NARRATOR: Ladies and gentlemen, please welcome Autodesk Fellow, Tom Wujec.

TOM WUJEC: Good afternoon. It's good to see you. Welcome to Autodesk University Innovation Forums. So we all know that today's work is more pressing, more complex, more interconnected than ever. And that's especially true in the world of design and construction. Tighter margins, stiffer competitions, higher risks, the competing needs of multiple stakeholders are forcing the AEC community to rethink how to do work.

And today we're going to hear from five innovators. Each is tackling their industry's challenges by shifting their focus from the design of individual things, to the design of whole systems. And we think you're going to be amazed at the power of this approach.

Now while you're going to see examples that range in scale from residential homes to airports, to entire cities, each innovation emerges by taking an integrated systems approach.

Our first speaker is Bruce Bell. Bruce is a founder and the managing director of Facit. He oversees all aspects of the company and is actively involved in architectural design, parametric design, and digital fabrication. Please join me in welcoming Bruce to the Autodesk stage.

BRUCE BELL: Hi. It's a really great to be here. Today I'm going to talk to you about Facit Homes and the D-PROCESS.

Now Facit Homes. The word facit means to make, or to realize, and that's what we do. We go from concept to virtual model to completed, realized home with the minimum amount of human interference or loss of resolution. We're the first company in the UK to have developed an entirely digital design and manufacturing process for making bespoke homes. And this is what we call D-PROCESS.

Now I thought I'd first start with a little bit of background into the origins of the D-PROCESS. And really what it's all about is products. The core of Facit Homes is product and industrial design. And that's what we love. We love great 21st century products.

And this is me. This is my bike. It's the best product I've ever bought. It fits me perfectly. It's robust. It's precise. It allows me to ride trails that I wouldn't otherwise be able to do. It makes me a better cyclist. And we can ask ourselves, how did this product get so good? And there's a

few different reasons for that.

One of the first reason is that, in this case, Specialized who makes the bike, have total control over the entire design and production process. They do research and development. And they make sure that every component of the bike performs exactly as it's supposed to. And even though there's products on there that are made by other companies, they still ensure that they're getting the maximum performance out of every single part.

The other aspect is that it's been designed and produced from a single computer model. There's a computer model that exists of every single part. And specifically for us as product designers, they've used industrial processes that create objects from the digital parts. So it's gone straight from digital computer model to finished part. Nobody's actually cutting them out of a block with a chisel. The brakes are being made by laser cut stainless steel. The actual frame has been hydroformed into a mold that's been three axis milled from a block of steel as well.

And we asked ourselves, how can we make homes in the same way? How can we make homes like products? And we came up with a concept, an idea.

And this is what we call the Facit Chassis. So most homes have a frame. And that frame is erected and then it's cut into by the electrician for cables. It's cut into for the plumber. There's a lot of reworking by different trades that appear throughout the process. Whereas a chassis, like a chassis of a car, is ready for all of the other building components to be attached to it. So, cladding, electrics cabling. Everything's predetermined. It's been conceived as a whole.

And then the other aspect that we wanted to develop was the idea that all the parts would be digitally fabricated, just like the bike. And a lot of people say to us, this is about prefabrication. And for us, the focus is not on prefabrication, it's on technology.

So we noticed that there's a lot of companies out there making homes that are in factories but we looked at what they were doing and they were quite often building them by hand. And as product designers, that's archaic. It's not progressive if you're just doing the same thing in better conditions.

So our focus is entirely on the technology and specifically, digital manufacturing technology. So we came up with a slightly different approach. And this is what we call our mobile production facilities. It's a 20 foot shipping container, side opening. It houses a three axis

digital router. It's got power conversion, computer console. All the tools that we need for the making of the components.

And the materials are delivered straight from the dock side, then they go straight on to the machine. They're cut out. They're assembled into the three dimensional parts and assembled immediately into the construction of the house. So this is a very lean process.

And actually, we say it's an example of lean production, which was something that Toyota developed for the production of their cars. And the focus of lean production is that you're analyzing the entire design and production process to see if there's anywhere that's not giving your customer value at the end of the process. So anywhere where there's waste, you cut out. And in this case we said, well we could produce these components in a factory but it would add transportation, heating bills, rent, overheads, logistics, loading, unloading, and ultimately if all of this is adding to the cost of the final product, is the customer getting any benefit out of it at the end, if we can produce the same level of quality on site?

And the components that we produce using this process are incredibly intricate. We get the most out of every component that we can. So we've got holes for electrics, ventilation, integrated channels for services, duct work, [? falls ?] for drainage, gaps the gutters. So it's a very complex series of components. And maybe a few hundred components in each house and then each component is made up of 20 parts, or 20 to 30 parts.

So we've got a lot of data to manage. And so we developed a system that we call the D-PROCESS. Now to a lot of industry specialists, they'll be things in there that you will already be familiar with, such as Building Information Modeling, CAD/CAM, data management, information management. But for our customers who are non-specialists, we call it the D-PROCESS.

Essentially, the core of the D-PROCESS is the building information model and we use Revit for doing this. And everybody contributes into this one source. So the architects, the engineers, the product suppliers, our chassis design team. All this information goes into one single source and is extracted from one single source. So G-code for machining, quantity specification, materials.

Everything comes out and then is reassembled into the final completed house. And the components themselves are digitally controlled as well. So they're parametric. You can control the size, the scale, the shape, by changing them numerically. And we've got a process that

allows us to go from architectural model to components through to the flat pattern version of the component. And then the machine code cutting version of the component. And there's a ripple down effect from the architectural design through to the final finished product.

And we, as part of this design process, we do continual testing for, this is a structural load test. And it ensures that the chassis that gets built is an exact replica of the digital Building Information Model. There's no loss of resolution. And this is very unusual given that we're doing things in a fairly traditional manner on site. There's no factory. And it's not a particularly expensive process.

And the process is designed in a way that allows us to do whatever it is we need to achieve. So this particular project, we needed to create two conical shaped tree houses that intersect. And every component in this particular project we'll never use again on another project. But the system allows us to develop these designs. Whereas there are other aspects that we do, which we use on a regular basis. So we have standard floor components, standard wall components, internal frames. And the design of those and the process that we go through to design them is continually evolving.

At the end of every project, we look at the components, we say, how can this be improved? What were the difficulties in producing it, designing it, assembling it? And every time we do a new project, it becomes cheaper, better, stiffer, lighter.

And the D-PROCESS doesn't just cover the chassis elements but also the final finished elements as well, so anything we can digitally fabricate, we will. So cladding, staircases, joinery, kitchens the entire project. And we will take each individual component, prototype it, test it, make it, get a feel for the materials' rigidity before it goes into the final production part.

And as part of this process, we're also, just like the bike at the beginning I gave you in this example, we've got third party products which we need to interface with. So, particularly things like windows, which we're not going to manufacture ourselves because there's too specialist. We need to make sure that the windows in our buildings perform to their maximum potential. And that means analyzing the products themselves, making sure that the interface details we do are an exact match for those products.

And then the final finished homes have and again, an exact replica of the Building Information Model, even though there is actually quite a large amount of hand finishing. So there's plaster

board, which is skimmed. There's external rendering. But because all of these aspects are being applied to a very precise chassis, the end result is identical. And we are, as a company, we're really only just beginning to get to grips with this process and see what it can do.

This is a project that we finished a couple of weeks ago where we've really gone to town. So this is a stair case which is being laser cut, assembled, welded, CNC fabricated inlaid timber. It's really starting to create quite a rich design. And again on the outside of the project, we've got Cor-Ten steel panels which are CNC spot welded, folded and cut. The shading is laser cut. Even the surrounds around the windows are pressed and stamped folded aluminum.

And ultimately, we are creating a better product. We are creating homes that have the precision and qualities we expect and the products that we consume on a daily basis. But what we see is this there's no separation now between architecture, industrial design, fabrication. The boundaries have been removed.

And it's about small scale cross pollination. You don't need to have a large company of thousands of people to have a multidisciplinary design team. We have a team of six in our core design team. And look what we can create. Now imagine there's hundreds of companies out there like Facit Homes. We see this as being a really exciting future. And that's it. Thank you very much for listening.

TOM WUJEC: Wow, wow, wow. Imagine that. A home built in that way. I want one. I want two actually. Bringing a factory to a construction site, that mindset.

Our next speaker looks at systems design through an entirely different lens. Eddy Krygiel is an architect at HNTB based in Kansas City, Missouri. He's LEED accredited and he's the author of several popular books on Revit. You may have read some of his books. In fact, if you look up on amazon.com, you'll find 31 references to his work. So you're already familiar with his project, the Denver International Airport. Let's learn more about it, shall we? Please join me in welcoming Eddy.

EDDY KRYGIEL: Thank you. Good afternoon. We just saw some really exciting things about systems integration with housing. I'm going to take that to a slightly bigger scale and show you some systems integration on the scale of an airport.

And what I want you think about when you think about an airport is not a big building that you fly in and out of, but it's really, in a lot of ways, a very small city. The Denver airport, which you

might have seen this morning that Carl Bass showed a little bit of.

It's the fifth largest, fifth busiest airport in the United States. It has the largest amount of ground than any other airport in the US. And for this particular project where we added a hotel and a rail station, some new baggage handling, we had to move over 1.5 cubic yards of earth. Just to put that into context, right, for how big of a process this is, that's enough earth to fill the Denver Broncos Stadium all the way to the rim, twice.

We're going to be using 2,500 tons of steel and we're going to create a rail to downtown, finally, for all of you in Denver. The 23 miles of rail out from the airport to the Union Station downtown.

So to do this project we actually had to assemble a very large team. Those are all the things, I'm going to talk a little bit about the people. On this project are 260 firms. We have 35 of those firms creating content, so that's all model content we have to assemble, and that's 46 models.

We move that material around on a regular basis, right? So here's kind of our process for what we're having out on the job site. We have, at any one point on this project, we had at the most 226 designers. Almost 1,000 people in the construction industry, that's the trades, the contractors, the guys in the shop. And that is a lot of people managing information, pushing information around, sharing information. And ideally it's all the right information.

So what we did in order to do that, in order to make sure that the right information is being shared at the right time, was we helped the airport develop a process. And this process was part of their implementation plan. And if you, since the airport is a public entity, if you actually want to download that, if you Google BIM and DIA, it'll be the very first link.

We came up with a number of components for this process. One of them was BIM for every discipline. So that is not only the vertical aspects of it, the building, the mechanical systems, the structure. That's also the horizontal stuff. So it's all of the groundwork. It's also all of the pipes and utilities under the ground. We wanted to make sure that we had a location for everything so there was no misinterpretation of where materials or assets go.

We wanted a cloud-based file transfer, right? So I told you a little bit about the number of people that we're sharing information with. And I told you a little bit about the number of files we have. It's a lot. It's about 100 gigs worth of data that we move around on a weekly basis. So imagine that you have the unfortunate job of uploading and downloading all the content.

You would not be very happy person.

We estimated that it would take a day alone to upload that many files and then another day to download that many files. So we instigated a cloud-based file transfer and synchronization service. It's in a combination of Buzzsaw Sync and of Box.net to push and pull that information around, make sure everybody has the right information at the right time and it's all up to date.

We wanted to make sure that we had the right information before we even put a shovel in the ground or a pencil to paper. So we had to figure out what the existing conditions were. When we first stepped into the airport and we began to talk about the program behind this project, they delivered all of their existing documents.

They gave us every digital file that they had. And it came in a box that was about this wide, about this deep, and about that high. And it was a combination of 5 and 1/4 inch and 8 and 1/2 inch floppy disks. None of them were-- some of them were labeled. Some of them weren't. And there were all kinds of information over the last 15 years that the airport been out there on the ground. We decided to push all that stuff aside and we had the project laser scanned.

So what you're looking at here is an animation of all the public space within the airport. We're adding on to the south side, which is there on your right. The interior hall. The level of detail in this scan is such that we can count the leaves on the trees in the airport [? Grant ?] Hall. I can tell you the eye color of some of the people standing in the queue.

And we were able to do scan over the course of three days, without any disruption to airport operations or to any of the passengers themselves. Throughout this whole project, it was very important that we try to keep the airport is operational as possible and have the least amount of impact for the 52 million people who fly in and out of this airport every year.

So we used the existing conditions of the LIDAR scan to create a BIM model. We gave that model to the design team and they began using that for the design process. Throughout design, we also wanted to make sure that we were capturing efficiencies in the construction process as well. So we have some components there we put into place. We're using mobile technologies out on site. And that's the use of iPads.

This took off to such an extent. There's a lot of projects that propose the use of a paperless job site. And we did not. We actually proposed just the use of the iPads out on the job site. The contracting trade crews liked this so much, they've left all the drawing sets in the trailer

themselves. That'll be the only place you find them. And they're using the iPads exclusively out on the job site.

This model will also carry directly into construction, out of construction and into asset management. So the Denver airport, when this project is finished, will not only have a building but they'll all have also have an as-constructed, design model based in Revit, one based in Navisworks that they will then tie to their facility management system.

So what you're looking at here is a little collage. That's a Navisworks model on the right. That's a photo on the left of the job site. So you can see the level of detail that we have and the level of integration that we have between the two systems and how exact they are.

Just a little story about these iPads. So we were watching the guys, you see, there's a lot of Rebar over there. We were watching the guys out there tying this Rebar out on the job site. And he's got his iPad. And instead of having a set of drawings that they would be reading from to measure off of and tie the bar, he has an iPad that's laying on the ground. And as he's moving along with the bar, he's kicking the iPad on the ground so he can move over with it and keep it in this field of view as he ties off bar.

We haven't had a single breakage of an iPad on the job site. The only people who seem to break them are the guys in the office.

So we have a combination of a variety of different components. Right? We have the BIM model. And we have 46 BIM models that aggregate together to create the project. We have the stakeholder access, so everybody has the most current copy of these models at all times, and we don't have to question whether the models are accurate, or they're a week old or a month old.

We have the As-Constructed updates. So this project is currently 50% through construction. But we haven't issued all of the design packages yet. It's a very, very fast schedule. So as the project is being created, the digital shop drawings and digital middle files are being sent back to the design team. And any changes that occur are being integrated into the design model. So that as the design progresses, we always know that we're going to hit components in the right spot.

And we have the on-site viewing with the iPad. So not only are they out there with a set of the drawings, but they're also out there with a set of the model using been BIM Field.

With all of this, what we didn't plan for was that as all of these components came together and all of the teams out there did a great job assembling these components and doing their work, we began to actually see that the sum of the components exceeded their individual pieces. The whole is bigger than all of the parts.

We were able to create a bunch of different additional options for the airport and additional benefits that we hadn't planned for. One of which you saw a little bit of this morning, which was the model by the fire department. They're planning a new fire station out there on the 23 acres that the airport had, 23,000 acres that the airport has. And they wanted to be able to figure out where the underground utilities were. Where they'd be able to hook up the water. Where would be the best place to locate a new station so if there is a fire event out there on the airport, they can get there very fast. They were able to do a number of different scenarios using the design models pushed into InfoWorks and find the ideal location for the new station in the course of the day. They claim that this process would have taken them weeks before.

Other things that we're doing with the airport. As you know, construction is a very disruptive process. So we have, what you're looking at that little black dot in the middle is the actual project right? What you're looking at is a totality of the airport grounds. And everything in white is airport roadway.

We have to reconfigure a lot of road way to get trucks and other equipment out to the job site. It's disruptive to the travelers and it's disruptive to the airport. We're trying to minimize that impact as much as possible. So we were able to actually use InfoWorks and the design model to layer in the photogrammetry and the aerial photography around the airport, so we get a better idea of what the airport grounds look like. And model the roadways so we can do a number of different iterations with the road design so we can have the least amount of impact on the entire project.

Ultimately, all of these parts come together to create a better whole for the airport and a better project for the state of Colorado. Thank you very much.

TOM WUJAC: That's great, thanks.

EDDY KRYGIEL: Thanks.

TOM WUJAC: Systems of systems upon systems within systems. We're going to continue this theme with Pete Kelsey, who is our next speaker. Pete has been working with civil engineering, GIS, and

reality capture technologies for now over 20 years. He's been an Autodesk customer. He's been an Autodesk reseller, an independent consultant. And he founded a technological services company. And he now works for Autodesk. And he's pushing the boundaries of reality capture. I think what you'll find what he has to say is technologically impressive but I think you'll also find it moving. So please welcome Pete to the stage.

PETE KELSEY: Thank you Tom. So a week ago, actually a week ago today, a team from Autodesk returned from the World War II Valor in the Pacific National Monument in Pearl Harbor, Hawaii, where we engaged in a project with the National Park Service to take a very detailed look at the Arizona memorial. That is the structure above the water and the actual ship, the USS Arizona which lies on the bottom in about 40 feet of water.

The objectives we had for this project. First and foremost, number one was preservation. The USS Arizona is of course, a war grave. It actually is a tomb for 1177 sailors and Marines who never got out of the ship.

It was also this was, of course the first comprehensive survey of the site in 30 years. The result of that survey in 1983, you can actually see behind me on the very large screen, which is a beautiful hand drawn rendering of what the dive team saw at that time.

Second of all, in terms of objectives, was risk assessment. So not only is it a tomb, but there's an estimated half a million gallons of heavy fuel oil still in the ship. That if you've been there of course, you can see it leaking out of the ship and moving on the tide.

So the thought of either a large oil spill or the collapse of that ship as a tomb is just unthinkable. So these are the reasons that the Park Service wanted to have a look.

And then of course to use this data for what I'm calling education through communication and education and communication through virtualization. That is, for the folks who can't get to Pearl Harbor, or can't have the amazing experience that I and some of the other Autodesk folks had to actually dive on the Arizona, you could do it virtually through the Park Service website to increase that exposure and education and communicating the history of this amazing place.

The team, very quickly, Park Service, of course, was the owner. HDR, a long time Autodesk major account served as project manager on site. The Autodesk team, we pretty much handled the photogrammetry portion. Sam Hirota and OIC, both out of Honolulu, handled the

surveying, laser scanning, and sonar respectively.

So again, we just got back a week ago but we've got some stuff we'd love to show you. So I'll take it through, take you through if you'd roll the video.

Oh sorry, I'm ahead of myself. The other thing that I really liked about this project in terms of innovation was this is the first ever integration of four different reality capture technologies, including terrestrial laser scanning, multibeam side scan sonar, photogrammetry, believe it or not, underwater laser scanner. A laser that works underwater. Pretty great stuff.

So now we can roll the video and I'll take you through some of the very early results.

So like any project that involves all this measurement data, you have to have ground truth. You have to be able to tie it to the ground with good survey data. So Dennis [? Roe ?] and his crew did that.

This is some really early look at the sonar data and recap, still actively working on this. And then the laser scanning of the memorial itself, which Dennis and his guys caught at sunset. I mean, it's amazing. And we were also exceptionally lucky that we had the memorial for ourselves. Cause, typically there's a lot of high tourist traffic on the site. So already you can see we're dealing with survey data, sonar data, and now the photogrammetry.

So this involved putting divers in the water. Taking a series of photographs around targets that the Park Service called out for us, note the one top left. That's actually a vent on the deck of the Arizona that's overgrown with coral. Bring all that data back into the office, a fair amount of post processing, and then get results like this.

So that is that vent that is overgrown with coral. The yellow targets, we actually surveyed so we could tie this to the ground and add to that cohesive model of all the different data types.

One of the obvious challenges, or maybe not so obvious for the photogrammetry was the water clarity. The visibility in the water is about 8 to 12 feet. So some challenges but we've still got some pretty amazing results of artifacts like this. So a Coke bottle on the deck of Arizona. Or a cooking pot on the deck. Because of course the attack on December 7, 1941 came at about 8:00 AM, so it was breakfast time. Makes you wonder about the back story to what happened here.

But the detail with this mesh is what's so exciting about the recap technology. Because the

precision and the accuracy is just. The product surprises us every day.

And while we while we were doing this of course, we were under the constant watchful eye of those 7,000 visitors per day on the memorial. And engaged in some amazing conversations about, what are you doing here? And what's this technology that your using? And why is it important? And most important to me, some really heartfelt thank yous.

So here you see an open hatch on the deck of the Arizona. What's interesting is every hatch we saw was open. Which I think speaks to the, for one reason the ship sank in nine minutes. This is teak decking. Actual teak wood.

This is the greatest day at the office I've ever had. This is Sean Hurley and I, in a Coast Guard helicopter, flying the site getting aerial still images and video of the memorial to again add to this cohesive model. And you can see the oil there on the tide, rising up from the ship. The result you'll see here in just a minute but boy, if you could see our faces, we were grinning.

And here's a very early look at the results of that model in recap. So we're still working on it but we were really pleased with this. It gives you instant context of what you're looking at. OK. We hope ultimately to take all this data moving here into InfoWorks and have InfoWorks host this. This model by colleague Rick Johnson, amazing, from actual original plan data of the ship, allows us to go inside and navigate up, down, all around, the ship.

So of course you can't be involved in a project like this and not have some really personal experiences, moving experiences, whether it's diving up on the bow where the 14 inch guns are. Or sneaking a peek into a portal, actually looking inside the ship. Pretty amazing day.

So there are a million more stories to tell, the finished models to show, and the visualizations, simulations, and analysis, all coming in the next few months, including what you're seeing here. And we can't wait to bring them to you. So thanks very much.

TOM WUJAC: That's great. Really well done.

That was amazing. Incredible story. And we'll hope to have you next year to tell us what you found even further. So we now shift our focus from the world of physical objects to the world of digital objects. Our next speaker is Stone Librande. Stone has worked in the game industry for the past decade on games such as Diablo III and Spore, which is you've ever tried is awesome. A great game. He's currently the creative director of EA Maxis where he led the design of the newest SimCity. And please give a warm welcome to Stone.

STONE LIBRANDE: Thank you for having me here today. My talk is going to be a little different than the other ones. Instead of talking about the real world, I'm pretty much immersed in just a completely virtual world of video games. Last month, our Maxis studio, we released the Cities of Tomorrow Expansion packs for SimCity. And our goal was to take the basic simulation that we already have and push it about 25 to 50 years into the future. But we wanted all the technology in the game to be based on ideas that exist today.

So before I talk a lot about the new future pack that we have, I want to just do a quick overview of SimCity through the years. It originally came out in 1989. Will Wright created it. And I'm actually curious, raise your hand if you played that original SimCity game. OK, actually quite a few of you have. Great.

And now, just to make those guys if you raise your hand feel old, who wasn't even born when the first game came out? OK. Just a few of you. All right, so we're not that old yet.

All right so it went through several generations. The last one, SimCity 4, came out 10 years ago. So as you can imagine, the technology has improved quite a bit since the last SimCity 4 game came out.

This is what SimCity 1 looked like. And those of you who played it might remember this. A very top down view, very pixelated, but you still could imagine that it was awesome. SimCity 2000, it actually started to look a little more like a city. But it was all two dimensional graphics with a fixed view, isometric view. SimCity 3000 just pushed the graphics a little bit. Not a big change there. And SimCity 4 kind of opened up the boundaries, made a bigger region that you could play in but it was still based on that 2D, isometric technology.

Flash forward 10 years and this is what we're looking at now. So this is the new SimCity game and how it looks live, rendered in real time for the players to interact with. 3D cameras you could move all around, the space you could follow little cars around.

But as great as a screen shot looks, the game doesn't really show off well until, go back one to the video, until you see it in motion. And we'll take a look at that now. And we can see what the game is like. So if you haven't played the base game, I want to show that really quickly. And then we'll show off some of the future stuff as well.

So what you're looking at here is a big region. This is one of our tropical regions. So there's a

bunch of islands and you can choose which island to start your city on. We also have desert regions and mountainous regions and other things to play with. So the player picks some plot of land that they want to build their city. They zoom down in on it. And then usually what you do to start out, you'll just take a road tool. This is a freehand x road tool so you could draw however you want. There are straight tools for roads and overpasses, by just clicking a button you could raise the roads or lower them and make tunnels. Arc tools to make perfect circles. Hook the whole thing up together and make these networks.

Once you've built those up, you could start the zoning process. And here, if you played SimCity in the past, green means residential zoning which we're going to put in a couple of residential areas here. Blue is for commercial zoning. So we'll put some shops next door to the houses so they can access them easily.

Now what you're seeing now in the simulation is every Sim in the game is a little agent. And so you'll actually see the construction truck come into the plot of land that you zoned. They'll start building up the houses. When the houses are ready, the Sims move into them. And like all good Sims, they say hey, where's our jobs?

So I'm zoning here some industrial area for them to move into. And this will have to build up as well over time. And the factories will start to appear. And every little Sim will then start to try to route down the highway system that you build, down those road networks. So if you've got a bad job of planning your roads, you're going to get traffic jams. Now they have their jobs so they're not to stop complaining yet, they still need their power.

I'm turning on a data layer here that lets us look at just the power representation in the game. And I'm putting down a wind power plant right now. Again, it won't work until people come and staff it. So you need jobs to make everything work here. And once I get the wind power going, then you'll actually see it flowing down the road through those yellow lines there as the power starts to spread throughout the grid, people are getting happier still.

But they're still upset there's not enough water. So I'm going to go into this data layer here that shows me the aquifer and how that's set up. And then I can put down a water pump somewhere near the water sources. And just like the electricity was flowing around, now you'll start to see the water flow through the pipes and give everybody the water that they need.

So all these data layers, the player can turn them on and off interactively. It's like an x-ray vision that you have of your city, that you're able to really dig down into. You can see the

population, who's working, who's not. What the school systems are like.

This is a little fire that just broke out in our kind of a low density, low wealth area there with a lot of trailer homes and shotgun shacks. So we're putting down a fire station. And the fire station, like a lot of the objects and civic buildings in the game, they're all modular. So the player can decide how big to make them by adding here an extra garage on, or a little bell tower, flags, things like that. They can create their own buildings, but that'll cost them more money in their budget as the buildings start to get bigger and bigger. And then the fireman arrive. The little Sims come out and they put out the fire and save the day.

If I decided not put down the fire station, that fire could have spread and taken out some more houses.

All right, so that's kind of the starting of it. This was the base game that we released back in March. After the game came out, switch back to the slides here, players started sending us a bunch of things that they've been working on. And it was really amazing the creativity that the community was able to come up with. This is the city based on a spiral. This is a YouTube video that someone made. There's actually thousands of YouTube videos up there. How to videos, walk throughs. People just showing off their cities. And this one was, I think it was like six hours of gameplay compressed down to six minutes so you can watch it really fast in fast motion.

So was a contest we had last spring between some architecture and urban planning students at MIT versus some at NYU. And we got them together in the same region. And we thought this would be great, that they'll build this utopia because there are all these students. And instead they just built gigantic factories and just blew pollution at each other. which was kind of fun.

And I'm really proud of the SimCityEDU. It's a grant that we have from the MacArthur Foundation where they're taking SimCity and they're putting it in the classroom. So that kids can take the whole game, they distill it down to the 20 minute lesson plans, that the children are able to get ideas about, like oh you want to solve pollution, just bulldoze all the factories. Oh wait, now no one has a job anymore. You're a bad mayor, give us jobs back. And the kids can start to see that.

All right, real quick let's go through some of the concepts for the Future City Pack. We looked at real world technologies but then we kind of brought them and imagined them 50, 25 to 50

years or so. So different types of power, utilities, transportation systems. What transportation in the future might look like. And some of these like the maglev already exist.

Manufacturing, things like things like fracking, what's that going to be like when we start to dig deeper and deeper into the earth to get our minerals that we need.

All right, I'll switch over to the Cities of Tomorrow video now. And here's what you're seeing. That same tropical island region but after about 30 or so hours of gameplay. And I've taken that really low density, low wealth trailer homes, and I've built up what appears on the surface to be this utopia. So it's got the maglev trains moving all around. And this was all, remember, this is not a static model. This is dynamic. The player can go in and adjust this whenever they want. They can blow things up, they can add new things down to it.

This particular city is the Green City. This is the Academy, which is a research think tank hub in the middle. And this will give the player access to all the new technologies that I talked about. So here I'm taking a fusion power plant and I'm researching it, which will be available later in the game. And all this technology costs a lot of money. It's got to come from somewhere. The flaw with the Academy and all this research is that it doesn't actually generate any money at all. It just costs you money. So from a player point of view you've got to fund this stuff somehow.

We also added this idea of this thing that we would call control net. Which, if you can see, this kind of blue circle emanating out there. That's this kind of wireless network of the future that binds all these technologies together in a little bit of a 1984 type way, a little undercurrent of the game is who's really controlling this technology?

This is a sewage sanitizer that I mentioned in the previous slide. They actually have these today where they can take sewage water and they can make pure drinking water out of it. But not surprisingly, nobody wants to drink that water. Even though it's pure drinking water. But we imagine in the future, you'll have no choice.

To fund the Academy city, this is what we call Omega City. And this is a mysterious mineral material that we've invented called omega. We never explain it in the game. That's up to the players to decide.

And so you start to build this omega. And you're more of an evil, kind of corporate takeover giant. And you're giving them this omega, which is very flammable and destructive and has all

sorts of bad qualities to it. Yet all the Sims in the game want more. If you stop producing it, they actually will complain and say, hey, where's our omega? Give us more.

Here you could see it starting to spread, the omega chain as it goes from factories down to stores and into houses. You could also build drones. These drones here at the time, we're like hey, we're 25 years in the future. They'll be drones delivering packages. And now I find out we're only two years away next to the Amazon announcement that just came out.

So here's a law drone looking around for criminals and trying to stop crime from the air.

Omega, like I said, it's very hazardous. The brown you're seeing is the pollution data layer showing the ground pollution. But I'm going to use some of the Academy technology. But this is a ground scrubber to take that pollution and then push it up into the air and turn it into air pollution, which doesn't really solve the problem but it makes you feel good about it for a while.

We also give you air scrubbers which bring it back down to ground pollution. So we take care of everything.

This is where the people work. This is another little city nearby. And these are what we call mega towers. And the idea here would be that we can keep building structures taller and taller as we go. So these are built up level by level by the player. They can choose what they want in each level. At the bottom of this one, there's some apartments and then some shops and malls for them. And some offices that they could work in.

Now I'm going to add in a sky bridge station. And this will let me connect my mega tower up to other mega towers. And the fortunate elite that happen to live up in these things never need to go down to the ground with the common people. They can just travel from building to building in peace and safety.

The last little part here is a crown that I'm putting on. There are several crowns to choose from. In the city, we use the solar power crown on the top.

Finally, this last little bit. The fusion power plant is now ready to go. We've researched it. So I'm going to mow down these house to build our new technology. And this will give us green, clean power forever. There's a little trick to it though gameplay wise, which is that you can't just start a fusion reaction out of the air. You need power to bootstrap it.

So in this case, we had to build a giant coal power plant just to get enough power to start the

ignition. This is actually based on real world technology at the National Ignition Facility, where they are right on the verge of actually making sustainable fusion reactions.

So this is the final city, all built up. And different ways you could play the game. It's completely open ended for players to mix and match combinations. So you can make these like terrible Blade Runner greedy cities or you can make the beautiful utopias. And then I'll end it there.

I just wanted a quick thank you to the team at Maxis. So even though I'm up here presenting this game, it's not my work. It's the work of 100 people programmers, artists, network engineers, and a lot of QA.

So thank you all for watching. Have a good conference.

TOM WUJAC: That was amazing. Thank you.

Kids using consumer products, now learning systems thinking at the age of nine, 10? Amazing.

So our final presentation brings together two speakers, a technologist and a city planner to, well frankly to make SimCity real. So let me introduce you to Tristan Randall. Tristan has a passion for technology and innovation in the construction industry. He's an infrastructure engineer, and he develops construction strategy at Autodesk. So please, Tristan.

TRISTAN RANDALL: Thanks Tom. Great, thank you Tom, You know, San Francisco is the city with a culture of innovation and really a history of entrepreneurship. And it's a city that has led the charge in pioneering and adapting, or adopting, excuse me, disruptive technologies to really change the way we work.

For example, San Francisco Bay Area has by far the most patents per capita, creating an astounding 15% of all the nation's patents. And this technology leadership really translates into huge economic value. With this area actually capturing 40% of all the nation's venture capital investment. And this rich legacy is apparent in the realm of infrastructure as well. If you look at the Great Depression and the height of it in the '30's, San Francisco build both spans of the Bay Bridge and the Golden Gate Bridge, about 10 miles of elevated highway and rail, in just four years, for the first time connecting San Francisco with the surrounding region.

And while technology has certainly improved the way we run capital projects since that time, the process of public outreach and community engagement has essentially remained stagnant

and unchanged for centuries, primarily leveraging the form of the public meeting to insight participation from the public. Now the good news though, as we'll see today, is that technology is beginning to bring change to this area as well.

And San Francisco is investing heavily in infrastructure across the city, whether it's building the largest self-anchored suspension bridge in the world and bringing world class seismic performance upgrades to all the Bay Area bridges. Or whether it's restoring a National Forest and city treasure, the Presidio. And putting commuters and tourists on a seismically safe path to an iconic bridge in an area that's environmentally sensitive and sees hundreds of thousands of tourists every year. Or whether it's building the nation's fastest high speed rail line, with an integrated downtown transit hub that will include the largest high rise in all the west coast.

Or, whether it's celebrating our existing infrastructure with the largest light sculpture in the world, consisting of 25,000 LEDs showing beautiful patterns each night that never repeat. Or finally whether it's rebuilding the primary downtown core of the city and establishing a civic innovation zone that promotes a new idea of street life.

Now this type of growth requires a new way of planning, designing, building, and managing our infrastructure at a city level. And technologies is beginning to play a crucial role in making that happen.

And we're starting to see a net effect, net affective technology. Nearly all industries, from ubiquitous access to the internet with a very powerful mobile devices to internet computing and advancements in robotics and sensing technologies. Now in the world of infrastructure, this translates into new capabilities that really have never been possible before in our lifetimes, such as the ability to capture with laser and photo based technologies entire cities in 3D. And then to leverage those 3D assets in intelligent city models.

Today we can visualize, simulate and analyze much more often. And with lower costs throughout the project life cycle and even into operations, allowing us to evaluate exponentially more design alternatives. And in turn, we can bring these designs to the public with advanced virtual reality and augmented reality capabilities that really bring life to the city and also to the proposed designs for improving it.

And this approach has really what has guided Autodesk's partnership with the city of San Francisco. And this began specifically with the planning department but really has expanded to be a rich collaboration with multiple city departments around the future of this great city. And

as you'll see, new ways of planning and designing and in turn, communicating those plans and designs to their key benefactors, of course, the public.

This has transformed the way that the city is approaching the role of the public in this process and in fact the relationship between the public and the private sector. Now today you'll hear the public sector perspective on this transformation in an overview of five key benefits of city scale technologies. And you're likely going to hear a perspective that sounds remarkably different than the stereotype of city government. And hopefully you'll see opportunities for you and your colleagues to imagine what's possible with disruptive technological change.

Now in the seminal work that I'm sure many of you are familiar with, *Innovators Dilemma*, Clayton Christensen talks about how when confronting disruptive innovations, the market applications for these technologies are not only unknown, but actually unknowable. And in confronting this, our plans for in considering this, our plans for confronting this change really should not be about plans for execution but for learning and for discovery.

So with this idea in mind, please welcome the manager of the City Design Group of the San Francisco Planning Department and the lead urban designer for the Better Market Street Project, my partner in learning and discovery, Neil Hrushowy.

NEIL HRUSHOWY: Thank you Tristan. There's a profound shift happening in San Francisco today. We continue to build our major infrastructure projects like the Bay Bridge, the Presidio Parkway, and the TransBay Terminal using traditional planning methods and tools. And yet we're witnessing a cultural shift to a more grassroots urbanization, where individuals and organizations are getting involved shaping our vision, our policy, and our public spaces in ways we've never seen before.

At the same time, technology and innovation are fundamentally changing both our economy and how we work. The combination of a cultural shift and the rise of the technology sector has led to some exciting new mindsets. But the government has the responsibility to change as well, while still assuring continuity and a place for every one at the table.

The City Design Group is responsible for urban design in San Francisco. That is, the space between buildings and the life that it invites, as well as the look and feel of the buildings themselves. We create public realm plans for entire neighborhoods. We do street and plaza designs. And beginning about five years ago, we started doing hyper local design that focuses

on the small spaces where we can test ideas, prototype, fail, learn and then try again.

This is the shift I'd like to focus on today. The physical changes began with very modest experiments. The Rebar group started parking day in San Francisco about six years ago. They gave individuals permission to take over a parking space and create an alternative reality for a few hours. We were inspired and we created the parklet program. Parklets allow people to build semi-permanent public spaces with seating, bike parking and landscaping, all the parking lane.

At the same time, we initiated our temporary plaza program called Pavement to Parks to make pop-up plazas. These types of temporary spaces have grown so much that there's even a new name for them, flexible urbanism. Because they are temporary, materials are cheaper. And this allows us to try more ideas and to learn from our mistakes.

What we didn't anticipate when the shift first began, was how powerful temporary designs would be connecting people so the design decisions and how effective they would be to fundamentally change the dialogue about public space and urban design. There's a movement in San Francisco to find new ways to shift planning and design decisions closer to the everyday resident. And this desire is rooted in the desire to democratize the building and the programing in the public realm.

Technology and innovation have been playing a critical role in helping this happen. And it is on Market Street that the city is focusing so much of our efforts. Our mayor, Edwin Lee, has declared the entire street an innovation zone and invited partners from the private sector to work with us to create new solutions to long established challenges. We're experimenting with a few new tools to help us along the way, to reach out to more people in the community. And I'd like to reveal one today.

The owl is a virtual reality device powered by Autodesk technology. It's based upon the traditional form factor you see of the coin operated binoculars found at vista points but it houses a screen and interface. If you haven't had a chance to check this out, it will be in the exposition room and it's a brilliant device. Really take some time.

But for the Better Markert Street project, a $400 million redesign of San Francisco's most important pedestrian and transit corridor we just finished a five day test of the owl in the Tenderloin neighborhood, one of the most economically disadvantaged neighborhoods in the entire city, to show residents and passers by, the two proposed designs for Market Street in

three dimensions.

Next we have a new program where planning is partnered with the Office of Civic Innovation in the Mayor's Office to create the Living Innovations Zone or LIZ. A LIZ is a public canvas the city provides to a private sector partner to experiment with new ways to activate using innovation and technology.

Its genesis was the realization that San Francisco, while the innovation capital the world, really had no evidence of that status in the public realm. We knew that had to change but we weren't sure what LIZ should actually look like. This ambiguity became one of its most critical traits. That is, LIZ presumes that government no longer has all the solutions that the private sector with this much more rapid pace of innovation should be given as an unrestricted a chance as possible to reimagine the public realm. So we did. And Exploratorium designed the first LIZ with a pair of whispering dishes, a singing bench, a bicycle powered charging station on public benches.

And it became an overnight success and gave strangers ways to meet, interactive and share a moment in an otherwise anonymous space on Market Street. And as important as the actual design was, the bigger story is that we proved that public private partnerships can produce new, better solutions for public realm activation then government acting alone.

Now these prototypes are different sides of the same coin. They both provide people with new ways to see existing spaces. The Owl quite literally is a virtual reality. An immersive and far more intuitive way to see our space then the traditional plan use sections or even renderings can provide.

The LIZ invites you see and to experience Market Street as a space for exploration, surprise, social interaction, and delight. And it's amazing to see how eager people are to jump into that alternative reality of Market Street, that a modest imitation can go a long way.

Now using technology and innovation to connect the public to the generation of new design solutions represents an emerging thread in urban life and not just in an American cities. It is an empowerment movement. And it's a movement that depends on crowd source solutions for inspiration and enabled by technology.

Now the city is responsible for finding new technologies to provide greater efficiencies in our interagency projects. Through a partnership with Autodesk, we are bringing the work

programs from several different departments together to greater alignment using InfoWorks. In our current framework, may be hard to believe, team members spend too much time working in parallel tracks, duplicating efforts because our design, our analysis and visualization platforms are distinct from one another.

For example, planning develops the concept plant, public works updates the CAD file, and then the traffic engineers take it, analyze it, return [INAUDIBLE] a language.

All this is happening in completely separate silos that lose precious time during some extensive back and forth dialogue. Then the project has to halt for two to four weeks while graphics for an upcoming public workshop are produced, debated, and then reproduced.

Finally, we host the public workshop and we reenter the interdepartmental dance. But on Better Market Street, our partnership with Autodesk allows us to test a new way to design. By integrating the 2D, 3D, GIS analysis and visualization to one single environment, we can move seamlessly between tasks in real time. That means as designers, we can sit at the same table as the other departments and solve problems with the visualization rich tool.

Not over two or three months but in a few weeks. More time to discuss design, much less time lost in translation. And of course, the public is a major beneficiary when we realign workflows. It means less time between workshops, and improvement engagement outside of workshops, leading to a more responsive public engagement process.

No more downtime for workshop production because we already have the updated 3D model to generate visualizations. We hope the platform will be agile enough to use during workshops to illustrate in a the dynamics trade offs between alternative designs.

The public can even ask to see new permutations there on the spot. And [INAUDIBLE] them to better understand, to contribute to, and to ultimately take ownership of the final design.

That's democratizing design through enhanced visualization and analysis. Tools mirrors trends we are experiencing in San Francisco.

The tech industry has fundamentally changed how a generation approaches problem solving. And as a result, we in city government now hold hack-a-thons as a way to bring new groups to the table.

We use rapid prototyping to test ideas. And We look to crowd sourced solutions when we can't

figure it out on our own. All this is brought the public much closer to the decision making process. As a city family we're trying very hard to work in a more collaborative way. Integrating design, analysis, and visualization into a single platform will help us accelerate our inter-department collaboration, faster, transparent, and real time testing of alternative designs will smooth communication and make self evident the risks and benefits associated with each choice. And this frees resources for more design.

We're confronted with a changing environment. Governments are getting smaller. And our ability to be the lone actor is shrinking as a result. Our urban culture is evolving as well. Fail early and fail often is a creed that would have been anathema to government only a few years ago. But technology is empowering this generation to create and share ideas far more rapidly than traditional methods ever could. Together, changes in government, technology, and culture are disrupting how we design and plan our cities.

We as government have a choice, whether to shift in that direction. Changing will require new attitude to service delivery. We'll need to learn how to say yes much more often and to empower individuals and organizations through smart public private partnerships to help shape future solutions.

Equally daunting for large bureaucracies is the challenge of adopting new, more efficient technologies to collaborate. The city's partnership with Autodesk on Better Market Street is one effort to bring in those new efficiencies.

Now, we learned early on in the living innovations zone process, that we didn't know where this more open approach was leading. But we didn't care because we knew it was on a path to something great. Increasingly, we're finding ways to embrace this kind of collective intelligence to problem solving. We can shift too. It's an exciting new way to work and I hope all of you will have a chance to experience it in your cities, hometowns, and neighborhoods.

Thank you very much.

TOM WUJAC: Great, really well done.

Wow. So there you have it. Innovation Forum 1. Cities, video games, underwater reality capture, massive BIM integration, digitally fabricated homes. So each approach is one example of how to tackle some of the tough but really interesting challenges in our industry. And we hope that we've inspired you to look outside in your quest to imagine design and truly

create a better world. Thank you. And we hope you enjoy the rest of your AU.