

**BOYD JOHNSON:** So my name is Boyd Johnson. I'm an architect at AECOM in Denver, Colorado. And this class is *BIM-BAM! Capture Reality and Get to BIM in a Single Day*. How many of you have been using scanning of some sort or another, whether you do it-- how many people have scanned themselves? Not yourself, yourself, but, you know, a building. So we've got 20%. And then how many people are using scans or receive scans and use it for design? So about 50%.

So this-- we're going to go through, talk about various things. I definitely come from this from a project manager's perspective. Writing proposals and what it means to kind of-- I've done scanning. I've done scanning in the field with terrestrial scanners and handheld scanners. I've also received scans from subs and use that for BIM as well. And so my experience comes from just that workflow of trying to expedite that process of getting the right stuff from the field, and then getting that data, and then getting into BIM, and then really getting on to what we typically are hired to do, which is create a design. That's usually how all this starts.

So, learning objectives. Talk about hardware and software. Not going to spend too much time on that stuff. There's-- I've got some stats in here. There's just a ton of classes have been on ReCap and things like that. And so I'm not going to talk too much about that.

We're going to talk more about pitfalls, and the workflow, and the things that you need to do to prepare to manage the information, make sure you're getting the right information from subs or when you go out there in the field. How do you try to manage your proposal? How do you manage the interactions with the client, field, and things like that. So you're making sure you get what you want, and making sure you're on scope, fee, and schedule.

So, workflows, and then we'll just talk about some of the softwares, ReCap, and you know the registration software any type of general modeling software. And then we'll also talk about automated feature extraction. How many people have used that? Clear edge. Anything. So pretty small.

That's really the crux of this. That's how you get there. That's how you can get there. I'm just waiting for AutoDesk to purchase. That would be great, if they would.

Because I think it's a great tool, and that's where this industry is going. In the very last section of the presentation, we'll talk a little bit about just where this is going. I think eventually it might get to the point where we don't spend a lot of time modeling and existing in conditions. It'll be a

lot of point cloud data.

So as I said, you know, scanning has been around for 15-- 10 years or so. 10, 15 years I think. It's gotten popular in the last three to five. I think I looked at AU since 2013. I think that's when they first started having classes on ReCap. And I think-- I've got some stats here, but that's like three years. And there's been over like 150 classes associated with ReCap in this three years. And so it's taken off quite a bit.

The other thing that I think that is really inspiring for just about anybody in the field is that there's a huge array of hardware choices and software choices. Some of the things that we've seen out there during this year at AU. Some of the smaller scanners, a huge variety of scanners. Handheld scanners that allow just about anybody to gain entry into this technology. About 10 years ago I was a sole proprietor. I never thought I would have been able to use this type of technology to scan buildings. But it's now getting to be possible. Whether you do it yourself or you hire somebody to do it.

Yeah, so the same thing. Just scale technology based on just what you need and what the technology is, and what you need to get through your design. And then last there, I said we'll talk about some trends in the industry. I've got some examples of some stuff, in regards to where this is going. Like I said, I come from this from a project manager's perspective. I generate a lot of proposals, manage these types of projects. And so I have that frame of mind. It's always this balance between quality, cost, and speed, which I equate a little bit more to the proposal stage.

If you're a project manager, or even if you're someone that goes on the field, there's somebody that's concerned about the budget of the project. And they want to make sure that you get in, you get out, and they get what you need so you can get on with the design. Versus I kind of think of scope, fee, schedule, a little bit more on the project management side. So, how do you manage those two prior to going in? Once you've been awarded, or you're going to go in, how do you manage those two and kind of make sure that you're getting what you need?

So, three key factors impacting your ability to get to BIM pretty quickly. Definitely planning and workflow, and that's one of things we're going to talk about. It's a bit nebulous. Not as sexy as showing a bunch of stuff. But I think it's very important.

And then skill set and experience. You just-- pretty much, you've got to do the time. you've just got to learn the software, learn the hardware in the field, and then you can get off and run it. And then technology, hardware and the software. That's just looking at it from a straight perspective of, I've got to write a check for a scanner. I've got to write a check for software.

So, how many people have seen this graph? It's been around for a while. It hasn't changed, actually. I was actually-- so it ends at actually 2004 at the end, right there. It's from the Bureau of Labor Statistics. So for those who haven't seen this graph, this pretty much says how bad we are, as far as the construction industry. Just how poorly performing we are. And we are actually continuing. We are not improving.

This comes from Professor-- I can't remember his-- Tico, Take, Teicholz? I'm not sure how to pronounce his last name. But he was actually part of this original study up to 2004. And basically, it's still because of lack of collaboration. It's kind of interesting, I think. This is probably, I would say, due to the fact that we were siloed. And we were in that mindset of doing this, and then doing-- you know, architects is this, mechanical and structural did this.

Now that we're more collaborative, and we're supposedly more open, that actually is still one of the problems that we still haven't quite figured out how to really efficiently collaborate. And that's one of the things that we'll talk about in regards to laser scanning. So like I said, we're talk a little bit more about the planning side of it, a little bit more of why versus how versus where to click. Any and all projects I think should be scanned and can be scanned. I go back to that thing, I think there's technologies that are available that just about anybody could do it, even to the point of your phone.

I mean, people have used ReMake. So it's photogrammetry. I've got a little video on that. But it's kind of a sister/brother to ReCap. And there are some possibilities there. Unfortunately it's not quite as great as the technology of scanning through lasers or structured light. But there are some areas where it might work. And so again, it's just another area where just about anybody can get in there and use the technology.

And then I think leveraging these technologies to additional services is another thing that we'll talk about. How I think-- right now I think I equate this to the BIM error, where we were very excited when BIM came out. It was great. I could draw something and plan it, and oh, I got a section, I get perspectives, and I get all those things.

I think we're still kind of in that stage with scanning. I think there's a lot of things to come that if

we open our mind, I think there's some additional services that just about anybody can do. So it's not just for pre-design. And potentially being able to use these type of services, scanning services, and migrating scans into BIM, over the life cycle of a building.

So as I said, a lot of the current resources right now are pretty robust. Here's a breakdown of just AU courses related to ReCap. 165 just in general Google searches. 1.5 million sites with that search criteria. And then on the Reality Capture channel on YouTube, there's 279 videos. So there's a lot of opportunities to learn the software.

So, getting to the point of BIM, and there's three main factors. Planning, skill set, and technology. As I kind of said. So I think there is a good opportunity. I go back to the fact that I can see a relationship between laser scanning, and where we are right now, and our perspective on laser scanning, and the way we were with BIM at one point in time.

But this document here on the left is 2002. That's when AutoDesk said, this is BIM. But BIM, I think it came around debatable 70s, 80s. But this is when AutoDesk officially said, this is BIM. And then how many people have seen the document on the right?

So at that point in time, that is those are BIM uses. So only like two people have actually seen that document? OK. So that comes from Penn State. That is in the Penn State's PxP. That is essentially their identified BIM uses. There is 25 there. And that basically says that, these are the things that BIM could actually be used for.

And this, right now, how many people know of BIM ThinkSpace? It's great resource. Right now there, we're looking at probably about 75 uses for BIM. And so I think it speaks to the fact that at one point in time we think we could do just these things. And then it's grown into many, many additional uses. But each one of these have consequences and implications in regards to planning.

So one of the pieces that I think is a very minor distinction, but very key, is the difference between use and deliverable. So a use being, what we are able to deliver, plan to deliver, or requested by others to deliver to them, so that something else can be generated. Versus an actual deliverable, where we're actually turning something over, and actually handing it in. So, the use piece, I think is very important in regards to automated feature extraction, from like ClearEdge and some of the other applications that I think that's what going to see more and more of.

So if you haven't seen ClearEdge, that's just a quick little snippet here. What this is, this was a central utility plant that we worked on briefly. Actually a small little company called Altria, if anybody knows Altria. Philip Morris. They changed their name. Sounds better, I guess. But it was actually-- it's in, I want to say Richmond, I think? I'm not quite sure. It's in Virginia. I went out there, and the facility is pretty amazing. It's very clean, very immaculate.

This was a central utility plant that we went into. And they were looking at BIM. They were looking for asset management. And we went in there and we scanned a central utility plant. This slide right here is basically to indicate that, as you go through their ClearEdge, you'll actually go through there and the software goes in there and it'll find piping and things like that. And depending on how many points are in there, you'll start generating the pipe itself.

But that kind of speaks to the fact of, use versus deliverable. I think right now we think of the mindset of like, well I'm just going to hand over a point cloud and we're going to be good. But this is where we're going to have to start focusing the attention in regards to what we're actually handing over in regards to scanning, and what someone needs out of that point cloud. What quality it is, how many points there are.

And right now, like I said, I don't I don't think in general do we really delineate how we use, versus how we deliver. So those of you that scan buildings, do you just kind of go about what level of detail? Do you kind of put in your contracts in regards to the product that your handing over? Do you specify anything? Or you just say I'm going to hand over a point cloud?

What about those that receive point clouds? Do you ask for anything other than a point cloud?

**AUDIENCE:** Yeah, we get it translated.

**BOYD JOHNSON:** So you get it translated?

**AUDIENCE:** Basically, [INAUDIBLE].

**BOYD JOHNSON:** So, already modeled. OK.

**AUDIENCE:** We do the same thing. We have [INAUDIBLE] Revit modelled, but the question is, what should I [INAUDIBLE]? That's where price [? is involved. ?]

**AUDIENCE:** There's a lot of back and forth between what our [INAUDIBLE] are, and what their [INAUDIBLE] is.

**BOYD JOHNSON:** Are you, from a the designer perspective? From the engineering, architect side of it?

**AUDIENCE:** Yeah. And so what we get back is generally, [INAUDIBLE] usually. You give them a sense [INAUDIBLE] that I think we end up re-doing a lot of it.

**BOYD JOHNSON:** Yeah.

[INTERPOSING VOICES]

**BOYD JOHNSON:** Yeah, so I think that's really where I think, from a project manager's perspective, that that becomes a problem. And definitely as we have more and more assumptions and expectations of the point cloud, whether it's from the engineering side or from the surveyor's side, I think there's a lot of work there that needs to be done.

**AUDIENCE:** Yeah, and it's good to know what all the [INAUDIBLE], and just asking for a point cloud. That can do a lot of different things. So is it going to be processed through ReCap? Are you [INAUDIBLE]? What are you going to get? I mean, obviously you want registered, but what's the [INAUDIBLE]? Unified, [INAUDIBLE], multiple scans of the room. [INAUDIBLE] a lot quicker than [INAUDIBLE]. And it's usually not an issue of cost, you just need to know what you want up front. So [INAUDIBLE] fees, it helps them [INAUDIBLE].

**BOYD JOHNSON:** No, I would agree. I would agree.

**AUDIENCE:** I know with us in the entertainment industry, we'll scan for internal cust-- for people within our company, [INAUDIBLE]. Certainly it's cheaper. Yeah, but what do you want? What happens with this scan? OK, what do you want? Is that [INAUDIBLE]? It's interesting trying to educate people as to the level of detail. And we went out there and scanned half of Disneyland [INAUDIBLE]. And they're like, oh, this is great. [INAUDIBLE] what I would call a high resolution scan. [INAUDIBLE]

**BOYD JOHNSON:** And we've seen, where we've asked surveyors to go out and scan spaces for us, we've received those scans and we've made the assumption, the assumption that we would be getting something-- in certain areas of the building we would be able to generate features. But we're not able to because line of sight and things like that. And so it's just getting beyond that assumption.

**AUDIENCE:** In my case I'm in-- I've asked for the deliverable, but had it pointed out [INAUDIBLE]. [INAUDIBLE], get rid of the scanner, [INAUDIBLE] the points. They know what to do. They

don't [INAUDIBLE]. There is some gap of omission when I'm [INAUDIBLE]. It's a problem. I want to have them all.

**BOYD JOHNSON:** How are you asking them to generate them all?

**AUDIENCE:** I would have [INAUDIBLE].

**BOYD JOHNSON:** Excuse me?

**AUDIENCE:** Because well, [INAUDIBLE] was a surveyor. And the [INAUDIBLE] thing also [INAUDIBLE] also [INAUDIBLE].

**BOYD JOHNSON:** So they just get it validated.

**AUDIENCE:** Exactly.

**BOYD JOHNSON:** And that's, again we'll get there with ClearEdge, is that that's one of the great things about it. It kind of removes that subjectivity. Not only does it speed up the process to get you into BIM, to get you to design, but probably the biggest thing, it removes that subjectivity of eyeing where to model on top of the point cloud.

**AUDIENCE:** Well, I think there's a lot of variables [INAUDIBLE] convert it into [INAUDIBLE] model [INAUDIBLE]. Not everything is built to [INAUDIBLE] And it slows your deliverable [? people ?] down when you ask them to deliver something to you. It's a lot of ambiguity.

**BOYD JOHNSON:** And I think the fact that we-- I think automated feature extraction is a great thing. But what happens when the walls are 88 degrees, not 90 degrees? And do we want that? In my opinion, as an architect, that would drive me nuts. And it would drive everybody else nuts. And everything's just a little bit off, when it appears to be 90 degrees or something like that.

And so we got to find that middle ground. And there's features within applications like ClearEdge that can do that. So I'll go through these pretty fast. So these are just a series of questions to go through when trying to identify what you may want from a point cloud. This actually comes from the BIM ThinkSpace. It's a very methodical way of looking at, I need this, and what are all the steps that might get me to that point?

And so it's a good process to go through in regards to generating a scope of work, depending on what side you're on. Making sure that you get what you need, versus maybe what you might be delivering. So it goes through a scoping phase, assessment phase, analysis phase,

and there's a little bit goes on more to execution. But it's a very methodical way to look at how you may generate a proposal.

So pretty general kind of planning site efforts. This is 101. I'm sure a lot of people have heard this. It's just visit the site. See all the spaces, interior, exterior. What's the activity around the site? Talk to the owner.

And see what hours you need to be there. We had a project, it was a news station-- a CBS News station locally in Denver, and they're 24/7. And there were certain days obviously we couldn't be there. We had to make sure we didn't disrupt anything. So just things like that.

We've got some images here, and some models of McDonald's. We've scanned a lot of McDonalds, and those can be problems. So you're trying to scan the exterior, and people are just going through that drive-through. And you're not able to get those scans. So, you know sometimes you've just got to really try to think about those things and be kind of methodical about them.

Record drawings, those are always great to have. Try to generate a good kind of scan lay out, scan plan. Try to talk to the design team. What are they looking for? From let's say, mechanical engineers, what do they really want? Are there some key spaces? Obviously those little mechanical spaces, those are important. Anything else? Parts of-- areas that are going to be renovated.

Try to think about ways-- and the last point down there, divide and conquer-- think about ways that you can diversify if you've got more than one person on the survey team. Can you use a terrestrial scanner and a hand scanner? A lot of times, problem with the terrestrial scanner is that you've got to kind of stand there. You don't want it to get hit. You don't want it to get stolen. I've had almost a couple of them get run over by contractors. So you've got to be careful with that. But if you can, try to see if you can diversify a little bit on your resources in the field.

Has anybody seen the-- I call them like Rosie the Maid, if people remember the Jetsons-- it's a roaming scanner. Has anybody used them, or seen them? They're pretty slick. They will go through-- I don't think I have an image in here, but there's a couple of services in the US that provide that. And you can capture and get a lot of square footage done in not a lot of time.

It does not right now, ClearEdge does not work with those, because they're looking for the



fixed point scanner. But we're looking to use those on airports a lot. We just go through there and it drops little, essentially theoretical breadcrumbs. And it just keeps scanning. You just keep pushing it around, and it just keeps scanning.

So this is just more the resource in regards to--

**AUDIENCE:** Do you lease or own your scanner?

**BOYD JOHNSON:** Right now, we lease. We have one within our company. We're a really large company. We have one in our company. Trying to get this thing to go. I've got a DotProduct. And then we also have a FARO on the west coast that we can use when we need to. It's an older FARO. I think we're definitely looking to purchase something else in regards to the technology. The older FARO we have doesn't have GPS. It's a 130. It's probably three, four or five years old I think.

This was shot on a 330, FARO 330. I've only used FARO and the DotProduct. This is just one McDonald's. I guess I just wanted-- it's not cleaned up, but I don't know if you can see or not. It's pretty hard to tell, but up here's a lot of reflection.

We actually-- this was in the middle Wyoming. Had to drive eight hours to get there. Tried to get there as fast as possible because the snow is coming. And then the snow came, and the sphere's ended up getting clunks of ice all on them, so they didn't register. When I wanted to use the sphere's to register, because they had ice covered on them.

So just things like that. There's a lot of reflective services, a lot of snow flying around. It became a big problem. Just another of those site awareness things, trying to do what you can to avoid it. It's not fun. And then of course people driving around, get their McDonald's.

**AUDIENCE:** What did you use that scan for?

**BOYD JOHNSON:** This was a renovation. If you've seen them across the country. You can kind of see, this is the 1980s-ish, or 70, 78ish McDonald's with the mansard roof. You've probably seen them. They've now come up with the contemporary design.

And they're rolling those out across the country. We have our company, AECOM, we have an MSA, a Master Service Agreement with McDonald's. And we go through, and we have a set fee to go in and do surveys. Not necessarily-- it doesn't have to be laser scanning. McDonald's is starting to look into that. There are a lot of other large retail stores that are looking for scans

because--

**AUDIENCE:** [INAUDIBLE].

**BOYD JOHNSON:** Excuse me?

**AUDIENCE:** [INAUDIBLE] below the surface to get all of that?

**BOYD JOHNSON:** Well, I scanned the roof.

**AUDIENCE:** [INAUDIBLE].

**BOYD JOHNSON:** Yeah, I scanned the roof. And then obviously from ReCap I can-- it appears to be a bird's eye. I got on the roof. I put the scanner on the roof. So it's just service.

We go in there and we scan everything, and we go through a really fast renovation design, and that's it. And then there's a contractor that does the same thing. They have a Massive Service Agreement with contractors, and they do the same thing. Just crank through a bunch of McDonald's. It's really fun work.

So as I said, there are no shortages scanning technology on the market. There's a lot of different choices. A little scan that we saw yesterday, the little [INAUDIBLE]. 16 meters? 16 meters, \$16,000, three minutes. What was it? Three minutes? Five minutes? Something like that, really fast.

**AUDIENCE:** Three [INAUDIBLE].

**BOYD JOHNSON:** Small. Putting that on a-- you could get up in your interstitial spaces, get above ceiling tiles. I think there's some really good opportunities there with that, definitely, and then with handheld devices. New stuff keeps coming on the market, seems like every week, every month almost. And like I said, multiple price points for those.

Pretty straightforward. You know I look at the technology is that, either there's two pieces you've got to do. You have the technology engages the site, and then the user engages the technology. And you have to make sure that when you're planning out your site, or in your visit, that you've got a good understanding of how those two are going to work. Again, I've almost had to jump in front of a scanner to save it from getting hit by a truck, because you have to deal with those types of things.

And trying to get this scanner up on the roof isn't easy. Sometimes there can be some pretty difficult things. And obviously you can't get up into ceiling tiles and things like that. You have a limitation. So let's go through this real quick, these are all pretty straightforward.

Different types of scanners, handheld, lot of other options there. The DotProduct on the bottom. That's structured light. Has anybody ever-- familiar with DotProduct? It's great, entry level, get your hands on scanning. It runs on a little Nvidia tablet. And you just kind of warm it up, and then you can start scanning. It's got a range of about 10 to 15 feet I think.

The Freestyle at the top has about a range of like 15 feet, I think. Freestyle is definitely more expensive. It's nice if you've got a terrestrial scanner or a FARO focus, it works well with seeing and everything. But there's a lot of workflows. you can find online in regards to DotProduct and ClearEdge. Really nice process that they can go right through the DotProduct scanner. And then Airborne, obviously. You know, drones.

Lot of different variety of applications right now. Obviously ReCaps a big one. People that scan, do you guys register your own? Do you do automatic registration? Have you done any manual registration? Have you bailed on manual registration? You rely on the software to do everything?

**AUDIENCE:** We use a combination.

**BOYD JOHNSON:** Yeah. I originally, when I did this, I jumped headfirst in and it was very painful. I put everything in to Scene. Probably the one building had 360 scans. First time doing it, I just went after it and did it and it was very painful trying to get everything registered in Scene.

Scene's a great application. You just got to spend a little more time doing it. ReCaps great in regards to just getting in there, and say, all right, I got this point on this, and I got this point on this side. Put them together. It's a lot more manual based, but you can move pretty quick on it.

And then there is somewhat of an automated registration with ReCap as many of you probably know. But it's nowhere near as robust as the Cyclone and Scene from FARO.

**AUDIENCE:** [INAUDIBLE].

**BOYD JOHNSON:** Yeah.

**AUDIENCE:** Do you recommend using a product like ReCap and having ownership or authorship over the

scanning procedure? Or trying to introduce into your BIM execution plan, or PxP, and indexed deliverable from the scanning company?

**BOYD JOHNSON:** I would get the index deliverable from the scanning company, primarily because of ClearEdge. You want those scans individually. That answer your question?

**AUDIENCE:** Yeah.

**BOYD JOHNSON:** I mean, I always think of-- get as much information as I can, and just have it. Because definitely, I think there's a limitation at some point in time. Obviously hardware, those of you guys that have been doing this, hardware becomes a big limitation. You don't put this stuff on your servers. You typically don't. You can, but to try to do this work over a network gets pretty cumbersome. So it's just another issue.

Again, the first time I did this, that Altria project was-- it was only 36 scans. They were high res scans of that central utility plant. But the guys that scanned it were on the east coast. And I said, what? Here, just put it in my Dropbox. And then it's like, well let me look at Google. No, that didn't do it. And next thing you know it was like, put it in an envelope, put a stamp on it, and mail it out to me. It was kind of weird, but it was kind of a kick in the face in regards to, well, it's difficult to manage that data.

So even though the data was under a storage amount that we could use, most files-- I don't know if there's any type of server out there that you can upload a file that is really, really large. You guys know back there? I don't think so. I mean, I don't think you can upload a 100 gig file. It just becomes too difficult, and it's just not allowed.

So these three right here. There are some other ones on the market. Edgewise is ClearEdge. That's their application. PointSense is FAROs. And then there's Scan-to-BIM. These are the automated feature extraction applications that will-- oops.

So this was the first time we took it in there. Might be the same video as before, but literally this came in there. There was basically about a zero hour, just bring it in. And then it goes through about a two hour computational process. Going? There you go. So what you're seeing right there is first the generated pieces, the features that were actually extracted. Then you see the point cloud in there. Pretty much everything that you see modeled in there, the orange and the yellow and things like that, was zero hours. Two hours of computational time, zero hours done by someone sitting at a computer.

Once it gets uploaded, you set it up. It goes through a process. In this case that was two hours and you have all those pipes. There's a workflow going from that point on. This is their architectural application, within there. Going?

It does a really good job at generating planar surfaces. And then you-- from those planar surfaces, you generate walls. And probably the great thing about this with all of the applications, the features of the elements are-- they're the pipes, the architectural features, the structural elements, are all native Revit elements. And so it's not DWGs, it's not things like that. The walls actually are Revit elements. So when you go into Revit, you don't have to worry about having to deal with typical issues where if you just brought in a SketchUp model or something like that.

The way it typically works is, you generate planes. You can pick planes. And that becomes those blue planes you just saw there, that becomes a level in Revit. And then this actually is a planar model at first. These are actually planes derived from the points. It calculates, it's got algorithms to generate those planes. And then it'll go in there and say, all right, take those planes and generate walls. It'll find-- whoops.

It'll calculate points on this side, and points on this side, and say hey, this is a-- it'll look for a Revit wall that is 5 inches or six inches or something like that. So it just doesn't fill the void. It actually uses a Revit wall. Windows is another cool feature. Again, it's a planar surface, so obviously there is a-- you can set a differential for that wall. So there are the planes of that glass, or either those points may not exist, or they're really sparse, or they may have got reflected out through the point cloud.

But basically, when it generates the planar surface, it goes in there and it says, hey, there's a window in here. And so it won't put a wall in there. And then there's another feature. I think I've got another video here. When you go actually in to Revit, you then can put in-- basically, you can bring that point cloud back in, but it's only a point cloud on the surface of the model.

And there's basically a heat map. And it basically takes it and says, OK, the wall is here. The Revit wall is here, and the point clouds are out here. There must be a window in here because there's nothing there. There's no points there. And it basically provides you choices to put the points-- or to put the windows in. It's going through that right now.

So for the most part all of this was just done automatically. And I think the question that the

gentleman asked, well I asked him, how do you generate the Revit model? Or how do you ask the surveyor if you're given the Revit model? What are they using to derive it? And this is one of the key things that I constantly look for as an architect, just to make sure that when these guys are delivering the model, what are they using to derive it?

I really don't-- the fact that this technology is out there. There's the heat map that it's finding where those points were. And so it knows where the windows are, and where the door-- those are all windows, or some picture frames and things like that. So from that, it will find those openings. But to use this technology, versus eyeballing where the windows are, where the doors are, where the walls are.

And extrapolate this over a hospital project. Where you just have an enormous amount of information that you need to analyze and look at and generate elements. And this is getting better and better and better. It's been around for maybe four or five years maybe. Kind of mainstream, but it's continuing to improve.

So, ReMake. So when ReMake first came out, I really had high hopes on it. Primarily because the cost of scanners, cost of ClearEdge. ClearEdge might be around \$6,000, \$7,000, if you want a network license. You know, it goes up. You're looking anywhere from maybe \$8,000 to \$12,000 for ClearEdge. And obviously scanners. DotProduct is right around \$5,000, \$6,000, all the way up to well above six figures for other type of scanners.

So, when this kind of technology came out, ReMake was there. I think we had some pretty high hopes on it. I did, because again I thought it was a good opportunity for just about anybody to get into the scanning market and use it. Definitely a sole proprietor. If you haven't used it, if you look on their website obviously it's used a lot for sculptures, and archiving of things.

It doesn't do great for buildings, except for, there are some examples online. And then this was one where we did here a McDonald's that, it does pretty well with very matte, non-reflective surfaces. To the point where you actually probably could use it to generate a pretty good floor plan. But when it orbited around, you can probably see what's going on there with the windows, and it just gets all goofy. It just gets all really crazy.

So reflective services, does not do well with that technology. But definitely kind of flat surfaces, concrete buildings it would probably do pretty well. This is-- has everybody seen this? Building Parser? So this was a research project in San Francisco. And there's quite a bit of this starting

to go on. And I think you can actually upload your point cloud to this.

So what this does-- and this is why I think this is important. And this is why I equate this to BIM, in regards to where we were with BIM and thinking BIM was great till we kind of got in trouble with BIM. And we realized that we really have to talk to each other, and collaborate with each other, and really work out all the steps that we're looking for to get out of the model. Point clouds are going to get to the point where we're going to start to be able to identify elements directly. And that's what this does.

It identifies walls. It identifies floors. It identifies elements within the building. You can then pull those out. It'll calculate square footages.

It'll start doing all these things automatically, that again, coupled with-- you can kind of see all those elements there. You can go online here and see this application. Like I said, I think you can upload your point cloud. You can see all the elements that it'll start to identify.

This goes back to, what are you asking for from the point cloud? What are you expecting to get from the point cloud? Because sooner or later, owners, larger clients, are going to be looking for something like this. They're going to start using this for facility management, asset management type stuff. And they're going to use this to do this instead of hiring somebody to remodel everything.

This is where I go back to, I think at some point in time in the near future, point clouds are going to get better and better. The technology is going to get-- the hardware is going to get smaller. We're going to be able to get into tighter places. And the point clouds are going to start to recognize a pump, a chair, certain, obviously all the duct work and things like that that ClearEdge does. So I think there's a lot of opportunity and there's a lot of area that we need to improve on in regards to quantifying the data that we have, and the data that we're providing.

That's it. Any questions?

**AUDIENCE:** So your automated [INAUDIBLE]. What do you think is [INAUDIBLE]?

**BOYD JOHNSON:** Sorry?

**AUDIENCE:** What do you think is the leading [INAUDIBLE] software for that [INAUDIBLE]?

**BOYD JOHNSON:** ClearEdge. Yeah. I mean, I want to be careful to not be too one sided on it. But it's got-- so it'll

do duct work. It'll do piping. It'll do structural elements, architectural pieces. They also have a more plant oriented application. Again, I'm an architect, so I don't work in that realm. But it'll tie in the specifications. It will tie- in full-- you know, the beams and things like that for structural pieces. So I mean it's--

**AUDIENCE:** [INAUDIBLE]. Another question with that, so your [INAUDIBLE] machines. Do you have people dedicated specifically to do this? Or do you have staff--

**AUDIENCE:** Specialists.

**AUDIENCE:** [INAUDIBLE] , thank you.

**BOYD JOHNSON:** Yeah, thank you. It kind of depends. You know, my quick answer is no, primarily because we're a really large company and we're seeing-- we work on really large buildings sometimes, stadiums, and so we hire. We hire it out. Our office, usually projects are kind of led by architects, that's myself. And so we look for this technologies and we may take it on.

For me, myself personally and our position in our office, I'm at this point of either hiring a team maybe to do this. And for us, we could sell it internally. We have so many different disciplines and market sectors within our company, that we could sell it. I mean, you name it, anybody can use this technology. I mean there's a need for this technology. And I think only going to continue to grow.

**AUDIENCE:** Does your interest [INAUDIBLE] technology is your own personal interest? [INAUDIBLE]

**BOYD JOHNSON:** Is it built--?

**AUDIENCE:** So you know, sometimes when I do stuff, I'll do it on my own time. [INAUDIBLE]

**BOYD JOHNSON:** Well, Yeah. I mean--

**AUDIENCE:** A lot of it's unrealized.

**BOYD JOHNSON:** My first project where I did a lot of time scanning was a lot of my free time. And you know, when I re-registered it multiple times because it didn't work well in Scene, and I kept having problems in Scene, that was my time. Yeah, so I mean-- but, moving forward? I think it's definitely-- and that was part of those series of questions that were in there to really methodically--



And some of those questions were, what's asked for? What is being asked for? And is there staff available to do that? Does the staff really have that? Again, on the BIM ThinkSpace, I can't remember the gentleman's name, but there's actually a really good process in there to kind of establish your BIM skill set. Do you do this? And can you meet the requirements? You know is a good general kind of process to go through for all those 75 different BIM uses.

**AUDIENCE:** I have [? a few ?] questions, but have you used this as part of a construction documenting process, where you're being able to locate all the structural beams and timbers that then get covered up later?

**BOYD JOHNSON:** You mean during construction?

**AUDIENCE:** During construction, and then you've got later. So scans on top of each other. So you can see-

**BOYD JOHNSON:** Yep.

**AUDIENCE:** OK.

**BOYD JOHNSON:** No I have not used it, sorry. I have not used it, but that is true. So you kind of asked, again, what's my application of choice? Well, ClearEdge just came out in the last I think six months, Verity, I think. V-E-R-I-T-Y. And that is their application that does that. To meet that market sector that you just described.

**AUDIENCE:** Construction validation.

**BOYD JOHNSON:** Construction validation, QC work, right before you pour the slab. Where is everything that's in there? Where is all the steel? Where the sleeves? Where everything?

**AUDIENCE:** It's [INAUDIBLE] valuable to be able to get back to [INAUDIBLE].

**BOYD JOHNSON:** Yeah. But again, right now that's why I go back to, go scan it. That doesn't work. Give me a BIM model. You know it just doesn't-- we need to get beyond that. And so scanning, just saying, give me a point cloud, there needs to be protocols in there. But, yeah that's another huge piece. I mean our company, we have Tishman in the New York area, that they are part of AECOM, and I've talked to those guys out there. And they would love to have the ability to go out there and scan various spaces before they get encapsulated. So that they know.

**AUDIENCE:** You could do hospitals.

**BOYD JOHNSON:** As-builts.

And to have them be able to go in and figure out what's in your interstitial spaces. And every bed is occupied, [INAUDIBLE] what's on [? it. ?] So you can't even get into [INAUDIBLE]. [INAUDIBLE] scale with these buildings.

**BOYD JOHNSON:** These guys want it when they're building it. Like a high rise, they want it right before everything gets encapsulated. Go in there, and this is where they'd use something like a handheld, the DotProduct or another device, and just get in there, scan it, and there needs to be work flow to grab that data. Either update the BIM, or capture that and just make sure they got it. Because I think they're getting a lot of pushback.

We don't work on skyscrapers. I don't, personally. But parts parts of our company does, and they get a lot of pushback from owners, clients and owners, saying, how I know those as-builts are really accurate? You know, [? the floor plan, ?] maybe the walls might be in the right location. But all that stuff that's hidden and encapsulated following construction, how do I know that's actually there?

**AUDIENCE:** Do you guys see that as contractor [INAUDIBLE]? Or their QA or is that [INAUDIBLE]?

**BOYD JOHNSON:** Well, I mean, they're responsible for it, typically.

**AUDIENCE:** That's true, yeah.

**AUDIENCE:** The problem with making them responsible for doing it, [INAUDIBLE].

**AUDIENCE:** Yeah, I know, but that's [INAUDIBLE]. Who's driving the cost? If it's the client, they don't want it, then [INAUDIBLE].

**AUDIENCE:** But as architects we go in all the time and [INAUDIBLE], the existing conditions and our work flow [INAUDIBLE] just horrible. It's a joke. To be able to go in-- I mean, we do it still with a tape measure and laser pointer.

[INTERPOSING VOICES]

**AUDIENCE:** --less detail, but I think there's still, to go in and scan it.

**AUDIENCE:** [INAUDIBLE]

**BOYD JOHNSON:** Yeah, during construction.

**AUDIENCE:** That's [? impossible. ?] That's quite possible.

**BOYD JOHNSON:** And I think-- I haven't done this, because I'm not necessarily on the construction side, but that's where I think there needs to be-- there's an area to understand that workflow. And that kind of stitching process, which you're going to have to do, is that let's just say this upper area right here, they're going to enclose this in drywall. I just need to scan it before I do. And then scan it, and update that overall scan model of what's in there. And just so that gets tracked and archived.

**AUDIENCE:** [INAUDIBLE] high-rise there, and it was almost like part of the building inspection [INAUDIBLE]. When they would get the code guy out there. [INAUDIBLE] that floor, and you couldn't move on to the next things until the scanner guy also came through. So part of the [INAUDIBLE] work flow.

**BOYD JOHNSON:** And, I guess. That's probably where-- that's where it's going. And that's the way, in my opinion, that's the way it should be. I mean, the cost savings. I mean, just like I said, scanning a slab that we're-- scanning of the form before the slab gets poured, the cost savings of catching an error. And that's why ClearEdge came out with this Verity application, is they know it's big.

**AUDIENCE:** [INAUDIBLE] so you don't have to go back and re-do it all.

**BOYD JOHNSON:** Yeah.

**AUDIENCE:** Like you want to do [INAUDIBLE] material?

**BOYD JOHNSON:** Yeah. To know where it is.

**AUDIENCE:** [INAUDIBLE]. But when it comes to [INAUDIBLE].

[INTERPOSING VOICES]

**AUDIENCE:** Yeah, exactly. [INAUDIBLE] and slab? [INAUDIBLE].

**BOYD JOHNSON:** Someone-- a guy from Hundt Construction, another company under AECOM. I was talking to him a couple of days ago, and he was saying that 10 years ago, they had that pre-BIM, pre-really using scan, and he said they-- every floor, they just had problems after problems where

they had to go in there and they'd have to x-ray the floor and everything. Look up a shaft, and it's going like this because of what was post tension floors what was in there. So it's just a nightmare.