ANNOUNCER: Ladies and gentlemen, please welcome Roman Mars.

ROMAN MARS: You know, I speak in a lot of places. And I always put in my rider, I have to be preceded by Storm Troopers. And no one ever does it. But Autodesk always delivers.

As the voice of God said, my name is Roman Mars. I'm the producer and creator of a radio show and podcast about architecture and design. It's called 99% Invisible. If you want to subscribe to it, I recommend it. In fact, if I see you on your phones while I'm talking, I'm just going to assume that you're subscribing to my podcast.

So I tell stories about innovation and designers all the time. And we have a bunch of great stories today and, too, tomorrow. So I hope you join us for other innovation forms.

But right now, I want to go back in time-- not to the future of makers of things, but someone from 140 years in the past. This is Almon Brown Strowger. He certainly had innovative facial hair that I enjoy. Almon Brown Strowger was an undertaker of all things.

So Kansas City, Missouri got its first telephone exchange in 1878. So telephone service is good for local businesses. And the funeral business is no exception. But at a certain point, Almon Brown Strowger, Kansas City undertaker, noticed that he wasn't getting as many calls as he expected for his funeral service. And he got really suspicious when a friend of the family died, and he didn't even get called about performing the funeral services.

So the story goes-- and this story is really hard to verify. But I like it, so I'm going to tell it anyway. So the story goes that Almon Brown Strowger discovered that the wife of a rival undertaker in the area was an operator for the local telephone company.

At the time, telephones were connected manually by female operators. They were called Hello Girls. And they would patch lines together on these big punch boards. So, like, if you were using the phone, you'd pick up your receiver, and you'd say, get me the local undertaker-- maybe even Strowger in particular.

But In this case, this unscrupulous operator would only connect those calls to her husband's business, and not to Strowger. And Strowger figured it out.

I need to go back one.

If you are Almon Brown Strowger, Kansas City undertaker, there's a few things you can do with this information. Number one-- and it's number one for a reason, because it makes the most sense-- you can contact the telephone company, and let them know of the dishonest employees that they have, and maybe get her fired.

Number two, you can maybe take the undertaker and the wife to court, and get civil damages.

But there's always option number three. You can invent an automatic telephone switching system that eliminates the need for telephone switchboard operators, and allows people to dial each other directly, thereby completely revolutionizing the telephone system. Almon Brown Strowger, the undertaker, went with option number three.

Now, he didn't know how to build the thing. He was an undertaker, in case I haven't stressed that enough. But he conscripted his nephew to help build a prototype. And it took longer, and cost more, than anyone anticipated-- probably because he didn't have Autodesk software. But he finally got it going. And when they did, it premiered in La Porte, Indiana. La Porte, Indiana became the first place with direct, non-operator dialing.

In a speech at the unveiling of the La Porte telephone exchange, the cantankerous Strowger addressed the issue of the Hello Girls, the operators who would lose their jobs because of his automated switch.

He said, and I quote, "I'm often told that the telephone girls will be angry at me for robbing them of their occupation. In reply, I would say that all things will adjust themselves to the new order-- that water will find its level. The telephone replaced the messenger boy, as this machine now displaces the telephone girl. Improvements will continue to the end of time, strike where they may."

The Bell Telephone Company eventually acquired the technology in 1916, and the Strowger switch, as it was called, became the standard equipment throughout the 20th century.

Almon Brown Strowger was an undertaker, of all things. But first, he was a customer. He was a customer of the telephone company that was not served very well. Either the company didn't know about it, or just didn't care. And what Strowger did was unusual for a customer in 1878.

But I would argue that it's much more likely today to have more Strowgers in the world-- and mainly because there's software and skills available to do these things. But there weren't there in 1878. To quote Almon Brown Strowger, "water will find its level." And how you pay attention

to what your customer needs, and how you keep on top of innovations, will decide if you will be above that water line.

Now, 140 years ago, innovation was all about automation. It was about taking humans out of the equation, in favor of making things more cheap, and making things more efficient. But today, a different type of consumer-- not just people who are going to build things, but also people who just want to-- are involved in the process of the things that they own. They want to know, what's in it for me? They want the human-- they want themselves put back into the process so that they can get stuff that's personalized, services that are personalized, that fit their needs exactly.

So what's in it for me is going to be talked about during this session-- all at different levels, different scales-- from the single person to the level of the city. We have a young CEO focusing on enabling individual creativity, while tapping into our interest in 3D printing, and the need for sustainability. We have an architect turning buildings into generators of data to form unique, connected systems of insights.

We have a leading construction firm who are using technology to collaborate locally to build places made by everyone. And finally, we have two stories from our nation's capital about future proofing an adaptive city, so our infrastructure is based on our future needs, and not on needs of infrastructure 50 years ago. Together, they're going to talk about what's in it for me on the scale of the city.

So please enjoy these presentations. I had so much fun listening to them yesterday and today. I think you're going to enjoy it. And please welcome our first speaker.

ANNOUNCER: Please welcome Dennon Oosterman.

DENNON OOSTERMAN: Hi, everyone. How's it going? I'm Dennon Oosterman. And I'll be talking to you guys about the more consumer-level, the individuals of what's in it for me. I'm going to start off with that, since we're all individuals in this room.

I thought I'd go over a little bit of my background. And I encourage you guys to sort of do the same. Think about what makes you different than all of the other Autodesk users in this room right now.

So my degree, I'm a UBC engineer. I went through engineering physics. Extremely proud to

have gotten that education. It was fantastic for furthering my career.

But that's just sort of scratching the surface, because I'm also a really avid maker. I like to make pretty much all my own stuff. I make my own boats, my own beer. Our first hire at our company actually taught us how to make our own footwear, our own shoes. So I love really getting involved, kind of empowering myself to create what I want, not just going out and buying what's on the shelf.

And I'm also really kind of an outdoorsman, a sustainability enthusiast. I was really lucky to grow up in Canada. Spent a lot of time up north when I was young. And I really love the true outdoors. I don't like when we take from the earth, consume, and throw out. But I do like making stuff. And that involves taking from the earth, consuming, and, ultimately, throwing out.

That led me to, sort of, I guess, start my own company with some friends from UBC. So I guess I'm an entrepreneur now, as well. And that company is ReDeTec.

So what ReDeTec does, is we have a recycling system for 3D printers. You can see one of our prototypes over there. And it takes in waste plastic-- water bottles, shopping bags, old, failed 3D prints-- any plastic you want. And it grinds it up, recycles it down, and lets you reprint with more ink.

We're very small. Very early, as you can tell-- it's still a prototype. But we're happy to be working with Autodesk to try and bring this technology to everyone. And we're really excited by the potential.

But one of the first things that we did when we started this company was ask ourselves, who's going to buy our product? Are people actually going to want it? And so we had to go after our target market.

And for us, this was a little bit weird. Because we were all engineers. We didn't want to eliminate it down. We wanted to sell it to everyone. We didn't know why we had to pick one, specific group of people. But all of our advisers, everyone said, no, no. You need to have a market.

And our target market is this guy. He's John Smith. He's probably age 25 to 35. Likely professional in the engineering, architecture fields. He likes making his own stuff. He has disposable income.

And I thought that was a bit ridiculous. You know, what about everyone else that could benefit from this technology? Why aren't we selling to them? And it led me on that, because everyone is so different-- we think of how we consume things today.

Everyone here probably has a smartphone. And you all probably have different applications on your smartphone. You want to make it yours. Some people might have productivity apps, some people might have social apps. It's the same thing with the cars we drive. We get different features.

And we're seeing a world today where everything is much more consumer driven. So we're not just marketing to John Smith, age 25. We're marketing to John, and Jay, and George, and everyone else, and all of their own individual needs. And that really means that we're not just marketing to one individual, we're marketing to all of them. And we're designing, and producing, and fabricating for everyone.

And that asked the question, well, what does everyone actually want? And we'll start with the consumers, because that's what I'm talking about. And they want stuff just for them. They want to know, what's in it for me? Am I benefiting from some extra sustainability? Is this going to make my life a little bit easier? People are willing to pay more now to get something that exactly solves their problem, instead of just being the off-the-shelf solution.

And one of the best examples, of course, is in automobile technology. When Ford first came out with the Model T, famous quote, "It comes in any color you want, as long as it's black." Today, the Tesla Model S comes in a bevy of colors, features-- pretty much everything you can imagine. So even if we're all driving similar vehicles down the road, they're ours, because we want them to be personalized for us.

Businesses, on the other hand, they want stuff a little different. They just want the very best product, always. They want it repeated. They want it to make sure that that specific application is met. So there's a new kind of type of individuality. It's the application of the products, not just the person.

But for them, cost is still a driving factor. They don't want to spend exorbitant amounts of money to make it theirs. They want the best solution for the cheapest price.

And last but not least, we turn to the creators, to the manufacturers, the designers, ourselves. And obviously, people like us want things to be very cookie-cutter mold. It's mass production.

You want to make the one design churn out the one car and sell it to everyone. And critically, this isn't just for making things. It's also, for all of us, for designing them, as well. We need to design each thing that gets produced. And obviously we want to save ourselves some time and compile that into just the one continual model.

And so this sort of leads to the killer application, which is something that, sort of until today's world, has been pretty well known. And that's, a technology itself isn't great, but there's a specific use of it that's so good, that you end up getting the technology just for that use case.

And so perhaps the most famous example is Microsoft Excel, or Apple VisiCalc. They were the first applications that let you do computational finances right at home. It brought the computer from being, you know, that mainframe, only nerds use it, to every single house in America.

And we're seeing that, later on, we've got Google Maps on your smartphone. Everyone wants to know how to get around when they're out and about. And we see that it's not necessarily the end product that is this killer app. It's a tool that the individual can then use to serve their purpose. They can do their own finances by using the tool. They can find their own route using the mapping software.

In 3D printing now, it's coming out, everyone is searching for that killer application. A lot of people in our field are wondering, what's going to be the big use case that drives 3D printers into every household in North America? And there's tons of applications.

If you guys are here this morning, we saw that one of the really great things we can do today is we can augment ourselves. We can use prosthetics. And there's some great companies like eNABLE, are 3D printing prosthetics for kids in need. You've got 3D-printed medical implants now that you can do incredible things with. And so maybe that's the killer application.

Maybe you're thinking, that's not quite mainstream enough. Not everyone is going to need a 3D-printed prosthetic. And so, what about buildings? We're building bridges now with robots. We're putting up concrete high rises in days for pennies, relative to the thousands we used to spend. Maybe that's going to be the killer application. But maybe that's not sexy enough.

So what about product design? What about jet engines, race cars? We're doing that, too-- we're 3D printing all of these things. And so I argue that the real killer application for 3D printing is that it can do everything. It is the end use case. It is our tool. We can use it to do whatever we want.

And because of that application of 3D printing, and the demands that everyone has in this market, they kind of come together. And now all of a sudden, things get really, really interesting. It really changes how we think of what a product is, or how we buy things.

Consider footwear, for instance. We used to go to a store. We'd get it sized. We'd probably wait in line. If any of you guys did shopping over the weekend, I'm sure you had some fun with that. And then, likely, our shoes are produced somewhere else. We're not really sure. They're in a line, factory assembly, and each individual pair is shipped off.

But today, that might not see how it happens. Instead of getting your foot measured, you might 3D scan it. Instead of waiting in line at the store, you might just go online, use your credit card, and check out from the comfort in your home.

And instead of it being made who knows where, it might get 3D printed right at your home. And this really changes things. Because now, when we all want our own individual things, we can make our own individual things. Mass manufacturing is no longer required, because with 3D printing, we can mass individually manufacture everything.

But this leaves one critical problem. Because if you'll remember, it's not just making things, it's designing them, as well. And so we can now produce for the market of one. But how do we design it? And so there's two major problems-- one for the consumers, one for the big companies. And that's, largely, that we want personalized copies for everyone. Which means that each of us now, instead of designing that one great product that our boss loves, means we have to do it for every single customer our company might have. And that the drive for perfection is greater and greater. That company wants the best solution, not the best one you've come up with.

And there are some solutions to these. We can offload a lot of the work to the end user. They can pick and choose all of their own features, so that you don't have to. And we can use stuff like generative design, that was discussed this morning, and use computer algorithms to really help us get the best products.

But if the end users are doing all of the picking and choosing, and then all the heavy lifting is done by the computers, it kind of creates a third problem. Because then what are we needed for? Why do we have to exist? If the computer can just generate the design that the user asks it for, we're completely cut out of the equation.

Except that, as I will argue, consumers are terrible designers. And that's where we all come in. So, for instance, let's say you wanted to design that shoe. You've already made it far enough that you want it to be a heel. You want to go have a nice night out, something like that. You've got the rough shape. You've got it all locked in.

At this point, you might decide, well, how's it going to look? You might want to consider the appearance of the shoe. So maybe you think about the color, what kind of lacing or buckles you'll have, just how high the heel is, stuff like that. That's only getting you part of the way there.

What about all of the other things that we'd have to consider just to get the appearance of the shoe? And this starts to lead to choice overload for each individual that has to consider this. Then when you factor in all of the other things required to get that to a finished product, it becomes completely overwhelming.

Perhaps more importantly, we're just not good enough to do it. To be able to make all those decisions is, as we all know, takes a lot of time, effort, skill, and, critically, responsibility. What if you just happened to be good at picking all that stuff, you have the time, the effort, you really want your own shoes, you design them all, you wear them out, your girlfriend comes up and says, oh, those shoes are hideous. Where did you get them? Well, you made them. You can't blame the designer anymore. It's on you. And so to ask the consumers, the end users, to do all of this work, with the computer or without-- it's not a great solution.

And so I think what we really want to strive for is balanced design, as I'll call it. And so balanced design is where everyone comes together-- the designers, the end users, and the computers all contribute on how to make a product.

And so one of the best examples I've come across-- and they actually presented last year at AU-- is this really interesting company called Normal. And so Normal makes headphones, earbud headphones-- but a little differently. So they use the designer to design the headphones. They're beautiful. They work great. They're comfortable. They're well manufactured. All of that stuff. And then they use some computer algorithms to tune the acoustics, make sure they sound fantastic. And they do.

And then when you actually go to buy a pair of Normals, you go online, hold up a quarter to your ear, take a picture. And then, again using some generative design, the computer matches the earphone exactly to your ear, 3D prints it in your choice of color. So now we have

a product that's beautiful, functional, performs really well, and is mine. It actually fits my ear, not anyone else's here.

And this is balanced design, to me, in action. We get to have all of the benefits. Everyone's involved. And we get really great products.

And so we at ReDeTec are trying to bring that a little bit further into the future. Because what if you made those heels, or those headphones-- and a year, a month, a few days down the road, even, you decide you want something else. What if your needs, your individuality, grows and changes through time-- as it of course does?

And so what we have is the ability to take old things and remake them. And when you put that in the hands of people that do all this design work-- now, if a child needs a new prosthetic, as they grow, they can remake it larger. They can adapt to the uses they have. All of these end user needs are more and more easily met.

When you empower people to control their designs, but have that support of the design industry algorithms, everyone, et cetera, you really do you create this market of one. And you can accomplish pretty much anything. And once everyone is able to do that, the design world takes off, innovation takes off. And we see this incredible future where everyone gets the perfect product for them as easily and affordably as we think of today.

Thank you all very much. Enjoy the rest of the talks. And thank you.

ANNOUNCER: Please welcome Michael Thydell.

MICHAEL THYDELL: Hello. I started this day with a beautiful morning run. Being jet lagged, and all that, it was easy peasy to get up early. And I ran to that "Welcome to the Fabulous Las Vegas" sign. Of course, I brought my smartphone with me-- listening to streaming upbeat music, having my Runkeeper app giving me cues how well I was performing. Pretty slow, I'll tell you. And it came to me--I realize that, right now, I'm one of those important parts of that constant flow of streaming big data that is the backbone of the smart city.

So our cities and our houses are producing increasing amounts of real-time big data. And so are we, through our devices, and through all the systems that constantly tracks us during our daily life.

If you combine that data with the framework of building information modeling, will do for a

paradigm shift which will change everything about how the industry thinks about design, how we build cities and houses, and, most importantly, how we live there.

The cities of the world are growing fast. And they all share one common challenge-- how to support them. The most important solution is probably that the city's need to be sustainable, self supporting, and flexible cities. They will become not only consumers, but also producers of resources

The future city will have a demand on incredibly much more electricity. Every city will be Las Vegas on steroids, I believe. And this is due to electric cars, electric public transportation, new tech, more people. And we need to produce that electricity locally.

We're used to seeing solar panels on the rooftops. But we are due for game changers. Maybe this is one of these. The transparent solar panel, introduced to the market by MIT quite recently. Maybe this will change our cities outlook in the future to become exactly the same as today, although all the panels will be electrical-producing transparent solar panels.

And the future city needs to produce its own food. And maybe that food will be produced in a system like this one-- the Plantagon. It's a vertical greenhouse with a climate shell that's exactly like any other facade system-- only this one produces vegetables in a slowly descending conveyor belt. So maybe soon you will look out through your office window to the city and see through an endless row of tomatoes and bok choy slowly passing by.

So we are into future cities. They must be very much more complicated than the cities of today. They will produce and enhance resources. They will have a need for an extremely flexible infrastructure. And we need to create complex transactions and distributions, not only for electricity and food, but for everything-- heat, cooling, water, bio gas, much more. So we need to design infrastructures that are open for constant change. And we need to know how these structures operate in real time.

And in order to illustrate exactly what we mean by that, is by changing scale down to a single house. This is the statistics of the electrical use of a colleague of mine at Sweco-- Magnus his household. The grey curves are accumulated statistics, and the whites are real time data collected from gadgets like this one.

This is a typical small part of the smart city. And what's in it for Magnus, then? Well, this data gives him everything he need to argue with this family members to wait for their showers, their

cooking, and watching TV until he's finished charging his electrical car-- around midnight.

Take hundreds of these devices, or thousands, and you get this-- the NKS, the biggest hospital project in Europe right now. It upholds over 100 connected data systems, and millions of sensors like this one-- most of them, of course, more complicated. It's also an interesting, complex [INAUDIBLE] project. So we will follow it during the upcoming years. Maybe we'll talk about it the next Autodesk University.

Let's change scale one more time. This is Utklippan, two desolate islands with a lighthouse in the far north of the Baltic Sea. They get their crucial electrical power from a submerged cable. And that needs to be replaced because it is becoming old. It's too expensive to build a new cable. So local production of electricity is the only option we have.

And in order to be agile, we need to have several systems connected-- solar, wind, wave, and, of course, some power stations run by diesel. And in order to optimize all this, we need smart technology to handle a lot of data.

And that, the knowledge of things, how it operates, it's important to the smart city. But it's also quite similar to how we look on things in the building information modeling. The BIM, the smart technology, gives us understanding. The building information model tells us how things will operate.

And I know that, for all you guys, BIM is so March, 2013. But let me just remind you of how great BIM is in the design process. If we put up our BIM projects correctly, we have all the tools we need for simulation and analysis directly reachable from the BIM models. And we at Sweco are working very hard to integrate those stuff.

This is an example. A competition in China for the Jinan West IT incubator. The program was quite clear. They wanted a really functional building. But it should also become a landmark. And in China, a landmark means skyscrapers.

But we wanted to create something out of the ordinary. We wanted something that integrated with environment, where people could thrive, social sustainability was a very important factor. So we designed courtyards, warm and welcoming courtyards, where people could meet.

In order to do that, we started solar and shadowing, wind and air pressure. The microclimate was crucial to create those warm and welcoming courtyards. And we integrated everything directly inside the model. The scheduling and drawings, the schemes, everything, was

generated directly from the model itself. So any change we did was immediately updated in all of the produced material.

Of course, we won the competition. We called the beautiful design a landscraper.

Here's another similar example. A small municipality outside Stockholm. We are designing a beautiful garden city. But the investors, they needed higher information resolution in order to invest. So we created lots of clever stuff inside Revit. For instance, intelligence monopoly houses that provided us with key values for the investors, like areas of different kinds.

And one of the outputs was an Excel spreadsheet, where we could play with different kind of key values and we came to realize quite soon that the initial estimation of 17,000 inhabitants in the area more likely was to become 25,000 inhabitants-- with the same investment costs, and with the same beautiful garden city approach. And I can tell you, I saw at least one of the investors drool when he realized the power of value-based design.

And finally, we are seeing truly useful and direct integration from the BIM models to powerful visualization. So thank you Autodesk for Project Stingray and Expo. This will provide great value for the entire market. And I also look forward to try out some of these cool gadgets here at the AU. So please invite me to the Occulus Rift booths, and so on.

There is great potential in reusing the BIM data as a framework for presenting real-time data. But the BIM models also have a great value for owners and facility managers, after their house is built, in the FM and in the running business.

If you combine the technologies, the BIM and the real-time smart technology, we will increase the profits for the entire AEC FM industry. And I'm quite surprised that most of the owners and facility managers still haven't taken this to their heart, and completely changed their business and their operation to harvest these enormous values.

In Sweden, however, some have. Vasakronen is the biggest facility manager and owners in Sweden. And they have really taken this to their heart. They are demanding deliverance of BIM models. And they're trying to use that BIM data into the flow of their daily FM process.

They're also very eager to create sustainability, and to become early adopters. Like this one they use smartphone app called Flowscape, which tracks all their employees in the office, combine that into the office, the information of office rooms, and meeting places, et cetera,

and creates information of everything running in the smartphone app or in smart TV screens.

Let me just talk a bit more about BIM models and BIM objects. There is a clear trend today to provide the market with BIM objects, that's not only a graphical representation of the real-life object, but also filled with information and links and important data to create a connection between the virtual world and the actual world. And this is a fantastic integration which connects the model data with the original source of data. And soon these objects, of course, will be smart city ready.

Like this one-- a Swedish elevator company. They have really taken this to the core business. And they have provided the market with Revit objects, filled with links and info. And they're looking to the airplane industry, and see if they can do the same-- connect their objects that are being built and delivered with our own center for operations, and providing real time, real support and maintenance advice to the owners, creating good value for those who purchase their elevators.

So when the BIM models meet the streaming big data of smart houses and devices, we create a digitally-mirrored world that, from beginning to the end, carry and generate great values. I personally believe-- I think it's not a very far-fetched guess that soon, a digital model will be worth as much as its real-life counterpart. If so, if I am right, we need strategies for this. We need to maintain the digital houses.

And this morning, when I was there by the sign, feeling a part of the smart city, I thought to myself, this is exactly how the good, smart city must be. It will empower us, helping us to go by the daily life a little bit easier, and bringing us a little bit more fun. Thank you.

ANNOUNCER: Please welcome John Jacobs.

JOHN JACOBS: It's well publicized that the construction industry has not seen significant improvements in efficiency in decades. But the technology and process that you're going to see today will change that. Let's take a look at how an entire community of people can leverage new and innovative technology, work together in new ways, and create something inspiring.

[VIDEO PLAYBACK]

-Literally a centerpiece for the whole arts community-- a world-class.

-I see it. I see it. This is going to be really cool.

[MUSIC PLAYING]

-Now, if we extend the glass all the way down to here, it's going to really open up the body.

-Bringing that design aspect in with the numbers that we've already worked up for concept two bring you right within budget.

-Are those realistic numbers?

-Absolutely.

-Well, it's pretty clear. Let's do this.

-Great.

-You got it.

-Look, I know this is last minute. I want to put an interior steel shell inside of both auditoriums. That shell is going to isolate the sound. And it'll make it sound a lot better.

-Let's get the contractor's perspective.

-You want to add that much steel mass to both domes? Has anyone worked up a model yet?

-Yeah. I've uploaded one already.

-OK, let me tell you what-- let me work out some numbers here on my end, and get back with you guys in just a few minutes. OK. Sounds good. Bye.

OK, I understand the impact of the steel numbers. I think everything's going to work out just fine. I've uploaded a new estimate. You guys can take a look.

-Is that really the number?

-Absolutely.

-If that's what it is, then I guess tomorrow we're all set.

-OK, great. I will see you tomorrow. Bye.

-We couldn't have done this without everyone. A true group effort. Just to go over some things

we've been covering the last couple of hours-- all this extra steel is not going to put us over budget. And we are going to be able to stay right on schedule.

-I just want to thank all of you for all of your hard work. My main concern remains that this place is inspired and that it performs. I'm excited about this. Let's do this.

-Great.

-That's cool. Are you building that?

-Yeah. I am.

-Is that glass?

-Yeah. You know, it is pretty cool. Hey, want to go to the groundbreaking?

-Yeah! Awesome!

-All right. We'll see if we can get you out of school.

-Cool!

-All right.

[MUSIC PLAYING]

-So the ductwork, the walls-- that's definitely going to give us a schedule problem?

-Absolutely. If we don't get this resolved today, then I can't move into that area.

[CELL PHONE RINGS]

-Hello?

-We're here having a coordination meeting. We're finding a clash with the phase one, level two ductwork.

-If we get this resolved today, I can move into that area and keep this right on track. So if you want to bring it up on your dashboard.

-Yeah, sure. Hold on, just a second. Level two ventilation. I got it.

-OK, now look on level two, on the east side of the building. See where the ductwork's going through the chase? That clash is going to slow us down.

-Yeah, I think we can get that resolved. I'll have a mechanical engineer upload a new model, get it to you right away.

-OK, thanks a lot. And we'll talk at you soon.

-Talk to you soon.

-Bye. Ed, can you make sure if we're done here that you confirm that that's taken care of?

-Yeah, I'll take care of it.

-Thanks.

-Great.

-OK, you want to move on?

-Yeah, let's move on.

-Hey, I need an update for that ductwork clash on second floor. We did? OK, let me look. Yeah, we can make that happen. Thanks. Hey, Colby. They completed that ductwork issue up on second floor. You can get started.

-Really? You got it.

-Great.

[MUSIC PLAYING]

-Wow. This is cool. This is really, really cool. Good job.

-Thank you. [INAUDIBLE]

-Wow.

-I'll tell you what, when you hear that performance--

-Yeah, that first performance.

[INTERPOSING VOICES]

[CHATTER]

[APPLAUSE]

[MUSIC PLAYING]

-Whoa. This place is so cool. You did a good job.

-Thank you.

[MUSIC PLAYING]

[END PLAYBACK]

JOHN JACOBS: Inspiration's a big word. It's cool to see it in a form like that. It comes in many forms, though. I personally am inspired by my faith, by my family, and by my work. In my work at JE Dunn, I get to work with an incredible team of technologists who have created new and innovative technology that have led to a new process. That process lets us work with our owners and our design team members in a way that is incredibly more collaboratively and significantly more efficient than ever before possible.

In fact, it's so seamless and efficient that it can cut months out of our overall project schedules. Now the inspiration in this form is what we call architectural inspiration. This is the actual sketch that we received from internationally acclaimed designer Moshe Safdie on the Kaufmann Center for the Performing Arts. Now, Moshe Safdie worked closely with his team and the team from BNIM Architects to bring this design to life.

The challenge for contractors, however, is how to turn inspiration like that into reality, on time and on budget. You see, somebody has to tell the owner and the design team how much that napkin sketch is going to cost to deliver. And then, in what many owners say is make believe, stand behind that estimate all the way through to completion.

That's a challenge that I faced personally many times. That whole budget-- creating a budget

with almost nothing, with a napkin sketch, or no information. And then having to stand behind that all the way through to completion. You see, I've been in operations for 14 years prior to becoming CIO. So I spent many a night poring over estimates, drawings, details to ensure that JE Dunn delivered on its commitments.

Now, how we deliver on those commitments is using a tool that we created in house. And then we enhanced it with the help of our friends at Autodesk Consulting Services. And yes, that's a shameless plug. Together as a team, we have increased participation in the estimating process, while significantly reducing the estimating durations. We call that tool Lens. Let me introduce you to it.

Lens enables us to deliver a fully detailed, fully comprehensive estimate, based on nothing but a napkin sketch-- or maybe less than that. Maybe just verbal instructions. Because, you see, we believe that early on, designers should focus on design. That they should be listening to the owner's intent and turning that into creative design-- not worried about details-- so that we can provide a price. We should be able to provide a price based on whatever information is available. And that price should be reliable enough that the entire team should be able to count on it.

Now, the results are shockingly accurate. With the level of detail that we can provide, and after years of evaluating those resulting estimates, our variance from final cost from that initial napkin-based sketch estimate, varies less than 5%. Now, what may be even cooler is the visualization power.

So the tools that we've created enable us to take the initial conceptual models-- because today, designers are going straight from sketches to early models to work out their designs. So we can take those conceptual models and tie into the estimate, pull out any quantities or any information that's available. And then, understandably, when those conceptual models don't have the details necessary for all of the pricing, Lens fills in the gaps.

Now, model based estimating-- many of you would say, that's not new. That's not innovative. And we would agree. You see, by the time a model is detailed enough to support a fully detailed estimate, all the key decisions driving costs have been made.

What we think is innovative is the ability to consider conceptually big decisions driving cost-- structure, anything that can affect the cost curve early on, and initially. Big questions, important questions, like what if the structure were steel instead of concrete? What if the

footprint was smaller, and the building was six stories instead of a larger footprint and five stories?

Or what about questions that our end users might ask? What if we could add 100 beds to our hospital? Or what if we could reduce one megawatt of power out of a huge data center? These questions today can be answered on the fly, virtually immediately, in a room together with our design team and our ownership team when it's most important. When those initial costs and budgets are being created.

Now, this leads us to what might be the biggest game changer of the entire process-- a shift from traditional milestone estimating to continuous estimating, with the ability to eliminate months off of just the pre-construction process. You see, traditionally, an architect will finish the design and hand it off to a contractor for pricing confirmation, and then have to put his pen down and stop drawing-- or continue to design, risking huge overruns and costly redesigns when the budget doesn't hit what was expected.

Today, with a process that we've enabled, as the design continues to refine from initial conceptual modeling, all the way through to a buildable model, we can keep up-- whether it's an hourly, daily or weekly update of the model-- because it's linked to the estimate. We can price as fast as you want to go. We recently used this process on a $62 million civic center. One estimator delivered 24 estimates in 19 weeks. He was able to consider all of those options we talked about-- structure, skin, scale of the project-- and in the process, remove $11 million out of that project without impacting the project scope, and while pulling 12 weeks out of the expected pre-construction schedule.

Now, for this to be valuable, all of it must be accessible. So we turned to SharePoint as the foundation of our project collaboration websites. We call them Dunn Dashboards. They are the single source of truth for everything on a project. Every piece of data is found in one location.

Now, yesterday was Cyber Monday. Cyber Monday has fundamentally changed how we find and shop for goods. Thankfully, we don't have to go out on Black Friday and go store to store to store, spending hours shopping. From the comfort of your home, from one interface, you can shop at any store, regardless of where it is geographically.

Well, for JE Dunn, Dunn Dashboards are our Cyber Monday. From a single interface, you can get all of the data necessary for a construction project, regardless of what application you

either need to contribute or consume that from.

Now, with over 38,000 external users hitting nearly 700 Dunn Dashboards, I think it's safe to say that those Dunn Dashboards have become our digital town square. They are our social licence to operate that we think no one else can offer.

Now, the industry has a challenge. Because traditionally, the design model and the buildable model are very separate. So there's a gap, that a bridge needs to be built between those two. So today, with the help of integration BIM 360 within Dunn Dashboard, we're able to take a single model and ask a new cast of players to coordinate. Detailers, subcontractors, builders can take design elements, pull them out, and replace them with fabrication elements-- out of that single instance model. It truly is the source of truth. Making that design model truly a buildable model-- that delivers or creates unparalleled efficiencies for everyone involved in the process.

Now, everything we've talked about is useless. It's useless if we can't get all of that data in the hands of the people that matter the most-- the folks that with their hands, and with the tools out of their tool bag, will turn digital reality into physical reality.

Because our system is cloud-based, it's accessible to everybody in the field-- all of those folks, those craftspeople that make it a reality. Now, JE Dunn is the first contractor to ever incorporate Autodesk's LMV, Large Model Viewing capability into Dunn Dashboard. And that allows us to fix something that our industry has been notoriously poor at. We take a beautifully coordinated, buildable model, and then chop it into 2D PDFs-- or worse, paper drawings-- and ask our folks to build off of that.

What LMV technology offers is the end user a choice-- out of that single interface, that fully-coordinated model-- do want to see it in 2D or 3D? It's your choice.

Now the construction's drawing to a close on a project like you saw in the video. And it's really clear-- dreams are being realized. And when you see pictures like this, you realize this truly is an inspired place. The beauty's undeniable. And when the new process that we were talking about is used, more people than ever before possible have contributed to deliver something like this. And now it can be delivered months faster than ever before thought possible.

But frankly, I don't think that's the coolest part. The coolest part is why we do this. We do it for the end users. We do it for the folks that will sit in the seats that you see there. We do it for the

folks that will perform on that stage. You see, as a dad of four boys, I have had the distinct honor and privilege of watching my kids walk into a place that I participated in creating, and see their eyes light up.

Who knows, someday, I'll get to watch one of them perform on a stage like that. That truly inspires me. Thank you and God bless.

ANNOUNCER: Please welcome Lidia Berger and Scott Pomeroy.

LIDIA BERGER: Good afternoon. It is a really pleasure to be here today. I am going to begin this session with a discussion, why I believe future infrastructure projects need to, not only an innovative thinking, but more and more, they need to be supported by cutting-edge technology.

So about the future-- we obviously cannot predict the future. But based on the latest science, we are now able and capable of understanding how climate change impacts continue to alter our environment. We obviously have experienced, recently, in Paris, a lot of high-level discussions about climate change.

At my company, Dewberry, our engineers use sophisticated geospatial technology to map changes, looking, for example, at future flood plains against population growth. But this question, do we stay, or do we go, remains to be a challenging one, especially in highly populated urban settings.

So ultimately, the right solution for resilient and sustainable cities is typically a multifaceted approach that is supported by long-term planning. But those innovative, cutting-edge technologies truly require innovative and cutting-edge tools-- tools that enable us to measure impacts that go simply beyond the bottom line.

Why? Because infrastructure projects are developed for the benefits of the public, and really should be vetted in a way that projects, not only economic, but also environmental, as well as societal impacts are revealed. If project stakeholders can't clearly understand its benefits, the projects typically goes on hold, or it's delayed, in a best-case scenario.

So we're starting to see how sophisticated way of thinking, revealing all the benefits of the project, helps in the decision- making process. I want to talk a little bit about triple bottom line framework, that is actually illustrated here in front of you in this graphics.

So triple bottom line framework-- It's a universal framework and a concept that incorporates all

three impacts-- economic, societal, as well as environmental. Scott and I, today-- we're going to walk you through two scenarios. They're very innovative scenarios that address what I called before multifaceted sustainable and resilient solutions for increasingly vulnerable cities.

So both of those scenarios are located in Washington, DC. Both are actually adjacent to each other. One that I represent, it's the National Mall Underground. This project is a multipurpose infrastructure project that actually combines parking and flood control measures. This project was developed as a vision by renowned DC developer, Albert Small, the National Mall Coalition, and then joined by architect Arthur Cotton Moore, as well as Dewberry, who I represent here today.

So before I transition to Scott, I would like to briefly showcase how important decision-making process and documenting that decision-making process is in the case of the National Mall project. This image, here, in front of you illustrates who is in charge of the National Mall. It starts with congressional oversights, oversight working for multiple mall management agencies, such as the National Park Services. And then from here, they, in turn, handed over the various planning and review agencies.

So you can imagine how critical this multi-benefit and multi-stakeholder analysis truly is.

SCOTT POMEROY: Now all of those complex relationships that Lidia has described exist for the DowntownDC Business Improvement District that I work for, that's represented here in yellow. This is an organization that was created coming out of federal receivership in 1998 as the city had been bankrupt.

And so the property owners, realizing that they need to do something to provide a higher level of services, they decided upon a self-imposed tax so that they could provide those services for their geographic area, and the buildings that they represented. Now this is covering areas like maintenance, and planning, and development, and marketing-- and with the creation of my position, those of environment and sustainability.

And we work very closely with the district government on their priorities, and assist them in achieving their goals. And that includes the development of the Sustainable DC Plan. This was created by much public input. And the goal is it to become the greenest, healthiest, and most livable city in the US by 2032.

Now, there are a number of cities that have proclaimed that they want to be the most

sustainable in the future. And so it's created a healthy competition amongst our different cities. Well, I'm here to tell you why Washington DC is number one.

We were the first in the country to pass the mandatory disclosure laws for energy and water benchmarking. And we were the first of all our cities to go for 100% clean energy across all of our municipal buildings. In 2015, we became the number one city in LEED certifications, and LEED accredited individuals. We became number one in green roof installations, passing Chicago. And we became number one in Energy Star label properties, knocking LA out of that number one ranking for the first time in the history of the recording of that information.

However, for city to be truly sustainable, it really needs to understand how to be smart. And so what you have there is the need to really understand how to decipher and use all of the existing information sets. Here's an example of just the wide range of different types of information available across buildings. But you need to know how to use big data, open data, and all the relevant future data sets and other inputs that need to be analyzed in real time.

Now, the truly smart city is going to be the one that uses the technology to realize all the possible efficiencies, and is open to creating new and innovative ways to involve all of its stakeholders in this process. For DC, that means creating what is called the District City Model.

Now, this is a decision support tool that utilizes all of these different multiple data sets in order to be able to figure out which public policies-- you know, which incentives, which legislative proposals-- are the ones that are actually going to be effective. We're able to use all of these different data sets, and some real time analytics, to be able to determine which of these will actually work.

So in DC, we are looking at, as one of our number one issues, how do we really address the issue of greenhouse gas emissions and reducing the resource consumption of our built environment? Because in DC, our built environment is responsible for 75% of the greenhouse gas emissions and resource consumption. This is far larger than the 40% percent norm that you see across the country.

And so for us at the Business Improvement District, what we did in really enabling our stakeholders to be able to address these deep, sustainable issues-- we declared ourselves as an ecodistrict in 2011. And this was a model that was developed in Portland. And something that allows us, with this designation, to signify to others that we're open to testing innovative

solutions and ideas on how to address the sustainability problems of the future.

And so we started working with-- this is what drew us to Autodesk. And through this, we've been using InfraWorks 360 to help us to create, and to use it to develop out what is called the Rapid Energy Modeling. And so this allows us to determine things like energy usage intensity, not only at a building level but at a district level. So these, as well as the lighting retrofit potential, across our entire area-- this helps us to inform things like our comprehensive energy plan or the grid modernization efforts that we're undergoing currently.

Now, all of these things are great for influencing and telling our stakeholders and our council members, what are the solutions that we can use moving forward. But the built environment is not the only area that we really need to address. We have some major issues that are residual to the history of the city.

The combined sewer overflow contaminates our rivers every time that we have a major storm fall, so the raw sewage is flowing into our riverways, making them unusable, unfishable. And so we need to come up with solutions that fit today's modern environment.

But what we're forced to do, because of a US Department of Justice order, is to build three major containment tunnels in order to manage the stormwater overflow. This is a cost of billions of dollars that is borne by all the rate payers in every new development project that comes along.

And so instead, we're coming up with some creative solutions. One of them is the first cap and trade program for managing stormwater that exists in the country. We're hoping that it really can set a model and a precedent for the rest of the country. Some of the other methods are what Lidia will talk to us about the National Mall program.

LIDIA BERGER: So back to the National Mall. National Mall is probably one of the most renowned civic spaces in the world. It brings over 200,000 buses, tour buses, to the District of Columbia every year-- and more visitors than Yellowstone, Yosemite, and the Grand Canyon National Park combined.

This, obviously, in turn, creates significant congestion issue, as well as parking issues for the National Mall. But as Scott mentioned, there's also another very persistent problem surrounding the Mall, and that's flooding.

In 2006, massive three-day storm overwhelmed the capacity of the city's storm sewage system, damaging many buildings, including the National Archives. So what is the National Mall Underground, and why it came to life? It is a multipurpose infrastructure incorporating flood protection, as well as parking underground, providing both resiliency and sustainability features for the city.

This particular flyover here was created using InfraWorks 360. For those who are not familiar with the National Mall, it clearly shows you the location of the project. If built, this project would be located completely underground. It will provide ample space for visitors, as well as tour buses.

But then it offers, also, a lot of other features that are important to mention here. During the normal storm events, this particular project offers significant rainwater collection cistern. So what happens here-- this framework collection system will fill in with rain, which is going to significantly reduce our need for potable water usage.

But then, during major flood events-- and I'm talking about floods that are 50 years and above-- what we're going to do, the two lower level of the garage would be actually emptied out, and the storm water would be allowed to come in, filling those two levels of the garage completely with stormwater. That stormwater would stay there for a period of time, and would be slowly drained out of the garage. This combined parking structure and flood protection measure will be able to hold more than 30 million gallons of stormwater during those major flood

So again, going back to cutting edge solutions and cutting edge tools-- certainly this ambitious infrastructure projects offers return on investment that's much greater than the one that we're able to calculate through traditional business-case approach. So this is why our company, Dewberry, developed triple bottom line analysis that is based on sustainable business case analysis tool.

So evaluation, not only of economic impact, but also those of societal and environmental impacts were added for this project, allowing for resiliency and sustainable benefits to be captured and bring as part of our decision-making process.

I will just walk you, very briefly, through several examples of the sustainable business case analysis and some of those outcomes-- including what you see here in the slide, which is s curves. So the difference between the curves, it's the net societal benefits. Or in otherwise, monetized externalities that are added to our business case analysis, such as things like

environmental costs of social water safe-- or, in other words, also, habitat enhancement value.

So the direct financial costs and benefits from this project is actually negative. If you look at the orange curve on your left, that is actually showing a negative net present value. But once we incorporated societal and environmental benefits from this green infrastructure, it creates a positive business case behind this project. So the green s curve, to your right, shows the positive net present value.

We also looked at other outcomes and division of costs and benefits from this project, which is illustrated here. The largest financial benefit is revenue generated from this project. But the largest monetized non-financial benefit-- it actually comes from water quality and habitat enhancement. This gives us the ability to mitigate the negative impact of combine stormwater and sewer problem that Scott mentioned in his presentation before.

So lastly, the same [INAUDIBLE] results are mapped against stakeholder account. The reason we did that-- if you remember, my early slides, we actually were showing how complex decision making processes is on the National Underground-- how many stakeholders are involved in the decision making process. So this revealed that the highest benefit of this project is actually towards external stakeholder, such as the public, as well as the environment.

So this level of sustainability analysis can be actually quite overwhelming. But there is an exciting news-- sustainable business case analysis tools just became much more accessible to all design professionals, and new generations of tools, that's called AutoCASE, provides cloud-based software for evaluating sustainable infrastructure. And with that, I'm going to turn it to Scott.

SCOTT POMEROY: Now, we've heard how technology will enable us to do things such as 3D printing. We'll have the smart buildings of the future that are massively filled with a number of different sensors that tell us all of the different information that we're interested in. And we have the ability to develop new processes using technology.

But the three 3D city of the future is here now. And you'll be able to see it on display at the exhibit hall. That will show us what it looks like now in Washington, DC-- what your big data feeds can tell you about activity that's going on in some of our nation's capital's buildings. What we can see from sensors, from buildings that are completely wired out. What we will see when we do different analysis in looking at, what are the opportunities to work throughout the

buildings in the city.

We're very excited with the partnership that we've had with Autodesk, and the ability to be able to animate and see these various visualizations, and what it means to be able to show this to all of the different stakeholders in Washington, DC that can see exactly what it now means, not just on a piece of paper, but they can visualize it here.

So I'm Scott Pomeroy. This is Lydia Berger, my colleague. And we really look forward to being able to answer any questions you have about Washington, DC, and the city of the future. And thank you so much for being here today and participating in this innovation forum. Thank you so much.

ANNOUNCER: Please welcome back Roman Mars.

ROMAN MARS: Can we have another round of applause for all the speakers who presented today? They're doing really good work. What I hope is, is that in addition to taking in what they're saying, you're thinking to yourself, what am I working on, and what could I be working on, that will put me on the innovation forum stage next year?

So we talked a lot about the changes in consumer demand. And that can be pretty scary. But the good news is, we have the tools to enable the future of making things. And the other good news is, is that there's lots of good business opportunity inside of that.

And so the real question is, are you ready? When water finds its level, in the sub-basement of the National Mall parking lot, will your lips be above the water line? So think about that.

So we have two more innovation forums, they're tomorrow. And I hope you join us. And I hope you have a great AU. Thanks.

[APPLAUSE]

[MUSIC PLAYING]