my soapbox. Sorry.

RUSTY STEEL: Better yet, he said he can tell you where those things are. What we're going to talk about is you can tell yourself-- you can have the data. You decide.

You don't need to send the surveyor out a second, third time to pick up some bridge abutment seat that they kept missing it. Get the whole bridge. The whole bridge is here. You figure out everything you want to figure out on your own. You're the engineer. You decide what you want.

BARTLEY ESTES: So now, I'm off my soapbox. I got to hustle because I can't take all of Rusty's time. I put accurate contouring on here because one of the other battles that we fought was we started getting these tiny triangles. And so our engineers were saying, my contours are ugly. They look like spaghetti. They're not rounded pretty like I'm used to getting.

And I had to step back, breathe for a second. OK, that's true. They are uglier-- quote, unquote, "uglier." But they're more correct. That's what the ground is actually doing.

RUSTY STEEL: If you want us to dumb it down, we can dumb it down for you. We can round those contours and make them pretty.

BARTLEY ESTES: Yeah, I can give you pretty round contours, but I'm making your surface dumber by doing that. So I just wanted to-- I feel like I'm in a support group. I'm just going to rant to you guys.

So with a very accurate surface, you can obviously do things like quantities, volumes, and drainage very quickly. We're pushing out more triangles. More triangles isn't always the best way to go about things. But you can produce more triangles.

That kind of answers the question of do you really need breaklines. And by breaklines-- I know you need the road. But do you need top of bank and toe of bank.

RUSTY STEEL: We'll talk about that.

BARTLEY ESTES: We'll talk about it, if I can represent it. I'm really not going to dive into multiples pulse returns. If anybody is really familiar with LiDAR data, you know what that is. Just in a quick synopsis, if I took this laser pointer and I shined it across town on the water tower, that point would be the size of a beach ball because, as that laser continues, it's getting wider.

The same thing happens in LiDAR. The wider the laser gets, it can split. So if my pulse comes out of my sensor, it hits a blade of grass, I'm going to get a return. I'm going to get a point at the top of that blade of grass.

But that pulse of light continued beyond it. And it can split up to four times. So that's why we say LiDAR can get bare earth because it's collecting vegetation. But those pulses are continuing to the bare earth. And so you will get a point at the bare earth.

RUSTY STEEL: Where photogrammetry isn't-- which I know you already said that. But just to retouch that. Photogrammetry's stopping on the picture.

BARTLEY ESTES: So these all go together with a highly dense, highly precise surface. You can do cut fill analysis very precisely-- stockpile quantities.

And we've talked about what's off the roadway. But even in the roadway, with a nice surface along the roadway, you can do a lot of analysis. So this is a small section of a stretch of highway that we did for a DOT back in Oklahoma.

Brand new highway. Had just been constructed. They had lots of calls coming in from drivers that were saying, hey, I don't know what's going on out here, but our cars are bucking like crazy. There is a dip or something and we don't know what's going on.

And the DOT knew roughly where around that was, but they couldn't identify the spot, much less try to survey it. So we went out and we drove that stretch of highway. And we colorized the point cloud by very small contours. And I hit the wrong button again. We're able to see very, very small undulations in the pavement where we had a joint problem. We had a joint that was settling. And when you hit that at 75 miles an hour in a car, it was like you were at the rodeo, which is in town, while we're here in Vegas.

But it felt like you were in a rodeo. And this is a brand new constructed highway. And we were able to go in, without putting a surveyor on the road, without really even being at the job site other than driving through it with our LiDAR sensor on. Went back-- did a little bit of analysis. within a few hours. And we were able to pinpoint not only where their issue was, but how much undulation there was-- in that separation.

RUSTY STEEL: And let's be honest, even if you could shut down I-40 in the middle of downtown Oklahoma City, is somebody going to take a shot every 1 millimeter with a tradition-- you know how they're going to-- this is the way to do it. I mean, it's great. Little ponding issues. I think you can find all kinds of stuff. It's awesome.

BARTLEY ESTES: So clearance analysis is one of the things we're really getting into with the DOT back home. They're really jumping on board with using LiDAR for clearances. This is primarily for mobile and static LiDAR. Obviously, you're not flying an airplane underneath the bridge.

But what LiDAR gives you the ability to do is, not only take measurements where you want to on the bridge, but do analysis. Not only on every single beam, but on every point on every beam. Not just in the center of the beam-- the face of the beam, the back of the beam, all the way across the beam.

And so intelligently, we can go in and generate things like, on that bridge, give me the absolute minimum clearance. Not just at the center line, not just at the striping. Tell me where the absolute minimum clearance is on this bridge.

And using that same type of workflow, we're doing wide load routing. I can find the lowest point on the bridge. Tell me where the highest point is on the bridge. If I have oversized loads coming through here, we need to be able to tell them what lane they need to be in to fit underneath that bridge.

And the same workflow goes for anything that goes over the road. 3D power lines. If there's any surveyors in here, you know how big of a pain it is to run out in the middle of the road, and run up a poll, and try to get a shot on a power line that's crossing the road that's blowing in the wind. So we can use that same workflow-- the same technology to pull out those clearances, as well.

Here's just an example of a top-down view of a mobile scan that we did underneath of a bridge. And you can just see each beam here and just how much data underneath that bridge we are collecting simply by driving underneath it. There's a ton of analysis that you can do with that.

RUSTY STEEL: And if you guys are structural people, there's tools out there that you probably already know about that, if you wanted to create a model quickly from that point, there's tools out there that can trace those I-beams because it recognizes a standard and it draws it.

BARTLEY ESTES: You'll pull on your beam standard library and pull it in. And it will recognize-- it's smart and recognizes what size of beam that is and will actually extract it across the point cloud, which is way smarter than I have ever-- than I could ever figure out. But it is very intelligent.

So in this video, before I go on to my bullet points, this is an example of the drive-through imagery. And then it'll show the resulting point cloud. But I want to talk about condition analysis. You are collecting where your assets are, just like a normal surveyor would. But you're collecting what condition it's in.

Here's an ADA ramp. You can do things like slope analysis. You can do your ADA compliance on it.

In the roadway, is your pavement cracked? Is your striping worn or faded? We've all seen curbs out there that are chewed up. And the surveyor's going to shoot it just like it's a curb-- like nothing's wrong.

But if you got a chewed up curb, it'd be nice to know where that is. And I just threw this fly-over in here-- it's kind of hard to see in this room. But we drove down and we drove back. And we picked up every asset within that corridor.

I don't know how many GIS users are in here-- but think about being able to extract every asset along a corridor and being able to push that intelligently into your GIS system. And GIS is getting better at handling LiDAR where it's managing LiDAR data. So if there's any data providers in here, you may start thinking about using GIS to actually manage and host your LiDAR data because it's getting better.

Here is a topic that I'm really excited about and I'm really passionate about-- kind of the next step for where LiDAR is going. It's no secret. There have been a ton of classes here about UAVs, UAS-- Unmanned Aerial Vehicles, Unmanned Aerial Systems.

Notice I'm not saying drone. Drone has such a negative connotation, too, with the public. Public freaks out when you say the word "drone." So we pretty it up and we say "UAS."

We are currently working with the FAA. We have submitted our petition for the exemption from section 333. And all that is the saying, hey, you can't fly drones to make money. If you're making money with it, don't do it.

But you can get exempt from that. It's quite the process. We've gone through it. We're actually supposed to hear back this month. So everybody cross your fingers for us.

But one thing that I wanted to push or-- share with you is some of the classes that I've gone to since I've been here has been talking about using point clouds from UAVs, which is possible-- but generating them using UAVs that are equipped with cameras, not LiDAR sensors. It is absolutely possible to create a point cloud from images. That is completely possible.

Is it the level of detail, is it going to meet the accuracy, are you going to get points on the bare earth like you would if you used an actual lighter sensor? Absolutely not.

RUSTY STEEL: It's the same thing we were saying before. You just have to be smart about when you use that technology. Same concepts as we were showing before.

BARTLEY ESTES: I'm not trying to paint it like it's bad. Just don't let someone come into your office who is trying to sell it to you and say, yeah, we're doing 3D laser scanning. And you see their system. And it's got a GoPro camera on it.

Just be smart about-- they say they can provide point cloud. Ask, are you using LiDAR to generate your point cloud or images-- because the accuracies of the two are very different. Sometimes LiDAR is overkill. If you're just trying to get the facade on the side of a building for a quick render you want to do, LiDAR is overkill. Don't use it.

RUSTY STEEL: Or stockpile volumes at your asphalt plant.

BARTLEY ESTES: Basically, don't go try to map a few acres of heavily vegetated area using a $1,000 drone with a GoPro camera on it. It will not turn out well. UAVs. This is no surprise. Public pushback, which is fine. I completely understand it.

The 16-year-old in his back yard who got his little drone for Christmas and is flying it next to the airport is making it a lot harder on people like us who-- we want to do it professionally and ethically. And we want to follow the rules. And we're all for more regulations. We want to do it the right way. We want to use UAVs for good.

But it's becoming a lot harder because-- I hope there's no FAA people in here. But the FAA has not done a really good job of roping in the drones that the teenagers are out flying now. And the accidents that come from them are only hindering people like us who want to use it for commercial purposes.

When we talk about UAS versus a manned aircraft, there are pros and cons to each. If you're trying to do a DM for an entire county, the battery life on this thing is not going to last that long. You can fly, maybe, an hour-- an hour and a half in some cases.

So if you're wanting to do a DM for a whole county, just put an airplane in the sky. If you're wanting to do an area-- something that could be flown in an hour and a half, it's a lot cheaper to put a UAS in the air than it is to put an airplane into the sky.

Again, going back to what we talked about earlier, just think about your project and what platform makes the most sense. And just make sure you're getting the right data set that you need. Ask a lot of questions. As a LiDAR data provider, I appreciate it when the client asks me questions.

They say, hey, can I get an accuracy report? Yes, I would love to give you an accuracy report. A lot of times I don't-- I haven't run into a whole lot of them. If you ask for an accuracy report and the provider dances around the question, you may look into that a little bit deeper.

But I just took a screenshot up here. This is a LiDAR dataset that was collected using a UAV. It looks just like any other point cloud from any other system. It's met all of the criteria-- accuracy criteria that all of the other platforms have gone under.

So UAS is a disruptive technology. I truly believe that. I think it's going to change the way we do things. And I do not think it's a fad. I think it's here to stay.

It has taken so long to get our exemption from the FAA only because they're so hammered. Everyone is submitting their exemption. Everyone wants to do this for business. And it's just taking them time to get all the way through that.

So now, we're going to jump into-- that's kind of my expertise of just what LiDAR is, how it works, the platforms-- just so you have a better understanding of what availability-- what types of LiDAR data is out there and how it can fit into your project. I'm going to hand it back to Rusty because he's the design expert. And he's going to talk about how LiDAR is fitting into his BIM workflow and the ways he's been able to leverage this high density data to do what he does.

RUSTY STEEL: I wish Bart would just be honest with this. And he just likes playing with cool toys. And then I just get to work with what he gives me after he plays with his cool toys. It's pretty neat stuff.

These are surface models made from-- the gray on both of these are surface models made from LiDAR. This job is aerial LiDAR. You can probably see these are bridge abutments. And I actually have these screenshots later, and I'll touch on them a little bit more.

So I'm going to try and-- we have a bunch of engineers, designers in here, it looked like. And so LiDAR's great. But how do I use it? Sometimes it's overwhelming.

And so I'm just going to throw out a few ideas of things that we are having to learn from and experiment with. And we want to share them with you guys. And then, if you guys have feedback--

BARTLEY ESTES: Rusty, I just want to say, your contours are really ugly, man.

RUSTY STEEL: But those are awesome.

BARTLEY ESTES: But they're right. They're right contours.

RUSTY STEEL: I mean, look at the detail on that ditch. I mean, maybe you don't need the detail on that ditch. And that's what we'll talk about. The point density-- I can do all kinds of stuff.

So I'm going to use the term "design different" several times because-- I almost changed the title of the class too late because that's-- to me, what it's all about-- bringing these models in. Looking at it three dimensionally. Trying to get away from the two dimensional world.

It's crazy, we've had Civil 3D forever now. It's called Civil 3D and yet, here I am in plan view, cranking out 2D sheets. So anyway-- so I'm talking design differently so much in the fact that here is my desktop-- three screens. My boss is like, really, do you need three screens? I'm like yes, we need three screens.

So if we got Civil 3D lovers in here, you got to have your Toolspace and Properties up all the time, right? That's crucial. So those are over there. Civil 3D is running in the middle.

And then those of you that, right now-- maybe you have Google Earth up on that third screen. So you're seeing that other perspective. But if you start getting LiDAR jobs, pull it up.

Come up afterwards. We have some Autodesk products plus some free third party programs that are great viewer platforms for these. Or open Bart's georeferenced pictures. I'm going to hustle because I want to touch on his pictures, how I use them.

So design different. So surface modeling. Let's think differently about that.

So Bart touched on do we need breaklines. Well, in the past, did we need breaklines? Yes, we needed breaklines. I'll tell you why. You probably already know.

But I tease Bart-- him, and his team. They do all this work. They trace the point cloud. And he's crying as he's tracing it. But that's what his client wants him to do.

Well, he gives me all these breaklines. And here, he gives me one that looks like this. He's got center lines, and toes and tops and all that. And guess what I do?

I, at minimum, freeze them. I don't even want to show on my plans. I want to show existing road, existing drive, and existing flow.

That's all I want to show. But I tell him, I delete them. I don't even leave them in the drawing because, why bog down my drawing? If I ever need them, I can go back because my surface model's already made.

They used the breaklines in the past. And so that's what I'm going to show you here. So if we were to try and triangulate just to those lines that I'm showing in my planes, it wouldn't work.

Specifically, it's hard to see because of lighting. But here's edge of road. And here's edge of road. Notice the triangles going through the road.

Well, on that job, there's a crown. And so in the past, traditional survey-- we would pick that up, purely. And so right now, I'm showing-- I haven't applied those breaklines yet, but I just wanted to represent them.

But this is what we get. We apply those breaklines. And it literally breaks the triangles. So we don't end up with these giant, long triangles. You guys all know that.

So that's how we had to do breaklines in the past. And my question to you is, if your triangles are already so dense and so accurate, why do you need those extra breaklines just to help you create your DTM?

And so as you start to work with point clouds more-- and it's funny, we're a LiDAR collection company and this almost hurts us because what I'm telling you is think about your budget, and your workflow, and how you can be more efficient. And maybe you can do it yourself. Maybe don't need to rely so much on the surveyor or the LiDAR collection. Same thing with linework. So go ahead.

BARTLEY ESTES: And I'll just jump. I think Rusty will even touch on it in just a minute. But we go scan, we go collect data in a day. Let me process it.

Get it transformed to survey control. That's about another day. In two days, you could have your survey-- topographic survey, not property, sectional, and all that stuff.

But you could have a topo that you could work with in two days. But at current, most of the time, I'm being asked, hey, can you go trace in the edge of the road, trace your top of bank and your toe bank, and draw those in for me, when that data exists in the point cloud.

So you are not-- you're not only going to pay me more money, because you got to pay my time to go in and draw in breaklines, but you're also spending money because you're waiting for a survey that you could already have.

RUSTY STEEL: Yes, I'll touch on that in a second. So thanks. So linework. Like he's saying, going in and tracing a linework. Or traditionally, the surveyor gave us a linework, 2D CAD. Why can't you just take the point cloud-- here, all I've done is I'm viewing the point cloud.

Of course, I can have the live maps on in Civil 3D, which helps even more. But here, I'm showing you all I have is a point cloud. And I surface model the point cloud.

I can see my flow lines I can draw it in myself. I can be the judge on how many vertexes I need along my existing road-- along my flow line.

It's my plans. Let me decide how often I need to have that. You give me what's out there and let me decide how I want to beautify or make my plans look like I feel like they need to.

So the drive, and the road, and the flow lines-- I'll just draw them myself. But I can do the same thing with fences. I can see fences. I can see buildings. I can see trees. I can see who's dropping 2D blocks. I can do all that.

And I want to say, right now, oh, yeah, that sounds great and everything. Are we doing it on every job? No. Are we doing it a lot? No. But do we want to be headed that way? Yes.

And so I'm just trying to share where we're at. Is it perfect for every job? Not necessarily. We were talking earlier. This is the way it's headed. I think we can all accept that-- especially as the software and hardware is able to handle things more.

But one thing I'm going to throw in right here is LiDAR in Civil 3D is just another set of data, just like images was for us forever when we were in xreferencing in CAD files. Let's be smart about how we manage the data.

Do we clip it down? You can clip the point cloud down. Don't necessarily have 8 miles in. Just have the intersection that your focused on at that time, just like you did with aerials and things like that.

Another thing maybe you did with aerials is you only used resolution that made sense for you. If you're looking at a whole county, you don't have 6 inch resolution in there. So I'm going to talk about that-- about when I say, sparse. What's the word I'm looking for? Just--

BARTLEY ESTES: Delivering it?

RUSTY STEEL: --watering down the point cloud when it makes sense to water down the point cloud. But to finish up on my linework spiel. So here's a great example.

This is a project we did. It's a few years old. But this white box, right here, represents the PnP, the plan view. And I just wanted to point out how beautiful this survey is. And we didn't use it at all.

How much money was put into all that detail right there? And what you may say is-- well, and what happened on this job is scope changed. We were going to do both of these bridges. And we ended up-- the funding changed. And we ended up just doing that right there.

And so what I'm trying to say to you is, just like Bart said, think about when you want to use different things. Let's think about pushing off the linework as far as we can because I'm going to show you here in a slide in a second to where-- actually this one-- to where-- what I'm thinking-- what we're doing specifically on those quick jobs that Bart's talking about where the PE comes to us. And they're like, hey, we want to go after this job. We need two-day turnaround. I want 30% super rough but preliminary plans like that.

So what I'm showing you here is we have a quick kickoff meeting with Bart and myself and the PM. Bart goes out. He does this quick data collection. Like he said, maybe a day of processing.

In the meantime, I'm in something like InfraWorks maybe. If it's InfraWorks, if it's civil 3D, whatever. I'm doing a quick conceptual.

If you don't know, I'll show you here in a second. He can feed that point cloud into InfraWorks, which is great. And we actually saw some stuff that Ramesh is doing. And it's awesome. What InfraWorks is going to do with point clouds is going to change our workflow even more than what we're showing you right here.

But we're doing side by side work. So here's an example. Interstate 35 through Oklahoma City. We waited for six months to get the survey.

We set there. The designer set there. We knew we had the job. We waited for six months to start design.

Now, if we go this method, I feel like he can go drive it. And a few days later, I can start doing cross sections, and profiles, and getting a rough idea. And then as he continues to work, he can feed me that data, if we're using data references and xreference well. And that's what I'm showing here.

So not only could he continued to work on it, but he could give me that point cloud. So here, I'm, working in Civil 3D with the point cloud. And that's all I have, like I showed you earlier.

And I've created a surface model with it. And imagine-- so you've got your designer here. They're working with the point cloud, doing the design-- cross sections, profiles.

And then you've got a CADJet sitting over here next to them. And they're, maybe a quarter mile ahead of them on this 8 mile job. And they're drawing linework in for that person.

And so as you're in here doing the design, you're seeing the linework populate in your design, right there, in front of you because as, we said earlier, it's inevitable. You're going to need that linework. But all I'm trying to say is let's think about different ways of going about this and not just sit on our hands for three months.

BARTLEY ESTES: Don't wait six months for an entire survey. When your topo can be done, but their deliverable-- the survey deliverable-- they're going to have property and section work, and utilities, and all of that in there. Without using the method that Rusty just showed you, you're just sitting on your hands waiting for the entire survey. Whereas here, after a few days, you can be working in conjunction with each other.

RUSTY STEEL: So this is the IDSP or U-- whatever you have. And literally, I wanted to step through the workflow. So I have the live data over there. You'll see it here in a second. I recorded videos last night at midnight because I didn't want to sit hear and-- so I'm talking about the design smart and think differently about things.

What we were going to have to do is have five Autodesk products up and running all at the same time, all of them with LiDAR data, all at the same time. And that thing was buzzing. Literally, it sounded like a plane in my hotel room. But if you guys want to, if we have time, we'll come over and you can say, jump in the data. I want to see you in it.

But I made videos just for speed. So ReCAP- you guys probably, at least, have played with it a little bit. It's the LiDAR data massager for as you move forward into your next Autodesk program. You can bring-- so an LAS is the most common--

BARTLEY ESTES: I'd say it's the most common.

RUSTY STEEL: It's the most common LiDAR file. Probably, if you have someone do a LiDAR for you, they're probably giving you an LAS. You can pull LASs into, I think, every Autodesk product that I'm going to show you.

But I highly recommend, as probably an Autodesk personally would, that you take it through this because, when you make an RCS or an RCP out of that LAS, you're going to be able to do more with it in the Autodesk platform. It's just their file. So they can do more.

So what do I use ReCAP for? If I'm being honest with you, mainly I pull the LAS in. Mainly, I look at coordinate systems. Do I need to go from UTM to a different state plane? I look at units. And that's sometimes as quick as I'm in there.

I'm in there. I look at those things. I save it. And I'm good to go. And I'm ready to--

BARTLEY ESTES: Can I jump in? So because I have proprietary software that came with our LiDAR system, that's kind of what I use most of the time. But ReCAP does have the ability to do this register multiple point clouds. If you do static or terrestrial laser scanning-- you scan from a fixed position, you may have five scans. ReCAP can actually stitch those together into a whole scene-- into one point cloud, if you will.

We don't use it for that because we have the tools that are for our specific LiDAR system. But ReCAP can do it. It's not just-- you want to create your RCP and you RCS-- that's basically just an Autodesk friendly file type.

So yeah, you want to do that. But it's not just for that. You can do things which Rusty will touch on in a minute. It does a little bit more.

RUSTY STEEL: Yeah, you can do your control with it. But like Bart's saying, he generally does that for me because it's part of his workflow. It comes with his software.

So the other thing I want to show you really quick that I'm doing in ReCAP is I'm dissecting point clouds. So he's going to give me this giant point cloud. And I'm ripping it apart. Specifically, one thing I wanted to show you is here is a job where our client likes seeing cross sections. That's their world.

And they wanted to see things like clearances in a traditional cross-section form. Well, if you guys know Civil 3D, like I know you do, you can't just have one point cloud and generate one surface model from that one point cloud. And surfaces can't overlap themselves. That's probably the easiest way to say it.

So if I wanted to do something like this, I have to rip it apart a little bit. So either rip it apart in ReCAP. Or when you get in to Civil 3D and you create your surface models-- make sure you're orbiting and be smart about.

But to me, it's really easy in ReCAP to spin, as I'll show you. Here, on this video-- if it works good. So look at this. At 11:00 PM last night, that was my first video I made.

[INTERPOSING VOICES]

Here, I'm just ripping it apart. It was a big job. And for time's sake, I just wanted to clip it down. If you guys haven't been in ReCAP, this is a really good beginner thing to show you. So just clipping it down, spinning around.

So what I'm going to do here is make two RCPs, RCSs. One of them's going to be just the bridge. And one of them is going to be just the ground underneath it so that I can do what I showed you on that cross section. Pretty straightforward.

AUDIENCE: What does RCP and RCS stand for?

RUSTY STEEL: So ReCAP Scan. ReCAP Project. RCP is-- basically, you can have multiple RCSs in an RCP.

Does that make Sense? Like ReCAP project is-- got all your RCSs--

BARTLEY ESTES: And our RCP is a group of scans. So if you have multiple scans that are multiple RCSs, you can export them as an RCP-- which all of your scans that are tied together now become one file. So an RCP is like a master point cloud file.

RUSTY STEEL: And I feel pretty confident saying that-- so here's all the products I'm using today, ReCAP, InfraWorks, Civil 3D, Max, Navisworks, Revit. I feel like all of them are going to take your RCP or RCS. They give you both options.

So anyway, ripping it apart. And then pulling it in to Civil 3D, which I'll show you here, in a second and doing stuff like that with that. So next, really quick, InfraWorks is awesome.

This isn't an InfraWorks class. You guys, if you're not InfraWorks, you got to get in it. It's amazing.

What's really cool about it is all the stuff they're adding. So this literally is like a year ago. This has point clouds in it-- a while back. It's even better now-- what point clouds can do in InfraWorks.

And like I said, Ramesh is adding even more stuff. So what I wanted to show you here is-- so this is the small town of Oklahoma City. I didn't use Model Builder. Like I said, this is prior to Model Builder.

I made these myself. But I wanted to show you the blend of city furniture-- traditional InfraWorks model blended with LiDAR. This is a cool shot. You're showing this client, right here, on their roof-- so you got your Revit expert, your BIM person over in this lot. Maybe you designed this building. And you come in here and drop it in to InfraWorks and show him-- that owner right there.

I'm going really fast. But I want to talk about more. So here, I modeled this in-- I used Bart's point cloud. This building had a funny face here. And I used it to model this building. You can even see the air conditioning ducts on top of it-- how well it all stitched together.

This is not time consuming. I promise. This was a quick thing to show. So here is a video just showing-- really, I'm the just moving around the same dataset I just showed you.

So I will continue to say, let's try and be wise about it is a lot of data. So be smart about-- like in this case, I have a long stretch through there. Maybe I clip it down. Maybe, I don't need to show that whole run of the point-- to minimize. So here, I was just trying to show you traditional InfraWorks modeling I did there. And then blending it with the point cloud over here.

It's pretty neat. I don't know how well this video will show it, but we drew the-- we're coming in here with conceptual design. Let me see with my laser. You can see it's two lanes with parking there. Well, here, we can come in and we can say, what if we were to make that four lanes. How would that fit and everything. So pretty neat that you can do that. This video-- I just want to-- I feel like I need to show you guys if you don't know how to pull the point cloud into these products.

So it's all I'm showing you here is-- one thing that's neat is InfraWorks is drag and drop. At the time, this wasn't drag and drop. So I want to show you everything resides in this data source's bucket. That's what I'm clicking on over here.

So whether it's buildings I've made there or aerial imagery or whatever it is, that's where everything lives. And so I'm showing you here how to insert the point cloud into it. And don't forget, what I'm showing you here is to go right click on it and go to Configure. And make sure you configure it to your coordinate system. You have to do that every time.

So really quick in InfraWorks. So even quicker-- I apologize, but for time's sake-- in 3ds Max. But again, this is what we're doing with point clouds. So if you're a 3ds Max guru, you're more than me. But I have used it. I made animations, make renderings, all that stuff.

You can bring point clouds into it. But can you pull them into in InfraWorks and do a fly-through in it? And is it maybe faster? Yeah.

So I don't know. It's up for you to decide when you want to use it. But I just wanted to show you that. It does do a good job of pulling it in. But I'll tell you, I've made renders from point clouds. And they sit there and bake, and bake, and bake.

But of course, if you're 3ds Max expert, you probably have some rendering farm on where you can shoot your renders off. But we don't have that. So just be smart about what program you use. And Civil 3D-- you can pull it in.

I'm going to show you Navisworks here. I apologize for going so fast here. So Navisworks-- you can pull it in. If you guys know Navisworks at all-- bring in your Revit model.

It's awesome. You can do schedule, timeline, or animations. But it's neat just how good of a point cloud viewer Navisworks is. Pull your CAD file in here with it. So Navisworks. Revit, not going to spend a lot of time on it. Felt we were running late. I apologize. I'm going to look here.

So Revit. Do we have any Revit people or is this mostly transportation? So we showed it before, but its awesome the detail. I don't know. Maybe you don't need this much detail. But being able to see the ducts, and the beans, and stuff. I showed this video here.

I'm not a Revit expert. They're back home in Oklahoma City. But they're using it. They actually needed to show me. I was like, hey, can't I pull it back and forth and basically section the Revit? I know that's super simple, but--

BARTLEY ESTES: Calling back home-- how do I import LiDAR point clouds again?

RUSTY STEEL: Why are you at AU?

BARTLEY ESTES: I'm supposed to show it tomorrow. Can you tell me how to do it?

RUSTY STEEL: No. But I mean, it's pretty neat. I don't know. You guys are the experts in this field. Does it make sense for you? Sometimes, maybe so.

BARTLEY ESTES: But the point cloud I had earlier with all the duct work-- and again, I'm not an MEP guy I don't know exactly what you use it for. But being able to have that point cloud with all of your duct work in there made of points that are survey points-- I can only imagine how much you can do with that.

RUSTY STEEL: I hear from that group that well, we'll just go out there and pull tape. That's how we've done it forever and that's we-- and write notes. Well. OK. That's fine. But if this becomes so affordable-- why not use it? Why not have all the imagery and everything?

So I'm going to dive into Civil 3D. I'm going to really fly through this. But I want to just show you guys-- so this whole point of this class was meshing multiple models together, right-- if we go back to the beginning.

So we got to get that proposed model built from this, right? So one thing I wanted to touch on really quick is-- what is the word I'm looking for? Decimating. That's what I was trying to use earlier.

So let's be smart about how we decimate our point clouds when we work with them. So if you were doing this job-- so you see the existing shoulder here. We're going to rip it off. We're going to put an extra lane-- scab on a lane. Scab on a shoulder. And tie it back in.

Well, maybe over here on this side of the road, I don't need that high density surface model over there. So just think about where I want to use. And so what this video is showing you here-- it's just a small example. But I just wanted to show.

So the green triangles that you saw right there, I had already generated-- so here I'm showing you how to bring an RCP or an RCS into Civil. If you haven't done it, let me show that over time. It's really simple. That's the great thing about it is it's super easy.

So you go to the Insert. You go to Attach. And then you just go find it and pull it in. So like I said earlier, these RCPs and RCSs are just like xrefs before. They literally reside in your xref dialog box. So you can unload them, reload them, clip them, stuff that. That's what I'm showing you here.

But what I wanted to say as far as decimating the point to surface models-- so right there. Those are 1 foot triangles, the green. But maybe, for whatever reason, on this lane on the right, I only need 5 foot triangles or something.

So all I'm trying to get at here is, we, as a company, are trying to be wiser about-- we don't want to just blindly accept the point cloud, throw it in there, and then complain about how it's bogging our machine down. Some of that's on us. We just need to be smart about how we use this software.

BARTLEY ESTES: When we first got into it, we ran into-- we had all of this data. We had all of this LiDAR data. And we were so gung-ho. And we were like we're going to use all of it. We're going to use all of it because we have it and it's awesome.

But when you do a long highway corridor. And at the right-of-way behind the fence you have, Jim Bob's field that is flat as could be, I really don't need a 3 inch triangle. I don't need 6 inch triangles out in this field. We could get way more sparse because there's not a whole lot going out there.

RUSTY STEEL: So this is a real time video. Look at how small that point cloud is or how quickly it pushed it out. But let's be honest. If you're doing a mile, 8 miles, whatever, it's going to take time.

And if you guys have done this before, it pops up a bubble in 2016, now. And it says, hey, we're processing it. Keep working. You'll see it here in a little bit.

But it's all based on how much you push into it on how long you're going to have to wait. So we had this happen earlier where-- we're pushing our projector to its limit, I think, on these videos. I don't know why it's doing that.

So here all I'm showing is the 1 foot triangle surface and the 5 foot triangle surface I was just showing you. I was cutting a quick profile and just showing you. You see them both. And obviously, they're giving you different results because one is more dense than the other.

By the way, that's exaggerated by 20. That's a profile. That's not a cross section. I should say it's stretched by 20. I felt like this video was going to show you one more thing. But I'm going to move on.

BARTLEY ESTES: [INAUDIBLE] don't want you to show anymore.

RUSTY STEEL: So this is another Civil 3D video really quick. So I've basically fast forwarded literally minutes-- like five minutes. All I've done now is stroke alignment and cut cross sections, sample lines. And there are cross section sheets.

There's the example I was showing you with two surface models. One's the bridge up in the air. One's the underpass road there giving me the ability to show the cross sections like that.

What I was trying to show you here-- this is kind of an interesting thing-- is notice, there's actually a northbound bridge and a southbound bridge. Notice how it closed that.

Well, once again, that's because I didn't break those into their own surface models. Remember, Civil 3D is going to try and close that gap. So that's another thing to keep in mind is you probably want to have that one bridge be its own surface and this bridge be its own surface so you don't get that fake-- it doesn't try and close that for you-- because it's trying to do quantities. At the end of the day, it's trying to do earthwork.

So here's the next video, which is literally a couple minutes after that where I have my assembly. We're really big on style, settings, and templates. So everything-- the assemblies are already in there. I don't have to go find things and pull them around.

So all I did here was, with that profile, I threw an assembly on it, made a proposed model because where I'm trying to do with this as quickly as possible is AMG ready proposed models. Existing model meets proposed model. Let's feed it to this grader. And let's go to town.

So this is the next part of my spiel. Honestly, it took Bart a day to collect it. It took him less than a day to do his massage. He hands it to me. And in a couple hours-- here I am. No exaggeration. So really quick, everyone knows what AMG is, right? Raise your hand if I need to tell you what AMG is.

BARTLEY ESTES: This is a safe room. There is no judgment.

RUSTY STEEL: So really quick. So there is a tripod over here on this job. It's got a GPS on it. It's communicating with these. And based on our digital model, that we made in Civil 3D-- that smart intelligent model, it's telling these to lift this blade and to grade the site for us. So automatic--

[INTERPOSING VOICES]

BARTLEY ESTES: It is building the project from your model, which is why it is crucial that you have a good model.

RUSTY STEEL: So when you shoot down to 0 elevation, they're going to grade to the center of the Earth.

BARTLEY ESTES: That thing's going to dig to the core.

RUSTY STEEL: So that's AMG. So we've done this presentation-- so in our area of the world, our DOT is with EDC, Every Day Counts. FHWA. Everybody's ramping up on this 3D modeling. And so we did a presentation. And that's where I snipped a lot of this from.

So I want to really quickly give you some-- what we're running into as we're starting to use this technology because I think it really fits in with the whole BIM in the transportation world. So this first one is traditional. This is a corridor. I'm showing you it in a different view. But sections every 100 foot.

Notice the smooth pretty ditches. It works great. Well, here, I've draped it over what the contractors that we work with-- what they're saying they need. I want to show you here, these are 10 to 12 foot, here, from this point up because that's in a horizontal or vertical curve. And they want even higher frequency at that point. But when you hit some of these tangents, they told me you can back it off and be at about 25 foot there.

But 100 foot is not going to work period. So I'm just showing you that. And so what I want to point out are things like this. So when we go from the 100 foot to the 12 and a half foot frequency, we're running into issues like this. And they're not hard to clean up. I just want to point out what they are. So as you start doing this, you can see them also.

Ultimately, those corridors are building as these proposed surfaces. That's what we're handing over-- DXFs. So here's the 100 foot triangles. Nice and pretty. This is the same example. But here is the more frequent or dense propose triangles that we're feeding to the grader that we need to clean up.

And it's really simple stuff. It's let's just taper this ditch together. And it needs to look something this. That's one example. Here's another one. So this one's kind of interesting. That's a hole. That's a vertical straight drop off because we're doing a 3 to 1, 6 to 1 lay down.

And we're going straight to a 3 to 1, like at a guardrail. And again, we need to transition better. It's all it is because, once again, we're virtually constructing the project in the office so the contractor doesn't have to clean up our mistakes in the field, making everybody's job easier.

So there's that example. Clean that up. Really easy. It's just finding them and being aware of them. So here's traditional 2D world.

We are doing a ditch realignment or a channel realignment. So we got-- if you're thinking BIM, you've got your right-of-way issues, your utility issues. Let's look at it three dimensionally.

It's going to help us design it. If I'm thinking AMG ready models, I'm going to go, whoa. On the cross sections, this section, right here, looked great. I couldn't tell anything was wrong with it.

But when I come in here, I'm seeing vertical faces. I'm not tying where I think I should be tying. And some really easy clean up.

And our cross sections still look great. But we've got an AMG ready model. So I just wanted to touch on that. I think I showed this earlier, but existing surface, proposed surface. The brown one was prior to wash out.

Not that long ago in Oklahoma, we had some serious rain. I think everybody did. And this creek completely washed out. So then they went and LiDARed it after it got washed out.

And then we did-- OK, we need to redo this. And we need to riprap and all this. And we were able to quantify, do all kinds of things, tie it all together, and make an AMG ready model.

So this is really silly, but I feel I wanted to show sparse data-- so decimated versus dense. So traditional 100 foot triangles. It's kind of what I was just talking about. In the red, I'm trying to show you 100 foot proposed and how we've always done it.

And I just want to show that, well, what's really going on. I know this is still an exaggerated-- the existing ground, as we all know, is not just interpolating between those [INAUDIBLE]. There's more information. So there's error there, obviously.

And so, I feel we're never going to eliminate all that error. But we need to eliminate it as much as we can. That's what the contractor is trying to do. That's why they want 10 foot sections or 12 foot sections. But we're never going to eliminate all of that assumed interpolated error because we don't want to go to 1 inch proposed surface models. Their graders aren't going to be able to handle that.

So we're working with something like a 10 foot proposed triangulation model. So people go, yeah, that's great and everything, but dirt is dirt. I got a buddy that says, it's just dirt. That's what he always says. And I agree.

So I've done projects where dirt has been significant cost. So I think it is important on earthwork. But what about hard surfaces? What about-- so on this example, if we're going to rip all this out-- the one told you earlier-- and come in. And you're going to do stringless paving. Would you rather tie to this much data or would you rather tie to someone on the back of their four wheeler taking continues topo every 10 shots?

And by the way, you've shut down traffic for them to be able to do that. So again, it's just thinking about applications and how you want it. So here's one that I ran into the other day where, at that point, right there, is where our alignment and profile starts. So we don't have a good shot-- a good elevation at our hard surface tie in on a ramp. This is a ramp we're scabbing in on an interstate.

Would you rather be working with sparse data or dense data to where, again, you're not eliminating all the error? But at that tie in point, you know you're not going to have a dip or a bump-- you can feel confident about that.

And yeah, can the contractor clean it up in the field? Yes. But we're trying to eliminate that. And on my thought of be smart about when you use too much data-- obviously, I should have-- my dense triangles probably should have just been where I need them there. And out here, maybe I don't need all those triangles.

So here, bringing it all together, bringing our AMG proposed model together with the existing-- so one thing I wanted to show you guys-- I know we're running late on time-- So this was an example of a project we did where Bart went out in LiDARed it. This is, again, two day turnaround.

He went out, LiDARed it. Because he has the cameras and he's getting georectified pictures, we created that colorized point cloud that we talked about. I had all those photos.

And he also creates a log. He has a photo log. So each picture has a number.

BARTLEY ESTES: It's time stamped.

RUSTY STEEL: It's time stamped, but it's also long stamped-- or x-y. Whatever you want to work with, you can convert it. So it gives me this log.

And it's just an ASCII file-- if you guys know anything about ASCII files. So I take that ASCII file and I dump it in to Civil 3D.

And so I literally had a shot with a picture number all the way through this project. So I have a colorized point cloud. And then, I have all the shots that show me every single picture he took exactly on the project where those were taken because-- what this project is, to tell you, is it's a pavement study. It's a pavement rehab.

And traditionally, as you guys know, they would have gone out to the site, pulled off the side of the road, taken some pictures, and then tried to find out where those pictures actually existed. And then try and make some-- do some plans from that. Or make them some assumed design suggestions for the DOT.

But what we were able to do is tell them exactly where every single photo was at. Like I showed you earlier, have Civil 3D up on one screen. Have the photos up here on the other screen.

And we literally went through-- we told them where you're slot stitching, where you're doing partial plan or placement, where you're doing dowel bar replacement, and where you're doing full panel placement. These pictures are so good we could even see the cracks in the point cloud-- and I think I tried to show you that on that last screen-- to where we could recommend to them exactly-- and the other thing I want to point out on this is-- so we went through.

We clicked in CAD. We dropped a shot. We told them whether it's an SS for Slot Stich, whether it's this, whether it's that.

With this next shot, you'll see. It gave us-- so right here, you see it says SS. And it also has station offset and side. So that report that you're seeing right here-- I just want to be clear on this.

This report which, is-- you saw, I keep scrolling down. We made this in one click. We generated the whole summary table in one click because we told it, when you're slot stitch, you're this quantity because we know that quantity. And so we were able to generate this whole table just like this by using this technology, by blending LiDAR, bringing it into CAD, using them together.

And this project isn't done yet, but what we've been told by the DOT is it was probably going to cost $4 million dollars. And we think by using these ideas and technology, it's probably going to cost like $2 million. That's all we're trying to say is here is-- let's think about this technology and how we can use it to do new things that we've never tried before.

BARTLEY ESTES: We're not even saying the way that we did it here is the best way. That's what we came up with on the fly. The DOT approached us and said, can you do this. We said, yes. And we went back to the office and we said how are we going to do this. And we had to figure it out on the fly. And so we're going to iterate on that process.

RUSTY STEEL: And when we told them we were going to do that, they were like, what, that's crazy. But of course, you save them $2 million. Now, they're like, so we want to look into doing this every time.

BARTLEY ESTES: Where do we sign?

RUSTY STEEL: Yeah. So back to this one screenshot as we wrap up here. Existing, blending with proposed. So obviously, these kind of things show me my existing slope here-- which, this is an interstate-- I got to keep it as is.

This is an off-ramp. Maybe, I need to have a retaining wall here. Or maybe I need to be raising my profile of my off-ramp here.

And can you do that with cross sections, how we've always done it? Yeah. But what are you going to do-- 1 foot cross sections? Why not get in here and use Civil 3D the way it's meant to be used.

Again, I just want to reiterate, it's a lot of data. Yes. But clip it. Decimate it. When you make your surfaces from it, decimate it.

What fits-- like you said, Joe's field over here. Do 20 foot triangles out there or 100 foot triangles. Let's try to be smart about how we use it and what ways because it's here, and we got to use it. It's great. We can do things that we could never do before.

So to wrap up, I just want to say that I think we-- our goal here is to teach you more about LiDAR. Wherever you were at in your LiDAR world, I hope you learn a little bit more about it. If you want to ask questions after the fact, like the technical ones we were talking about before, hit Bart up, please.

BARTLEY ESTES: I'll nerd out with you. Come ask me some nerdy questions. I'll get nerdy with you.

RUSTY STEEL: We hope that you learned how we're using LiDAR as a firm that collects and uses it, and the different products we're bringing it in, and why we bring it into those different products. And then how we're building those proposed models so that we can mesh it all together to where we're eliminating as much error we can to virtually construct the project in the office.

BARTLEY ESTES: So with that, we have probably 5 or 10 minutes left. Does anybody have any questions off the top? I'll take all LiDAR questions. Design questions and go to him. I'm not your designer.

AUDIENCE: I'm sure this has been asked. But what about dealing with you're out there with a tripod, and you've got giant, 500-acre pastures with a foot of high grass? I want natural ground, and not only scan the top of the grass. So what do y'all do with the software to remedy that?

BARTLEY ESTES: So that's the type of job that we would traditionally used aerial LiDAR for because we want to get a [? nadir ?], top-down view of the ground. Proprietary softwares that come with LiDAR sensors have algorithms that filter the data.

Like I stated earlier, because we're using lasers, it will penetrate tall grass more than you might expect. The points on the grass still exists. And so by using a macro-- a filtering algorithm-- you can actually tell the computer, the only points that I want are points that are bare earth. And it will go through. And it'll wipe them all out, put them in a different classification.

You can look at it. Approve it or disapprove. If you don't like it-- you think there may still be a little bit of grass in there, run the same program until you're confident that that is your bare earth.

RUSTY STEEL: And the geniuses that wrote those algorithms-- one of them, Ramesh-- who we worked with at his prior place-- he now works for Autodesk. And we were talking about what InfraWorks is doing. I guess, we can't go into it. But Ramesh is bringing those crazy algorithms into the Autodesk world that he did through these other LiDAR specific programs. He's bringing that into our Autodesk world. And we're going to see the benefits of that very soon.

BARTLEY ESTES: Not to get too much into it. But in the InfraWorks Sandbox, they're getting ready to be able to push out existing ground models from a point cloud that you load into InfraWorks. And your existing ground model will be pushed from InfraWorks straight into Civil 3D. And you won't even have to handle a point cloud in Civil 3D. You'll have the model that was generated in InfraWorks.

RUSTY STEEL: And that's already in it. So something he showed us that's really cool is the assets-- the power poles and all those things. Those are blobs of information. And Ramesh is doing things that are so cool-- where he can identify those blogs. A light post looks like the other light posts 100 feet away from it. And he can start to drop things CAD blocks--

BARTLEY ESTES: Automatically. It's recognizing it.

RUSTY STEEL: We're already saying more than we should be saying. But it's going to be crazy here in the next year or two.

BARTLEY ESTES: But we're excited. So here, when I came through here, I, with my eye ball had to go in and say, that's a sign. Go grab my sign block. Drop it there. Go find a light pole. Drop it there.

The new things-- that again, we're probably not even supposed to talk about-- that's in InfraWorks is the software is going to be smart enough to say, you tell it one time, this is a stop sign. And it learns, hey, that's a stop sign. A stop sign block belongs there. It'll go through the entire dataset, find every stop sign, and drop a block.

RUSTY STEEL: And so he's telling us a lot of it's built in at the front end. But then, you as the person that's using this data-- you help teach this software. Like you can customize a block, you can go in and customize-- so this blob of points means this-- means a palm tree, as opposed to-- pretty neat stuff. It's crazy.

BARTLEY ESTES: Any other questions?

AUDIENCE: Is there a reason tiny things can be traced? The last two projects we used LiDAR on, I was getting files that were broken down into 20 to 50 gigabytes. And I can't handle two at a time. So I need to have traditional LiDAR. We need to show existing conditions [INAUDIBLE].

BARTLEY ESTES: And I would say that's completely fair.

AUDIENCE: Well, how big are your files? Are they that big?

BARTLEY ESTES: No. The last roadway project I did-- are you trying to jump in?

RUSTY STEEL: I was going pull one up and see.

BARTLEY ESTES: Typically, our per file is no larger than 2 gigs. It's usually closer to 1. I'm talking mobile LiDAR. So this is down a corridor. If you're using big-- can I ask what type of project was it? Was it roadway or a very large area?

AUDIENCE: Theme park.

BARTLEY ESTES: A theme park. So a very large area.

RUSTY STEEL: So is there an opportunity to clip the point cloud down? Did you already do that?

AUDIENCE: We tried to do it in 10 sections.

RUSTY STEEL: You did?

AUDIENCE: There were about 14 including the subsections. But the point cloud was so dense, my computer could barely open them.

RUSTY STEEL: Sure, I understand.

AUDIENCE: [INAUDIBLE]. So I had to get a surveyor to suss out [INAUDIBLE] and things like that. [INAUDIBLE] so I could manage the [INAUDIBLE] and any other work.

RUSTY STEEL: And then again, I'm going through that, too. Again, we're not saying we have all the answers. But we're trying to-- OK, right here, I need 1 foot triangles. But over here, I don't need that. I need 10 foot triangles. Because all that, you can do in-- so did you try and pull it into ReCAP?

AUDIENCE: They pulled it in to ReCAP [INAUDIBLE] partly use Revit. [INAUDIBLE] and just trace out buildings very quickly. That was easy because the section just [INAUDIBLE] the walls [INAUDIBLE].

RUSTY STEEL: So I'm glad you brought that up because-- sorry, I didn't mean to interrupt you. One thing I didn't say is, in ReCAP, you have an opportunity to decimate. And that's a great example of where maybe it's so big that he couldn't even get it into Civil 3D to decimate it.

So you have an opportunity in ReCAP-- it's right there at that home screen where I did the unit conversion and coordinate system-- where you can decimate it right there to maybe were you could-- if ReCAP could handle that large LAS file or RCP or RCS--

BARTLEY ESTES: It should.

RUSTY STEEL: It should. All the big ones-- and I'm talking 20 miles worth of roadway, it's handled. And this is roadway corridor mapping. High density.

Then I can water it down, clip it down, and push out. Similar to what you're saying. But maybe, there is an opportunity for you to even water it down more in certain areas on that point cloud.

BARTLEY ESTES: I think you can go in and say, hey, push out a point cloud from this point cloud that's every 10th point. So every 10th point in a point cloud is still very dense. But if you're literally only getting 10% of the points of the original file, you're going to have a much smaller file. Like I said, we don't claim to be experts, but I would try decimating in ReCAP before you push it out into your next program.

RUSTY STEEL: We have our business cards sitting up there. When you sneak out, if you want to ask us more questions, you can call us, or e-mail us, or whatever. We can do a webinar with you some day-- just teach you more if you need to so. We appreciate everybody being here.

BARTLEY ESTES: What was your question?

[APPLAUSE]