KEVIN GROVER: All right. Sorry for making you sit here for so long, we figured we might as well wait until pretty much 8:00 so we're just a little bit-- Good morning. Welcome to the first presentation to officially kick things off, so bright group eyes this morning, which is good. Better than Thursday morning. So thanks for coming over.

My name is Kevin Grover. I'm region of technology lead with Stantec in Edmonton, Alberta, Canada. My background is a land surveyor. Been involved with point cloud collection for the last eight or nine years. We're into drones and other types of terrestrial-- kind of got into mobile collection, aerial collection, all that kind of stuff. So we do pretty much the whole gamut of things. The presentation today is going to be on the extraction side of things, specifically for point clouds, and tailored to infrastructure projects.

So co-presenter is Ramesh with Autodesk. He's the principal research engineer for Autodesk. Do you want to do a bit of a bio? No. OK. If anybody's been using the InfraWorks products with the point cloud capabilities for the extraction functionality, he's the brains behind it. So we're going to be going through some of that. We're going to break it up into two sections. Overview from my start of the beginning of just some best practices, how we can leverage the data, how we can use some different tools we have today. And then we're going to get into some of the live side of things to see the InfraWorks in action.

Maybe I'll just get a feel for the audience here. I'm assuming everybody knows point clouds by now if you've been to AU. Does anybody collect their own point clouds? There SE are all end users of point cloud data? And extraction? OK. How many have actually used the extraction tools within InfraWorks to this point? So a few. OK. Perfect.

So this class is going to be talking, specifically, how to more effectively use point cloud data. If you've used point cloud data you realize it's a real challenge to deal with. There are big data, especially for infrastructure projects, for large corridors, that kind of thing. It's a lot of information to manage and handle on a project, and utilize effectively. So this is what we're going to focus on is, how to effectively utilize that data.

So my handout that we kind of did before-- We're not to go into all the detail of all the nuances of data exchange between Civil and everything. So we're going to focus more on just how to actually use the point cloud-- Some best practices for collection, and the types of technology

actually used for some of the data collection itself. And the benefits of how those will roll into more of the automated extraction. And then will get into the end part of the modeling infrastructure assets on automatic ground classification, and the InfraWorks tools.

So we'll start with just how to utilize point clouds for visualization. So if you've used recap and all the styling, I'm not going to go into normal view and intensities, all that kind of thing. I'm hoping we're past that point. And again, I'm not going to bore you with the technology itself. You've probably seen so many ways to collect the data. I'm just specifically going to be talking today about terrestrial laser scanning, which is a big part of our business in our company. We've got 18 scanners in our firm, and primarily we do the majority of our own data collection.

Also going to jump into some mobile data collection. I'm not sure how many people actually use a lot of mobile data, but it's kind of the Cadillac of the data collection technology for point clouds, especially for urban environments, corridors, that kind of thing. So they can collect it at faster driving speeds. Of course, there are hand-held data collection. There's aerial LiDAR and of course, drones-- which, I run our drone program in our company, too. So I'm not going to be talking about drones. There's enough presentations on that, as well. And they're not typically lighter anyways, so we're focusing more on just terrestrial mobiles. And they're typically the two predominant technologies-- more so for corridor and infrastructure-type work.

So just a bit of comparisons-- I'm not sure if you're familiar with the two sides of it. But just kind of going over a couple. So terrestrial, of course, it's less expensive. People don't think it's cheap, but it actually is. I guess the $50,000 system as opposed to-- the picture that you saw there was about a $1 and a 1/2 million system. Just very different data collection methodologies because the mobile system is actually moving when it collects the data. It's got a lot more sensors involved with it, so of course the cost gets more expensive.

If you're just kind of an end user of data products, you'll also find that there's a lot more data vendors out there that are actually doing terrestrial data collection, as opposed to mobile. Purely just based on cost. There's a lot of other nuances along the way for the data processing methodology that's a little easier from the terrestrial side. But for the mobile side, there's more that are popping up. But not all of them are built the same either.

Accuracy-- this is kind of one that's subject to so many different things. So terrestrial is typically more higher accuracy because we can actually QAed a lot better, integrate it with better survey control, and you can just get much better information, in general. But mobile has come

a long ways, and depending on the system-- That one that you saw there, as well, it can collect at highway speeds and you can get down to a couple of centimeters accuracy, even driving at 60 miles an hour. But that also is dependent on the methodology, and processing, and the vendor and all that kind of thing too. So there's a lot of nuances with it but they're both very good for feature extraction for ground terrain, as well as leading infrastructure information.

I'll get in to this a little bit-- Terrestrial has a lot of line of sight issues, especially when you're working on, say, an urban roadway. As you're scanning, there's constantly cars driving by. There's other features that are blocking your way, whether there are power poles, trees, and where you're set up-- That's typically why it's kind of challenging more on a corridor type thing to use terrestrial scanning, because you're bouncing around and trying to collect from different locations. And you're getting a lot of gaps in your data.

Problem with some of the gaps-- which I'll talk about as well-- is it makes some of the automation a lot more challenging. Manual extraction can be very easily done with it, because you're always going to kind of work across some of these voids. But for the automation, and some of the algorithms, they need to have a very linear, seamless data set.

So that's kind of where mobile does have its advantages, because it can actually collect at faster speeds. You can work in, and around, traffic. It doesn't look like a bunch of noise on the road. It can actually follow the speed of the road. As long you're not sitting next to a car when you're collecting data, then you'll actually be able to see the whole road corridor.

Some of the big ones to us is just safety issues in general. So terrestrial scanning-- of course, it has its safety nuances, or safety benefits, well over traditional ground survey methodology because we're not physically entering the road. But you're still physically setting up on the side of a corridor, the side of a roadway. So there are some challenges with it, as well.

The benefit, again, in mobile is being able to do that at highway speeds as you're driving. So you kind of take some of the safety aspect out of it with the mobile collection. Longer time to collect for terrestrial because you're physically sitting static and moving from point to point. Mobile you can collect miles of corridor in a matter of hours. It's ridiculous how fast those systems are collecting data now.

Again, more about the nuances of the two. So from the terrestrial side, everybody's seen the point cloud. We tend to primarily work in just intensity views. I don't know, RGB is-- it looks nice

but it just costs too much money, and time, and effort to actually collect it. Especially for some of these projects.

So this is just a single scan location. So you'll see this is when we get some of the void things. Our scan location is here. You can't see across the road. We can see the curb on this side but not on the other side. So again, from the line of sight challenge thing is, you're set up at a certain height and you can only see so many features from one given point.

You add a second scan into it, and of course, it starts getting a little bit more complete. But it's still done on the one side of the road. If we had another scan in, jump the other side, of course, notice this is when you start getting more completeness of your data set. So every time that we start doing this it does add time in general, because you're doing more set-ups And more strategic locations, to be able to see all of the areas you're trying to extract.

So this is kind of one of the challenges again, with terrestrial. When you start putting all of the scans together, you'll still see that there's always going to be little voids in your data set. You know, honestly, it could just be because there's a parked car. It could be just because you can't physically see another location. So all these things do come into play from the automation side that some of the gaps in the data are going to be a challenge to do some of the extraction in. But again, you get you can still get a very robust data set with terrestrial.

So this is some of the gaps thing we're looking at. And this is where it is challenging from the automation too. So we're set up on this side. Of course there's a pole in the way and you get this massive gap of data just on a section of the roadway. So if you zoom in to that-- you can see it-- your dense point cloud of your curb stops here. You've got very little data in between and then it stops on the other side.

So if you're manually extracting features, that actually is pretty easy because you can just work your way across here. Pick the point, pick the point. But from the automation and the algorithms, it'll basically just stop at those locations. It doesn't know how to basically extract what's not there. I know they're trying to come up with that, to do some of the occluded areas, but that's really challenging and more of an infrastructure environment.

So, of course, in the end the intent is to get one, big, complete data set. It looks really ugly because this is just part of the game when you're actually working on an infrastructure project, or a roadway project. All that crap you see, is all just car noise. So, again, it takes a while to clean all this messy stuff out, whether it's people or vehicles. So this is where we can do some

manual cleanup of this to kick it out. Or we can throw it into some software to actually just work around it. You don't actually physically have to clean up a lot of that noise information if we want to just derive a terrain surface, and that kind of thing too. And that'll be part of the demo part in the end.

So now for the mobile side. We love it. It's something that we don't technically do in our company yet. It's kind of part of the next area we're going to get into. Our challenge in Canada, we got six months of snow out of the year. So it's kind of a paper weight for six months. So in other offices you might be looking at doing it.

But some of the nice things about it-- when I talk about how linear a data set. So this is actually just a single pass on the roadway from a single scan head. So some of the scanners-- the mobile systems-- have two scan heads. They're typically fastened like a crisscross pattern. So they are collecting at two different angles that's actually driving. So the benefit of that is it's actually getting all the information as it's driving down the road, and kind of getting into all the nooks and crannies that are needed.

So this is just a single pass here. So you can see that there's a very linear data set. That that's the scan line. So it's actually driving and the scanner is actually oriented at about a 45 degree angle. So once you add in a second scan-- so now this is the second one in the opposite direction. You'll see now the scan lines are going this way. But you see how just linear the entire data set is. Everything looks very clean because there's very little noise, as long as you're not following a car. It's actually collecting the data as you're driving.

You put those two data together and now that's when you start seeing this real crisscross pattern in your data set. So you get this incredibly dense point cloud of a roadway. And you get all the features that are even outside of it too. And this is down to a couple centimeters accuracy for specific systems. There are some systems that aren't nearly that good. But like I said, the Cadillac one, the RIEGL system, just over a $1 million, $1 and 1/2 million. It's incredibly phenomenal accuracy, overall, for that system.

When you drive to pass in the opposite direction-- So now we've got the two corridors. This is in two passes. So this is just showing the opposite side here, as well. You've got two passes in both sides of the road. This is where you fill in every little nook and cranny along the way. So you get curve on both sides of the road. You get a very seamless ground surface. And there's very little noise even right off the bat. So this is kind of a benefit with the technology, just in

general, over terrestrial, because you get a much cleaner data set right off the hop.

If you kind of look at that in a bit of a cross section view, you can just see how clean all the features are. The paint lines show up just perfectly. It's a very nice data set.

So that's kind of just more about the two types of technology. Then we can kind of get into some best practices of how we actually manage and work with the data to augment some of the data collection itself, and the automated extraction. One of the big ones is to unify, or not to unify. I'm assuming that most you know what unification of the point clouds is.

For terrestrial data, we prefer not to unify in a lot of cases. Just because we like having this scan location information. Just for the ease of filtering things, you also get that kind of bubble view of your scan view that looks like a 360 panoramic image. You can do a lot with that type of data. As soon as you unify the data, and basically merge it, and average it all together-- you lose the scan locations.

I know it works a lot better in the InfraWorks side, when you do get a unified data set just because it does simplify. You put less data in so the algorithms don't have to work so hard to basically filter out even more of the data it doesn't actually need. It is a smaller data set, so of course, all your Autodesk products will work a lot better with a unified data set. But it depends what you're going to do. For the building side-- for whenever we working in Revit, et cetera-- we never will unify just because we like having the scan locations. But in this case, you've got your two sides.

Tiling a data set for corridor work. This is definitely a no-brainer. If you're working on a long linear corridor that's-- whatever, 50 miles long-- you don't want to have one giant point cloud that's 50 miles long. Ideally, you want to break that up into chunks.

There is some regioning functionality within Recap. It's OK, but you might also want to simplify it even beforehand, and tile it even outside of the products. And just bring them in chunks, whether it's a mile long, or a half-mile long. And then you just load data as it's needed. Because the benefit, again, in the InfraWorks automatic extraction, you can load as many files as you want and just process individual ones. So you don't have to have it all loaded into one project.

Of course, the last one-- we struggle with this in our company, just for data size and data, in general. We've got a massive amount of portable hard drives kicking around all of our offices.

Our IT guys despise us.

We just did a count the other day and I think we've got 42 terabytes of data from the last year and a half. And it's just sitting on hard drives or computers in our office. And that's not even in the mobile collection side. Once you get into that side, you could technically collect about a terabyte in a single project, just from a couple of hours of driving between point clouds imagery.

So big data is a big challenge. We can't run things on a network. We typically do everything, locally, off of a hard drive.

We're pressuring Autodesk to come up with some better ways for that, because of course, that's kind of some of the challenges. But that's also where we get into-- only bring in the data that's actually necessary. Only work with the data that's actually needed. And then through a lot of the filtering process-- the information as well. We'll filter it down to the point where it has the same visual fidelity. You can get the same data out of it, but it might be a tenth of the file size because you're just filtering a lot of information out.

I'm kind of getting into just some of the methodology of how to generate information out of this. If you've done some extraction you know how painful it can be to do a surface extraction, or even just breakline extraction. If you don't have the right tools to do it, manual modeling is a real nuisance. But it's, by far, one of the easiest ways of doing things because the tools are kind of built into Autodesk products right now.

So what I mean by manual-- this is just in AutoCAD-- just a basic view. A little bit of an oblique view of point cloud. And your basically going through and just tracing features, or adding points. It's like gouging your eyes out doing this type of manual modeling. I don't know if you've done it. It's not fun. It's not pretty.

You're trying to extract all these features-- breaklines for bottom of curb, top of curb. In this case, we're picking off vertical features or manholes. You just need good software to allow you to do this. But anybody can do this. There's snapping tools on Autodesk products. You can kind of manual model some stuff in InfraWorks. It's not the most glamorous way of doing it. So that's kind of why we're always looking at pressuring software companies to do things a little bit better.

We can kind of get into the next level of things and how we do a lot of extraction and other

ways of doing it. It's more of an assisted manual workflow. And this is actually a lot more of our preference. The automation side is going to be a lot better in the future, and we trust it. Or we'll trust it a lot more as the tools in Q8 grow.

But this is really nice because it is some manual effort, but it's using some more intelligence. So for like a linear corridor-- what we typically do in a station like that-- we're working in more of a cross-section of view. I'm not sure if anybody's worked in a view like this, where this is actually in Cyclone product. It's just the screenshot that we had at the time, with the codes that were showing stuff.

Basically, if you've got a linear corridor you create an alignment file. You create your cross-sections every 10 meters along the corridor. And you're just cutting a slice of the point cloud, every section along the corridor. So you get this really nice cross section of the roadway. And there's a lot of intelligence software now, where we can basically take these data sets and you can manually start coding or extracting 3-D features, and picking off all the features in a cross-section of view.

As you hit your next station 10 meters away, it leaves those point locations there that you actually had from the previous time, and you're just tweaking those locations. It's a really fast and efficient way of doing it. It's not as monotonous as you physically tracing and make it to your snapping to an actual node. This more of an assisted mode, for us, is really ideal. Because we can actually Q8 the data as we're going.

Manual, of course, you're doing it as you're doing it, as well. But in this case, every section you go along you'll know that all the features you're actually creating-- especially if you've got just a long, straight corridor-- you're just picking up very nice features along the way. You've got almost perfectly clean, three-dimensional polylines, or features along the entire corridor.

Then from the terrain side we've got different options. And I know, ideally, it's the easiest just to throw a whole shitpile of points into InfraWorks or Civil 3D and let it create a surface, and then you've got something. That's not the most efficient way. Of course, if you work with Civil 3D-- or even InfraWorks or any product-- the more data you throw into it, and the more data you have in a surface, the harder it is to use.

Civil 3D-- it's gotten a lot better at handling surface data. But you definitely want to have a lighter weight surface, especially if you're going to look at things in three dimensions, or start working with it after the fact. We've got a couple of different ways you can do this. Again, the

top one is typically more our preference. Or the workflows that we have now, is to create a surface from all your 3-D features.

So if you're extracting just all your 3-D polylines, and breaklines along a corridor, you're actually just creating your surface out of those three dimensional features. So it creates a very nice, seamless surface. It's not very dense because you're only doing it to the density of whenever your cross-sections are. It's very lightweight, and it's clean, but it's very time consuming, because you are physically just creating these features you need along the way.

Second part is to create a surface from a point cloud. Of course, this is kind of the holy grail of it, where you've either got to manually clean it enough to get all the data out of it-- There's some tools in Civil that are in the handout I talked about. Some of the ground extraction functionality in Civil-- it's OK-- but you're still left with all these kind of spikes and peaks within the surface. And it is based on only what you can see too. So it is a lot of editing that you have to come up with as well.

The last one-- You can do it just off a grid of points. So we will typically do, is from our aerial collection, or if an area is completely flat-- I want a 5 by 5 meter grid, and that's kind of the surface. So it's just going to randomly pick points every five meters, and you can generate a surface out of that. Again, very lightweight. You miss a lot of the detail in your surface, especially if you've got curb lines, and maybe a little narrow drainage courses, that they won't actually be picked up that way. So there's a lot of different ways you can create a surface and they all kind of react a little bit differently in the software.

So now we're going to get into more of the automated one. And the crux of this presentation is how we can start leveraging technology and computer vision, which is-- and I'll throw this in, Ramesh will like this-- is his magical computer vision. I don't understand all the computer vision side of things. They've done a lot of very impressive algorithms to start working with raw data sets and kicking usable products out of it.

I'm going to hand this over to Ramesh to kind of jump in for part of this. This will kind of get in the next two sections of how we're using the data-- not so much putting in InfraWorks in Civil 3D, but just purely an InfraWorks we're going to show you all the extraction tools, and point cloud functionality. And then how we can actually use it to automatically model infrastructure, right within InfraWorks.

RAMESH SRIDHARAN: Thanks Kevin. Let me see if I can pull up-- [INAUDIBLE]

So it's always interesting working with Kevin. So you start a project as a simple project-- using this data he said, there's the intersection project data we have, let's work on it. And then I open the data, there's a lot of cars on the street, and there are some glass buildings and stuff. I'm like, something's wrong with the data. And he says, OK, let me give you some other simple data. And that was this. A lot of cars again, in the noisy environment. It's always interesting.

The duplicate doesn't work. [INAUDIBLE] works. I'll try to work it out.

OK. So like Kevin said. the data has lot of-- I don't want to call it [INAUDIBLE], I mean they are features for those who are interested in it. But it has a lot of points for the regular project. If you want to create a surface, if you want to extract some features out of it, then all these things come in the way.

Even if you do it manually, it's a very tedious process to go through it and also, there's an easy chance you might end up missing something when you do the manual process. And that's not specific for this particular data set. At any point [INAUDIBLE] data set is the same thing. So the more you work with it, there's the possibility of making mistakes. It's a tedious process on that part.

So when we started adding tools [INAUDIBLE] in Autodesk product we were thinking how to handle this particular part better. Let me actually show you my part one, then I'll come back to this data to give you-- It's kind of hard to maneuver. This way.

So when we started adding the tools in Autodesk product we were thinking how to handle this particular situation, because it's-- how do I say this? It's not that hard to create a cross-section based tool and go extract the vertices, just like everyone else is doing. But we thought can we do a little bit better than that? So that it's actually a much better workflow for the modeling, as well as the design perspective, and provide a completely end-to-end solution for a large data set. Not just the intersection, not just the road-- liberal, large data set.

So that's where we came up with the concept of the end-to-end solution to handle this. This part I'm going to skip because Kevin already talked about it. So that's where they came up with the concept called Points to Models. So completely putting myself in a customer perspective, you are sitting on top of a lot of point cloud data. And yes, you go through a manual way of

extracting some lines from it, and you're doing it, but point cloud has much more to offer. Just because we don't have the tool doesn't mean that you cannot use it in thing.

So having the capability like converting a bunch of points to corresponding models in a reality world, makes the worth of point cloud much, much more. And you can do things which you never imagined you can do with it. That's when we came up with this concept. So how to do that?

When I am talking about automated tools, then all the nicest-- in the middle of the road, and side of the road-- all of this comes in the [INAUDIBLE], it's very hard to do something. So the first basic thing we have to do is filter out the data. And it has to be automatic. We cannot expect users to come up with a paint brush kind of a thing you go over and filter it.

So we came up with a concept called extracting the data derivatives. Extract something that's a sense in the point cloud so that, number one, we have the information content. And number two, we can use that to filter out the stuff so you get to see things, or do things with it what you want, instead of loading up with gigabytes of data sets. Once you have that-- and the rest is actually very simple, it actually paves the way for everything else.

My really little favorite is-- Which one is a laser pointer here?

KEVIN GROVER: Yep. Just the red button.

RAMESH SRIDHARAN: Oh, this one. So my favorite is the vertical clearances, and on the route modeling, and things like that. So route modeling, for example-- I was working with the Oregon DOT. If you want to go from point A to point B, right now the big trucks, the [INAUDIBLE] trucks have to get the permission from the DOT. And the only way they're doing it is, they have a picture-- like a Google image kind of a picture-- and they have the bridge and there's a sign-- 16 feet or something.

The person who authorizes the route just looks at the picture and says, well don't go this way, go this way. But it's a super elevation. You can actually try to go in one lane and you can get there if you want to, but that's not the way the system works right now. So we are losing a lot of efficiency, even though Oregon DOT has a lot of mobile LiDAR data. They are sitting on top of the data. Still, the ability to get the route modeling from point A to point B with your 3D data sets is not viable right now. So that's exactly what we are trying to change with our automated process.

So what is it that we do? So basically, this is a typical mobile LiDAR data. This is not Kevin's though. It was a different data. So we bring in this data. What we want to do is to remove the nicest first. Generate something bare earth. And I kind of like the concept of bare earth. I know this bare earth is not the exact thing you will use in design, but this is the bare earth people started collecting point cloud data, 15 years back, 10 years back.

So now when we start using it, we always go to the line worked interpolate between them. In my mind, it cannot be wide, the purpose. I understand the purpose. Don't get me wrong. But there are much more in the point cloud data. Like a bird bath in the middle of the road, you might miss when you do a cross section based approach or something. Maybe you don't want that for your project, but it happens. It's there in the data, it's useful for you. So having this bare earth, removing all of the noises, and provides you a clear solution. You can use it. If you want, you can use it. It's much, much better. And that's just the tip of the iceberg. That's number one.

Number two is, we started with the vertical asset. Since we started working on the InfraWorks-- InfraWorks, when you see it, is a lot of 3D models. And it's kind of easy to do that part first-- to get the attention of the customer, then we go to the linear stuff and things like that. So that's the approach we took.

So the vertical features-- this is it behind the screen-- just to let you know-- but you can see that software goes ahead and tries to group each and every feature so that we can use some machine learning, or some kind of approach to ease the user part. My philosophy on this part is, user comes across as the expert. You tell the software what you want to do, but I don't want you guys to do every single thing. I want software to do it. You paid big machines to do that, lets make use of it, obviously. And that's the second part. So vertical features.

And the third one is the linear features. And we are working on it. And like Kevin said, there are some snapping tools and everything, but again, that's a lot of data. You are to go through it in here. The software highlights some of-- the pinstripes are very easy to see. I think I used this slide before. So there's the curbs here, top and bottom of the curbs. You can see it.

The software classifies the point cloud data. High density point cloud data here, so that when you're doing-- even the worst case scenario-- I'm not saying you have to do it, manually. I know that's the only tool we have right now. But even if you are doing it manually, this simplifies your job. You'll just highlight what you want. You can snap through and move on

instead of messing with large point cloud data. That's the key here.

So once we have these three-- that's why I call it a derivatives. I know the data is a raw data here, but the concept is applicable for other point clouds also. Infrastructure point clouds, at least. It could be a rails or it could be a power line you are working on, but the concept is exactly the same. Same workflow works for all different types of projects. Workflow works for all different types of point cloud also.

Maybe it's a mobile. In this case it's a mobile. Kevin's project we're going to show is a static there's still LiDAR data. We have some customers who work with the UAV data. UAV is a little bit odd with the point cloud but it does. It does the job much better than-- if you're going to build with the UAC data by itself, it's a very tough thing to do.

So let me just show that once. The large data is the large data. As much as we try to ignore that when it comes to point cloud data, it is large. And you are sitting on-- like exactly Kevin said-- you're sitting on top of hard drives. So we are trying to see, once they do the information content it leads the way there. Why can't they just store the information, and for lack of a better word, pass everything else? I mean, you have the raw data if you want to, it's always there.

So can we do something like that so it makes it better for the processing perspective? It's not just for the-- Of course, it makes software job much easier. You need to show only a few points and maneuver a few points. In my mind, it makes user's job easier also. You're looking at what you want to see and get your job done, instead of looking at millions and millions of points. I don't see the purpose of it, in a way. You know what I'm saying.

So that's when he came up with a lightweight point cloud data. So the one on the left here, is an original one. The one on the right is the lightweight one. I kind of like this slide. I use this slide before. But this kind of conveys the point of what I'm trying to say. That both carries the same information. Both has all the points. In my mind, this actually looks a little bit better than the other one.

But the cool thing is that the one is just a 1/10 of the size. And I'm not saying you're going to get 1/10 on every single data. It depends upon [INAUDIBLE] resolution, and all those things. But this does break it down significantly. Even though I couldn't convince Kevin yet that he can use this. But it does the job. It does the job for you. It makes it much easier. You can share the models very easily.

In a bigger picture-- In my mind, this is how it works. Let's say you have a project-- let's take a simple project of 50 gigabytes of data, for example. And you run through a processing software. It processes it. Let's say it brings it down to-- let's say 5 gigabyte, I'm not even going to exaggerate-- let 5 gigabytes for an example. Then how easy for you to share your model, share your project, with your customers, or with your colleagues, across the country, or across the world, with just a 2GB or 3GB of data on the cloud, instead of 50 GB of data on the cloud.

It makes your project much more easier to handle. That's my opinion. And we are making efforts on that to get better and better. As a matter of fact, some of the slides we are using here on the project was-- it was a little bit of pre-discussion software. The new version makes it much better. I know only a few hands came up when using InfraWorks. You guys should try it out. It makes your job much easier with the point cloud date. Whether you collect it or consume it, it doesn't matter.

So the point cloud terrain generation-- So like I said, you can use different types of data, it doesn't matter. It creates in Infraworks. It creates a wireframe brazier kind of a looking model for you to put your models on. Same thing translates much better in Civil 3D or AutoCAD, as well.

This slide, actually, I had this slide also yesterday-- I didn't like this data. Because it kind of conveys the big slope areas, how to do the terrain extraction. Like for example, this is the one on the previous that are data, and once you process it, it removes a lot of niceness on the data. And there's mainly some of the vegetation points around here. Then, when it overlaid terrain on top of this, it looks like this. And then here's the contours.

And I'm sure there are a few points here and there-- there could be some trees, or here, somewhere-- But this is a drone data. And you can actually use this and create a better surface. Use for the model-- I mean, it's a Civil 3D. I can use the word design, but drone data on its end has completely different things, like Kevin mentioned. I'm not going to go there. But the point is, you can use the point cloud data. You can filter it out and use it with very little effort, is what makes this tool much, much better.

Well let me just play this across-- Whoop, not that. How do I play this?

AUDIENCE: [INAUDIBLE]

RAMESH SRIDHARAN: Yeah, but my mouse--

AUDIENCE: [INAUDIBLE]

RAMESH SRIDHARAN: But I don't see my mouse pointer. Yeah, but-- Oh there's the mouse. That's why.

So this just shows the crux of what we have in the product right now. And you get the idea where we are going to. Point cloud, like I said, reiterating lots of stuff. This happens automatically. No manual work involved in here. It creates a terrain like this. Imagine having a terrain like this in your project, enforce it with the proper breaklines, makes it much, much more useful-- your data.

And this is the model-- the one thing I really like is that when it comes to reality capture, creating a models with real information-- signs or the street lights-- wherever you say there is a street light, there is a street light in the real world. And I know the modeling doesn't translate into design. In my mind, design and modeling are close.

Modeling is just a way of representing in a nice 3D model where the points-- the view just converted to X-Y-Z. That's the design point, that's the design line. Both are pretty much the same, just the interpretation of how you look at the data. So modeling-- once I have this in a model, imagine I can export this as-- I don't have a line here, obviously. If I have a line that's a poly vertices, or the features as a points, those are [INAUDIBLE] point. Those are the extractable points. Those are the feature lines you can create your design with.

So in just the interpretation, but the modeling way of working with the point cloud data makes more, more productivity from the customer perspective. The usage perspective. You're looking at-- well, I don't want to call it eye candy, but it does makes it much easier to look at.

How we do it? I'll just show you a real quick video on how exactly this works. This is a complete workflow. At least for what I'm showing right now. [INAUDIBLE] in point cloud that comes in, it goes into ReCap, obviously. That's a set, you can prep them. There are some [INAUDIBLE] light out, you can register them. Or sometimes I used to clip out some of the areas I don't want, because mobile light out, or something, collects too much information than I want to.

So here this is about-- this is a West Virginia ridge. There were two kilometers of data. You

can go ahead-- in this case I'm clipping it-- so my point is, you can prep the data. Here's your point cloud file. In InfraWorks you bring it here, you import it, all the corners from the set. This part goes a little fast, but bare earth, I'll show you later. So you click this thing, point at the terrain. It creates this [INAUDIBLE]. Same data, there's no mock-up here, just a recording of actually what the software does.

And when you go up in the point cloud data, this is what it actually did to your data. You can have the linear features classified, the vertical features, everything is right there. And this is actually a lightweight, too. You don't see it, but it's actually lightweight data.

And modeling part-- the software autobody recognizes many of them. Like the street lights here, street lights there. Once we have the linear stuff we are going to have the orientation, but for now, the points are already there. Software understands what your group of points actually mean and replaces them with the real world model. And you can change the style, change whatever you want-- depending upon your project, your area, and your data set-- but the software does the heavy lifting for you.

And one thing-- I worked with this kind, like I'm sure Kevin worked too-- I worked with this kind of projects before with a mobile LiDAR, especially for asset collections. It is easy to miss. I know any product of that comes and tells you, I can do it 95% accuracy, 96% accuracy-- what are you going to do with the remaining 4%? You have to go through manually to check what it missed. This one has a little bit more false alarms, but it doesn't miss anything. You get everything you want. So you spend 20 seconds or something, but you get the job done.

This, once you have the data, you can bring it down to Civil 3D. We have a couple of ways to bring it in. I'm not going to go through that here, but you can get it done, you can get a surface. In this case I'm showing you the points. You can bring it in here. On top of it, there's all that. [INAUDIBLE] come through it. The other way of bringing the point cloud to create a terrain for you. So this is what I'm talking about. So once we have the data set, how quickly you can use it, and get it to design, is what makes it more powerful.

And then on top-- I'm not saying breaklines are not necessary. I'm not including breaklines here, but having a breakline here now. Here's the way the software stands today, you can do it with a lightweight point cloud data. That's what I'm trying to say.

So let me show you this data. It's kind of hard to open here. You want to show something in

your data?

KEVIN GROVER: It's fine. Doesn't matter.

RAMESH SRIDHARAN: The only thing I would say, like you mentioned, unified, or non-unified-- by the way, we fixed the non-unified issue. It works perfectly fine. But the unified-- the problem with the non-unified is that it's a surprise. That's what happens. So in one area, it's just like a hell of a lot of points. Software doesn't export that much. The whole memory blows up. So that's what we're handling.

The unified makes it a little bit uniform. It doesn't shrink data size that much. The original was 30 GB, the unified is 12 GB. It's a good data. It does a lot of [INAUDIBLE] if it's a good data.

So unified helps-- at least from the software side-- on evening it out, so that there's no surprise while processing. You won't have a spikes in your memory. It's a point cloud stuff. Anyone process a point cloud in the last five years, you know that it takes time. It takes a little bit more space.

But a lot of users today, especially when I talk with the InfraWorks users. they are used to something real good. They're used to something that's a model-based approach. So any computer user, they will open InfraWorks, they do the modeling, then they open up the other ReCap session, and then they open the other thing. Then you end up using your memory a lot, and that's the problem. That was the problem, at least. Now we've fixed it.

But this is a unified data but I have exactly same model, non-unified, also. It works fine. What else? Yeah. This data is good. I really like this data because it's a really challenging. When it comes to surface extraction and things like that, it's a very challenging one for us.

If I go back to my-- we didn't clip out anything, we used that for data--

KEVIN GROVER: We clipped some of the edges out just to--

RAMESH SRIDHARAN: Oh, just to even it out?

KEVIN GROVER: Just to clean up a little bit off--

RAMESH SRIDHARAN: Cool. And if I go to my-- feel free to interrupt anytime.

KEVIN GROVER: Oh, that's fine.

RAMESH SRIDHARAN: I'm just going to show the InfraWorks model. There you go. It's kind of awkward to see this way. What am I looking there? That's a master proposal? OK. So this is the intensity-based view. Bear with me a little bit. OK. That's the intensity-based view. I want to stop right there. And we do this-- When I told you the processing-- There we go.

So this is the tool we used-- well as long as it comes up. So this is a tool we use for the terrain generation part. You can actually select the UI and the options-- It always goes back and forth. Options. What kind of options we need to give? To some, I'm going to give less options. Users saying, I don't have control over it, it's a black box. If I give more options, users say, it's complex. You have a lot of options in there.

So we have to find a even way out. So we came up with a simple [INAUDIBLE] solution there. If you say you want some additional stuff, you can go to custom, you can change lots of stuff. But personally, I want to take it out so the user don't have to worry about the parameters. Software should do what it is supposed to do. And we can overlay the model. You can export what you want. And you choose whether you want to choose all point-- I still kept all points for Kevin, so that he'll be happy. And lightweight and key points.

So I'm not going to run it now. It's going to take some time, this particular data. But this is the UI. If you're thinking of the workflow, you will load the data, bring the terrain and you can keep the default parameters. You can choose what you want. Click the Start Processing, it processes it. I usually put in a different proposal, but that's just me. You don't have to do it. It won't take space on you. So when I do that, I go to my other proposal--

KEVIN GROVER: So just to add to that too. Sorry, I don't have a mic on.

RAMESH SRIDHARAN: Sure, sure.

KEVIN GROVER: That's at the top. You can actually list the point clouds that you wanted to do. So if you actually had your tiled, linear data set, you could actually click as many of them as you want and process like-- if you had 100 tiled data sets you could do all 100 or, just pick and choose which ones you want.

RAMESH Yep. Or you can bring the RCP file.

SRIDHARAN:

KEVIN GROVER: Yeah.

RAMESH SRIDHARAN: It can convert everything. Or else in this case, a unified. They both are the same. But you can do that too. You're right. So this is a processed one. So what I'm going to do first is my color theme.

OK. So this is what I did, actually. This is a keep one. I kept only the keep ones here, nothing more. So there's very few ground points, you see here. And all the cars, all the signs, are classified separately. That was the intention of this particular project, at least. The traffic light, everything, is unique color. And if I switch this off-- I really apologize, it's very hard to maneuver from this side.

If I switch off my point cloud-- Nope, I clicked it twice. OK. So it created the bare earth. It also overlays an image on top of it, because if it doesn't have it, it's very hard for a user to do anything. I mean anything, in the sense, because it's just a white-- [INAUDIBLE] out white. So we added the capability of air. If you have RGB it'll actually put RGB [INAUDIBLE].

In this case, we put intensity image. So you'll get the context information. So rather the claim is everything. And then will be added with the point cloud modeling tool to go over for the vertical features. And that's what it is. So you can actually see our traffic lights and everything. Like I mentioned before, it's exactly where they are. And this data is very challenging from the filtering perspective, because this one it's very-- You can actually see there is an overpass bridge going through here. That's the railroad, right?

KEVIN GROVER: Yeah.

RAMESH SRIDHARAN: That's the railroad going there. Actually if they open the point cloud you might actually see that. Do I click that? There we go. And if I open the theme-- switch it on. You Let it go right there. There you go. So it's an overpass going through there. So if we need to remove the points, but not too much. You don't want the surface points to be removed. So that's exactly what software did. If you can see it. Yeah. I'll move my mouse away. There you go.

So you can actually see that only the overpass cars are removed. The surface remains the same and so on and so forth. You see lots of cars going through-- the software removed everything. It has some linear features too, but that was not a focus in this particular project. And there are some guardrails here and separate. But anyway, you get the idea.

So the software cleans up the point cloud data, uses it and we came up with the 3-D model part of it so that you can create a realistic-- I don't want to call it realistic-- real 3D model from the point cloud data for its purpose.

KEVIN GROVER: Just to add to that. So the benefit of doing the classification of different colors is to now start leveraging other tools for extraction. So the classification is just the way to layer the data set, to start segmenting items. Now they've got point cloud modeling tools, as well, which takes you through a bit of a wizard interface. It's still in a bit of a work in progress, as well. For a detective feature it shows up and actually places an object of what it thinks it is.

So it's the first step with it. And I guess as we start expanding the software it's going to go past just vertical features, and we'll get into theme lines, curb extraction, perhaps even building extraction, other types of features around the models. You're going to actually start generating your entire three-dimensional context from much better data. Rather than just using ModelBuilder and InfraWorks, which just takes free open street map data, random data from all over the world-- and who knows what kind of model you're going to derive. It's not as spatially accurate.

The benefit of this is taken really good-- serving great data and actually deriving three-dimensional models. A lot more lightweight. You can use it in InfraWorks. And also exchange back and forth between Civil 3D, you can take it into Revit, you can bring Revit back into here, and actually start getting all this data working together on a platform like InfraWorks.

RAMESH SRIDHARAN: It is a little awkward.

KEVIN GROVER: So we're pretty much wrapped up here from what we wanted to do. The handout does have a lot more of the workflow in between. They're adding a lot of new functionality, like you said. As part of the Sandbox, which is the data release for InfraWorks. It's like, every month?

RAMESH SRIDHARAN: Every two weeks.

KEVIN GROVER: Every two weeks is actually a new release cycle and it's constantly bombarding new tools and adding new functionality every two weeks. So that's why that I didn't know that even a couple things [INAUDIBLE] this point. We had a few issues with some things along the way, but

they're advancing stuff very quickly.

There's a lot of challenges working point cloud today. And this is where-- again, try to put more of the focus on the software aspect and usability of the data, to make it a little bit more easy for all of our users. In the past it's only been very specific people actually working with point clouds and that's all that they've ever done. You get used to it and you start looking at point clouds and you can interpret them. It's like looking at a weird art or something like that.

It used to be a lot harder. Not Now that we're introducing these other tools that more and more people can actually [INAUDIBLE] to the data directly. So some of the challenges with it, is large data sets, [INAUDIBLE], I already talked about terrestrial and mobile. We didn't even get into having 360 imagery or having-- you can start doing handheld data, UAV data. Starting to merge conventional survey information back into it. It's all just information of different quality. So it is kind of challenging to fit them all together.

Again, I have to reiterate point three. It's not every point cloud data is created equally. We've seen a lot of really bad data collection, and that just in turn, makes a lot of the extraction incredibly awful. It's garbage in, garbage out. Especially on the mobile side we've seen that there's a lot of less expensive systems on the market now. They might be a couple hundred thousand dollars. They're OK for more GIF-type data extraction, where your features are going to be good to within a couple feet, or even a foot. But there's a lot of lack of consistency of the data, a lot more noise. The noise really translates a lot of challenges from the extraction side. It needs a more accurate data set to do better extraction.

So that's how it starts. You're going to start doing curb and gutter extraction because it actually looks like curb and gutter. The software is going to be trained a little bit easier in that way. So just a word of caution, that you do get what you pay for with different types of mobile collection, for sure.

Terrestrial doesn't have the same challenges. Most of the scanners are pretty comparable. It more just comes down to the vendor doing the collection. Or how you do your data processing. Again, challenges create deliverables efficiently. We've struggled with this for years-- everybody kind of has-- It is hard to work with the data. Enhancing software tools to allow you work [INAUDIBLE].

Ramesh mentioned perhaps even leaving the high resolution point cloud instead of just taking the filtered version. This is just one of use bases for a data set for us in point cloud. We'll take

it into InfraWorks, we'll take keep it in ReCap, we'll leave it in Revit, we'll use it in Civil, we use it in other third-party programs. I want to keep that point cloud data in tact along the way. But I want to filter it, and manage it, and have it a little bit easier. Almost like a better layered data set. Because I might want to actually use some of that building feature, and actually start building models in Revit, or something like that. That I actually want to do more with it afterwards. We need some better exchangeability between software.

So I do have to put pressure on Autodesk, [INAUDIBLE] They're starting to build tools, but we need to add more functionality in the software to even make our lives a little bit easier. So full automation is kind of the holy grail. Everybody's looking for that easy button to take this massive data set in, walk away-- not just grab coffee anymore, but, it's pretty much going to sleep, and coming back the next morning, and hoping that it's running overnight. That's getting a lot easier.

But again, software is cheap. Computers are cheap. People add a lot of cost sitting there and doing manual extractions, we need to start leveraging the tools. What you just told me here yesterday-- she was there. We've asked him for assisted manual modes, like I showed, like cross-sectional views. Those [INTERPOSING VOICES] So that's pretty much it from our side. I'll--

RAMESH SRIDHARAN: Let me-- Let me say one more thing. If you guys haven't looked into InfraWorks Sandbox, please do. It's not going to cost you anything. Like I said, we're releasing every two weeks. Not that I'm saying you have to install every two weeks, but imagine a software that caters your needs, listens to you, comes back to you, with the tools so you can try it out and give us the feedback.

I, personally, like the feedback. I'll personally follow up with you. When you sign up for Sandbox send me an email. My email is right there. So I'll personally follow up with you guys to make sure the tools we add addresses your problem. If it don't, then what's the point of adding the tool. So please. Thanks.

KEVIN GROVER: We'll open it up to any questions if anybody has anything at the end here.

AUDIENCE: [INAUDIBLE]

KEVIN GROVER: I know from our experience, most of the aerial collection isn't good enough to do some of the vertical feature extractions. You might be able to get some of it if you've got incredibly dense

data.

AUDIENCE: [INAUDIBLE]

KEVIN GROVER: Yeah, typically aerial is more meant for just general topography. And you won't get a lot of the features, especially curb and gutter. You'll never extract that level of detail from aerial. Once you get down to terrestrial it's just too much data. Or even mobile. Then that's when you start doing more of that feature extraction. Buildings you can do from aerial, that's not an issue. But it's still only [INAUDIBLE] to do. Most sliders, air gliders only get to half meter, horizontal anyway. So you kind of got that fluff in your data anyways, for that type of data. UAV is a whole other ball of wax [INTERPOSING VOICES] Yeah.

You know, honestly I think [INAUDIBLE] all this data can be fed into it. But you've got to make it more manageable to a certain degree. This is just a one use case that we're using it for, in this regards. Again, that's one of the benefits of point cloud data capture to begin with is it can be used for so many different things. It's not just for one purpose. You can use it-- video game industry has been using it for years. Most of the new movies that are out there, the real world scenes are all derived from point cloud data in one way or another. So I think there's going to over a lot of overlap in the 3-D technology.

AUDIENCE: I believe in the next few months we're going to see some amazing technologies evolve. [INAUDIBLE] Open our eyes to how easy is [INAUDIBLE]

RAMESH SRIDHARAN: [INAUDIBLE] is a gaming technology where we can actually bring the terrain, it uses the gravity, and all that stuff. That's actually one of the applications now where I'm working with a couple of customers who use drone-based data to create a terrain. And you import it into the gaming environment. So now they can build stuff based on the real slope and everything. These kind of tools help a lot on that.

So if you see the output you can actually import very [INAUDIBLE]-- too-- I mean, I'm not saying very one, that's a very liberal statement-- but most of the place you can import and get your job done, as well. It helps a lot. I like the gaming aspect of this.

AUDIENCE: [INAUDIBLE]

KEVIN GROVER: No. And again, for certain applications, yes. If we're just looking for general topography that doesn't have a lot of the little feature nuances. Yeah, we can definitely utilize it. But as my background as a line surveyor, I'm overly anal about everything. [INTERPOSING VOICES] And

again, that's just putting pressure on the software too. So it is becoming a lot better. The challenge as well is the next steps out of it is, this is just your first kick at it. The next steps are having other tools to actually start cleaning it up more.

So ideally, the purpose of it, is to, in my opinion, is to get it 90% of the way there. So you're not spending all that other time, and work out front. So that's where you want start taking it at breaklines in, start turning it in more of a design-ready surface. It's not quite there yet.

AUDIENCE: Would you rely on that as a starting point in Civil 3D, start bringing those features, or [INAUDIBLE]

KEVIN GROVER: You definitely would have to do both overlaid, and that's where, honestly-- I think working for more the filtered point cloud data set is probably where you'd almost would want to start. That surface derivative can't really be edited. There's no tools within InfraWorks or anything to edit that surface.

But again, it's just derived from the lightweight point cloud. So if you took it back into Civil or InfraWorks and they start adding breakline functionality, to start cleaning up, to make more hard edges. That's where we'd rely on it more. There's a lot of smoke and mirrors in technology right now. That easy button's not quite there yet. But they're getting a lot more functionality added. The feedback from us, as users, needs to be-- we need these other tools to get it to be more design-ready. I won't fully trust an automated surface for design.

AUDIENCE: It's always good to have as another layer on your raw data in Civil 3D to have a quick [INAUDIBLE]

KEVIN GROVER: For sure. And honestly, if you're just starting from some basic conceptual work-- it's great. You've got this expensive data that you don't have to spend a lot of time to do a lot of extraction with. You just let the software do something. Give you a starting surface, and it's better than-- ModelBuilder surface is-- who knows how good some of that data [INTERPOSING VOICES]

AUDIENCE: Just general site development. Not residential, but industrial. It'd be great just to have some kind of a background. [INAUDIBLE]

KEVIN GROVER: And again, if you don't have a lot of hard features, it's fine. That would perfectly be good enough in a lot of cases.

RAMESH SRIDHARAN: So just adding what Kevin was saying. The surface by itself, when we bring into Civil 3D that's not editable. But we can generate a-- I colored a key points right there. So that gives you a-- let me see-- it has-- you can export only ground points from this. So now you can bring-- it's much, much smaller-- so you can bring it to Civil 3D. And you can generate surface with it. That's editable. [INTERPOSING VOICES] Yes. [INTERPOSING VOICES] Only ground points.

That by itself is not the design level surface. You need to enforce the breakline depending upon your project. But that's the way it is right now. Any design software use that kind of a breakline-based, software generation for your design stuff.

I asked this exact same question five years back, when the mobile LiDAR folks were saying-- I was talking with Outback-- I'm getting high resolution data, why can't we design directly from it? You can't because there's some shadows or something. You cannot see the curbs and stuff. The technology is there, but it's not there yet. I strongly believe in future. Lines are important. But lines-- our segment can make an interplay between those. But if there is a technology that uses the high resolution point cloud data, create your surface, which lines are doing it, without extracting the lines-- that is awesome.

And I'm sure it'll happen in future. I don't know when. But it will happen in future.

KEVIN GROVER: Got to work a little harder, Ramesh.

RAMESH SRIDHARAN: Yeah. Baby steps.

KEVIN GROVER: Any other questions at all? Perfect.