ANDREW MANZE: OK I think we'll just make a start then. So welcome to this InfraWorks session on concrete bridge design. And my name is Andrew Manze. I'm the InfraWorks 360 business development manager. I'm located in the UK, as you can probably tell from my accent. We will have, at some point, Ara Ashikian with us. He's the senior product line manager. So he's responsible for development of all things bridge, basically. And he'll be contributing later on. So what we're going to cover, we're going to cover InfraWorks 360 as a bridge design and modeling tool. It is a live session. OK I'm going to be spending most of my time inside of InfraWorks. But we're going to also see how we can use an Autodesk Structural Bridge Design, Civil D, and Revit as well, towards the end of the presentation.

So I've got I've got a few slides just to explain our current thinking. It's just any one or two of them, and then we'll drop into the software, and run that along. We'll build a bridge of some sort and run it through those other three products, and then hopefully by the time we get to the end of that, Ara will be here and he'll be able to give us a technology update. It's quite a treat to have him here to do that, cross fingers he'll turn up. We've got some quite interesting developments, which we're just on the cusp of developing and will be really interesting, if you're a bridge designer.

OK so just a word on workflows, really. At the moment bridge design workflows are pretty linear. And you usually start with some sort of alignment. You're either going to create it yourself, or it'll be handed down from a DOT or a local authority. You'll go through some process of creating drawings, layouts. You'll go through some iterations, different schemes, different options. There'll be analysis and design processes thrown into that, and so on and so forth. And eventually you'll end you'll end up at site. There'll be a lot of 2D work probably using this sort of workflow. And it's just definitely it's not a BIM process at the moment. And generally speaking what happens is that if you get halfway down this process or even further, if something changes, and it always happens, but you always almost have to go right back to the beginning to follow that through the rest of the workflow. So we think that's a little bit unsatisfactory. So what we're trying to do is work with a reimagined workflow, something like this, where we can use InfraWorks 360, use its really powerful parametric modeling tools to model many different options very quickly in InfraWorks, use the built-in and also external analytical tools to validate girder arrangements, and things like that. And then look to Revit and Civil 3D for the documentation and eventually we get to site.

So some of you probably think, hang on that's exactly what you showed me on the previous slide, but just with different colors. But obviously you have to start at the start at the beginning with nothing and you end up on site. But it's what happens in between, which is the interesting part. So what we are what we're trying to work towards is a system whereby you go through these you go through these processes and at any point, if something happens we need to be able to accommodate those changes far easier. So say you get all the way to reinforcement detailing in Revit, for instance, and something happens. It might be to do with the reinforcement, it might be an external factor, but something something needs to change. Maybe even you need to move a pier or something like that, would normally mean that your design is shot, or you have to reanalyze everything. But what we're trying to get to is, if that happens in this new workflow, that everything is automatically updated all the way through the workflow. So InfraWorks 360 60 model would be automatically updated. The analysis and design of the girders would automatically be reanalyzed and tested, and validated to see if they're still good, and then you could just carry on. So that's what we're working towards.

We're not there quite yet. This is basically where we are at the moment, where we can use InfraWorks as the model for the bridge itself. We'll use the internal capabilities to analyze and design the girders themselves, and also linking outside to alter that structural design for even more detailed analysis. We can then take the and we can take the model itself of the bridge, plus the surrounding area, into Civil 3D, make whatever grading changes we need. And we can also push that back into for InfraWorks 360. We can then take the structure itself, the bridge structure, push that through into Revit very quickly and easily, so that you can then move forward with other types documentation, reinforcement detailing, plans and sections, and that sort of thing. So that's where we are. And that's pretty much what I'm going to try and demonstrate in the time we've got. So I don't know if you've had a chance to download the handout, but basically the handout contains some of these slides. I'm not going to talk through these, but just very quickly flick through them just so you can see what's on there. If you download it, you'll see it's going to hit the main points that I'm going to touch on when I'm going through the live demo time.

OK so it's worth picking up and having a read. OK, so what I'm going to do then is I'm going to fire up this model that I've got prepared and we'll start modeling. OK so this is where from this is we're going to create this bridge. We've got a bit of a cutting, you can see what that's looking like. So what I want to do is maybe connect this road over to this area right over here.

So what I'm going to do I'm going to use Component Road, so these are the newer methods of creating roads inside InfraWorks 360, where you can actually build up a road assembly basically, rather than the styles using the style editor that you might be familiar with. So we need a road first. So if we go to Component Roads, I've got a got a road type down here. And I'm going to select that there and probably come down here, across there, and just connect in over here. OK, so let's put my road in. And you can see this sort of thing gets done, but I'm not really concerned with what's happening over here. But we can see what's happened here is that it's tried to connect into-- it's tried to be clever and connect into these two rows. We don't want it to do that. We actually want to go over the top. And it's also put the grade in that level.

So what I need to do is, what I need to do is change that. If I just want just select it, right click, and I can pull up a profile view. And I can I can work on it using this. So this is more of a Civil 3D view that you might be familiar with. OK, so these are like PVIs, so you can actually pull these around and change the grading. So when I make a change, nothing changes until I come out of that profile view. I can add extra PVIs just by right clicking like that, and then I can pull that up and if I come out here you'll see that you'll see that change. OK, then I'll want to maybe remove these two, so it's not connecting in like that. And to be honest, I can leave it like that, I think. Yeah, that's great. OK, so you can see what's happened here. So I'm going to put a bridge across here. That's pretty simple. Once InfraWorks responds to the link, great. So just right click on it and just say add bridge. OK, so at this point I can, it depends where I am really in my process. You can either click roughly where you think it ought to go, which is what I'm going to do, but there is the ability to actually specify a specific start and end station. So I'm going to say, maybe I will go from there, and then just roll out that extent of the bridge to that point there. OK, and you'll see it's created something for us.

OK, so at the moment what we're using here are the heuristic rules, which are built into InfraWorks 360. So these are just basically rules of thumb that over the years we've used, span-depth ratios, those sorts of things to put the right number of piers in the right place, the right sort of girders that we ought to be using for those sorts of spans, all things considered. OK so it gives us a good starting point. And then from there we can then later on look at the analysis and get a better answer.

OK, so the first thing we to do really is we just put the bridge in but we're using the same style, basically, across the across the top of the ridge and we wouldn't want that. So what we can do if I right click on that road what I can do is say replace assembly. So I can click on that and it

brings up my list of assemblies again. But this time I'm going to click this one above, and then what I can do is just position this orange square, OK? So maybe I'll put it there. OK, and so these two points are going to be the extent of that new style. So what I can do is grab hold of this end then drag it out to somewhere where I think would be appropriate. OK, so you can see what that's created there. So that's my that's my style.

So the next thing that I want to look at are these are these piers. They're pretty standard, and quite utilitarian. But we can make lots of changes to these. So if I just select one, the first thing to see is we got we've got a number of grips around it. So I can actually pick this up and move it around a little bit, If I want to. That's the first thing. And of course I can also rotate it as well, should I want to. OK, so you'll notice as I rotated it, the length was increased automatically to suit the deck and then, because of that it added in another column. So this is just the parametric nature of InfraWorks just kicking in, giving us some help. But what I want to do is actually change these to something a bit more interesting. So I can click on a different pier type.

OK now this pier type is slightly different. So we get a different set of rules. So it's gone back to two columns. But I can also change that manually. So if I come over to the right hand side, number of columns two. I can just say, actually I want three, and now I've got three. And I've got a skew on this now, so it's 32.66 degrees, but I'm going to round it down to 32 degrees, like that. And then what I can do, if I'm happy with that, I can then say, right click, and apply it to all piers. In fact what I want to do, I'm going to change, make a few changes to these dimensions before I do that. So let me just do that. So I'm just going to change the width of the cap of the pier. There you go, that's better, and then, as I said before, I can just apply it to all the pier. And that will be copied around, everything except for the rotation. OK, so you can see where we're headed at the moment. OK so if we move down this time towards this foundation area, if I change from conceptual view to engineering view, it does a number of things, but the one thing it does do that I'm interested in is that it makes the ground transparent, so that I can see what's underneath. So if I select this foundation, I can then configure this particular one.

So I want to go for a different style. So I'm going to go for around pile cap, I think. Something like that. That's a lot of piles there. And so I'm probably going to reduce the number of those piles, I think. I don't think we need all those. So if we just make that two, like that, that will give us a better distribution, like that. And as before, I can tell it to basically copied that to all the other foundations. OK. So it's done that for us. So when we're doing bridges, your piers can go

in all different directions, but my OCD is telling me I like to see all these in the same direction, so 32 degrees. So I'm going to actually get them all facing the same way. There's no copy available for this particular function, I'm afraid. OK, there you go, so I'm a bit happier about. OK so that's taking care of the piers.

What I'd like to do now is look at the abutments. So if we look to over here, there is actually an abutment inside there. And if we look underneath, you'll see what we've got. So clearly I need to make some changes to that, the main one being to bring it forward into the length of the of the span. So I do that by making a change to this offset value. So if find put that there, we should start to see it emerge. OK and then we can make changes to the geometry. So for instance, I can make these the 180 meters there. That's it. OK, so we've got something a bit more realistic. We can actually change the length of it as well. So what I can do, again, apply to all abutments. So this will copy the individual values, but not the positional data. So if we go back over to this side, we'll see there's our configured abutment. But we need to reposition it, so. And we've got a different geometry here. The ground is different, so we'll make some changes. OK, I can get more. OK, I think that will do. OK, so it's pretty quick to make these changes to get something that is usable quite realistic. OK, so that's taken care of the substructure, if you like. And now I'm going to start looking at the deck and the bins themselves, the girders.

OK, so if I right click on here, we have this component display function now. Because I've used the component road, I can now turn on and off these different components. So I can turn off the road, for instance, so I can just see the deck itself, and then select it. OK, so once it's selected, of course I can change the thickness, change the width, all sorts of things I can do with the deck. But that's fine for what I need to do today. But what I want to draw your attention to is the fact that we've now got some design criteria, featuring in the contextual stack. So I've got concrete strength. I've got superimposed dead load, wearing surfaces, and distances from the edge of the deck to the curb. And those are all parameters, which will be used in the analysis of this bridge. OK, so nothing really to change here, apart from one thing which, will very much influence the design of these beams. And that is the beam continuity.

So we have three options here. At the moment it's set to deck and girders. So it's considering the beams and the deck to be continuous over all of the piers. Now for this type of construction, we probably wouldn't have that. We would have either simply supported or deck only. OK, so I'm going to select deck only, and what that will do, you'll see now that these

girders have now been cut up to suit, over the support. OK, and that's pretty much how you would expect for this type of construction, I think. OK, so the next thing we can do is, if we turn the deck off, and turn our attention to the beams, you can see that is the arrangement that we've currently got. OK, so Ara's here. So sorry mate, we talked about you earlier.

ARA ASHIKIAN: That's fine. That's not a problem.

ANDREW MANZE: OK so we have these beams. These are the ones that we're putting in using the heuristic rules. I've got the whole span selected here. And you see on the right hand side, I've got the section sizes displayed. And if I select one in particular, I can click on that section type. And it will bring up a list of all the available girders within InfraWorks 360. Now this is quite a comprehensive and complete international section catalog for precast bridge beams. And if I scroll down, you'll see all the different all the different types that are available. OK now to--

AUDIENCE: May I ask a question?

ANDREW MANZE: Yeah, go ahead.

AUDIENCE: Can you create your [INAUDIBLE]?

ANDREW MANZE: You can.

ARA ASHIKIAN: --and then bring it in now. [INAUDIBLE] would have to use project [INAUDIBLE], so you'd have the inventor model. We've introduced many custom sections, with all the [INAUDIBLE].

AUDIENCE: Of course, but you know they'll really never fit exactly.

ANDREW MANZE: Yeah.

ARA ASHIKIAN: But as the user, as [INAUDIBLE] --then the user-- it just varies all the parameters, I think. Then you can vary them along the way for the bridge as well.

ANDREW MANZE: So are you going to show, maybe be a little bit of that later?

ARA ASHIKIAN: Yeah, I can do that.

ANDREW MANZE: So towards the end? Yeah, OK. And so just to carry on then, so I was just looking at this particular beam. And if we want to change its section, we can just double click it. And you'll see that's now been changed to that section type. Another thing that we can do is-- you'll notice these little rectangles. They are specifying the section type at that point. So if I actually select

that, and hit add. I can then select a point along the section, and now what I can do is I can use this position to specify a different type of-- change the parameters for that particular section. So for instance, just to show you something that happened, just how it's working.

So I can just change that to three meters at that point. And if I pull on top, you'll see what that's done. OK, so it's a certain width at this end, it's a certain width at this end, and then in the center, it's different and it's interpolated between those for the length of the beam.

OK. But I don't want to I do that for this particular this particular one, so what I'll do is I'll right-click and say reset girders, and then it will put them all back to how they were before. OK, so I'm just going to bring the deck back, just so I can change that back to deck only. OK, so I'll put the right back on. OK. So let's have a look.

What we can also do is show any super elevation that's been applied. So again, just from the right-click menu, we can pick that and it's now displaying the super elevation. So if I click on one of these sections, we get the section available to us.

OK, that's what I was after. OK. So, you can see at the top here, we have the section view and we can slide this along and see the different super elevation as we're going along. On the right-hand side, you'll see the super elevation inputs there. OK.

OK, so at this point I think we will probably want to have a look at the girder design itself. So what it's going to do-- if I go to the bridge module, select line beam or line girder analysis, click on a bridge, I'll get this panel will be displayed. So, this one here, product information, this is just general stuff. The company name, the address, these are the sorts of things that are going to be populated in any calculation reports that it's going to produce.

You would give it a name, a job number, there's a permissible factor here, which is what it uses as a conservative factor for the tendon design. And we've got one here called reverse bending plot. All that is just whether we plot positive moments on the top or the bottom of the axis in the report. Some engineers get excited about that sort of thing. So that's included and then we've got consider heart tendons as the last option on there. So whether we want to consider bent up strands.

OK, so at this point, you would click start analysis and it would gather all this information on the bridge. It would take all that information up to our cloud service. It would do a lot of optimization to determine what the loading's going to be. It's got some information about the

about the dead loads already and it will do a line beam analysis for each run of beams, and then it will do a design for each girder, individually, which will include a tendon optimization.

OK, for a bridge that size, it's going to take five to 10 minutes to do that. So what I'm going to do is just got to a bridge, which is almost identical to that, which I did earlier. But this one actually has the analysis results already in, so we can have a look at these. OK, so what I'll do is I will remove the road on the deck, and you but you can see there-- because I'm fiddling. OK, what you can see there are the color-coded beams, and color-coded in accordance with how stressed they are, basically.

So if you hover over each beam, you've got a unity factor. So that one there, 0.91, and it's showing the leading design case is a lot of load bending for serviceability. OK. So, if I now click one of these beams, individually. If I'm interested in one in particular, you'll see in the panel we get a lot more detailed information. So we get the unity factor. It's not just for the leading case, but for all the other cases that it's considering. So we got a little more information there about what's going on.

If we want to dig into the detail of the calculations, we can also do that. So we can say get full report, and this is the report for that particular beam. So you can see you've got the tendon layout graphically displayed and then you have a number of stress plots together with all the calculations pertaining to that particular beam. You like that over there.

OK, so that's pretty good. What we're using is, as I said before, we've got Autodesk Structural Bridge Design, where we have a cloud service using that product as a design engine, and that's what produces these designs and calculations. So, maybe further down the line we want to refine this even further or find out more about what's going on inside these beams. So, this is where we can then click this button and it will take that line beam structure into Autodesk Structural Bridge Design, and we can examine it in a bit more detail.

So that's the structure that's been taken through and then we can go to Design Beams, and these are the individual beams. So there will be six of them. We can look at the beam definitions. So this is what's actually been created in Infraworks. And if I turn the transparency on, and you can see there, we've got some reinforcement in the top of the slab, and this is the tendon arrangement that we can see there. OK, that's good.

We can also look at the results of the analysis. So if we just look here. These are the different cases. So for instance, the erection of the beam, these are the results, here. So you've got the

position along the beam, and then you've got moment shears and actual forces, and then that is then displayed graphically above. OK, and it's obviously going to be different, depending on what you're looking at.

OK. What you can also do, if you're-- we've used a simple line beam analysis for this particular structure, but later on, maybe you might think OK, we want to develop this a little bit further. Maybe go to a grillage or something or something like that. This data isn't wasted. We can swap to a more refined analysis, create a grillage, put the meshes in using this product, and then reuse these beams in that structure. OK, so we can we can still use these.

OK, so that's probably enough on the analysis side. I'll turn that off. Turn all this back on. OK, so, what I think I'll probably do now is have a look at pushing this data through to Civil 3D and also to Revit. OK? So we'll do Civil 3D first. For Civil 3D, I need to close Infraworks down. So I'll just put that back to the model that we actually created in this session. [INAUDIBLE]

ARA ASHIKAN: No, what were you doing?

ANDREW MANZE: Just closing it.

ARA ASHIKAN: Were you closing it to go to Civil 3D?

ANDREW MANZE: Yeah, just closing it. [INAUDIBLE] press that button, there. That's what I'm doing.

ARA ASHIKAN: You mean just hung in the closing process. Just shut it down.

ANDREW MANZE: Yeah, just going to kill it. [INAUDIBLE] OK, don't know what was going on there. OK, so let's fire up Civil 3D then. OK, so we're there. OK, so in the Civil 3D workspace, we can go to inserts, and you'll see there is actually an Infraworks 360 button. So if we click that, we get two options. So this first one is just to go straight to the model and pull it in. The second one is to configure the exchange settings.

Now, you can actually configure the exchange settings on the fly during the import, and that's the option I'm going to go for today. So I've got a dialog. It's asking me to find the Infraworks 360 model. So if I just click there and this is the model that we've just been working on. So I click to open. OK, so that's brought that through. I then need to select the coordinate system and then it's asking me how much of the model do actually I want to bring into Civil 3D.

OK, so I can take the extent of the Infraworks 360 model. So that's everything, which we could

do. But what I'm going to do today is use the area of interest option and then select an area. So what that's going to do is that is going to bring through a map of the locality of the Infraworks 360 model, and put a box around the extent of the model so I know where I am, and then I can select within that. Connected to the internet. OK, it's looking for the map, but it's downloading that from the internet. So I'm not sure what my connectivity is like.

ARA ASHIKAN: Which network are you on?

ANDREW MANZE: Venetian [? Palazzo ?] Wi-Fi. It says we got internet. Yeah, but it's hanging.

ARA ASHIKAN: This may take a while to download. Maybe go to the Revit [INAUDIBLE].

ANDREW MANZE: All right, here we go. It was doing something.

ARA ASHIKAN: The connection was not that fast.

ANDREW MANZE: Yeah. OK, we just have to wait for a model, I think, while it downloads the map.

ARA ASHIKAN: Should we turn Wi-Fi off on our phones?

ANDREW MANZE: Yeah, this is a bit frustrating.

ARA ASHIKAN: [INAUDIBLE]

ANDREW MANZE: Oh, is that a better one. Let's try that one. OK, let's just try that again. Right. So that was just the internet. So that was what I was actually after for. Let's pull in-- this is more than I need, actually. Let's go from-- Let's just run that again. That's not right. Area of interest, right. So we're going to select, I think from about there to there, we'll pick it up. We should find out.

So it's just looking at the Infraworks model, seeing what's in it. So I said earlier, at this stage, we can configure the exchange settings. So you can do it here and you can see how you can configure stuff. No need for me to change any of that for the moment. but what I will do is look at refining the selection set.

So what I'll do is I'll turn it all off and then just say I want the terrain surfaces. I don't want the planning roads. I'll take the design roads, the coverages, and the bridges. Click OK, and then what I've got to do is say open model, and then it will bring that in. That will just take a second.

OK, so let's just make that a bit bigger. So, this is the model that's been imported. If we turn off the map. Where has that gone? [INAUDIBLE] turn off the map. All right, it was there. I have no

idea where it's gone. OK, let's just get-- OK, so you can see in Civil 3D, the model's been brought through with the surfaces and any change in terrain that we made need in Infraworks are now in there.

OK, but what I really want to show you now is to take this structure from Infraworks, into Revit. So I'll just close this down, get Infraworks back up. We'll open that model that we were using. Here it is. Go back to our bridge, and the best thing about the Revit functionality is there's literally nothing to configure.

So all I need to do is right-click on the bridge and hit send to Revit, and that's all I've got to do. So that will take a minute to do. So we can just watch this creating the model. It shouldn't take too long, maybe a minute or two.

ARA ASHIKAN: Creating the same model directing in Revit, that would be a non-encrypted pass.

ANDREW MANZE: For sure.

ARA ASHIKAN: [INAUDIBLE] super elevation and all sorts of other variations of the alignment. [INAUDIBLE] In the next version of Infraworks coming out in a few weeks, the [INAUDIBLE] functionality is both much faster and able to take all of the geometries of Inventor, all the way across.

In some cases in the current version, there are limitations, so we can't introduce as many parametric components of the bridge, as Revit doesn't have the same solid modeling capabilities. But we've overcome that in the upcoming version. It makes it really possible to go all the way to Revit with very complex components. [INAUDIBLE]

ANDREW MANZE: I don't know. It shouldn't take that long. It's on the last section now. It will go to-- this next process is the last one, I think. So this is what happens when you come to a live session. You sometimes have to wait a little bit to see things happen, rather than the convenience of videos and stuff like that. But sometimes I think it's good to see this sort of thing because you see this is what you're going to experience when you're using it yourself.

ARA ASHIKAN: But, put in perspective, a couple of minutes [INAUDIBLE] Revit model and--

ANDREW MANZE: It's not a big deal, really. It's just a bit frustrating seeing the percents click up.

ARA ASHIKAN: And once in Revit, you would be able to use the different tools that create drawing sheets, add rebar, and so on. Now, we're making a lot of improvements in Revit 2018, which comes out in

the spring, to handle really complex curves. Today, when you try to place rebar in complex depths and so on, it doesn't really understand it. We've spent a lot of time improving Revit for drawing and rebar placement on complex geometry, which is typical of bridges and tunnels.

ANDREW MANZE: OK, so it's completed that process. So it's fired up Revit automatically and we should see a model any moment. OK, so there's our model. I can change the view a little bit, but there it is in all its Revit glory.

ARA ASHIKAN: Right on time.

ANDREW MANZE: Right on time.

ARA ASHIKAN: All right, that's the quick overview.

ANDREW MANZE: So that's the quick overview of that. So, back to Infraworks. That's of the end of my little bit of live section. So what I'd like to do now is hand over to Ara, and I think he's going to show us some even cooler stuff.

ARA ASHIKAN: How many of you were in the tech [INAUDIBLE] yesterday? OK, and transportation center? Right, OK, so you'll have to endure the same video, but it's kind of cool. So that's probably not the world of the world.

ANDREW MANZE: Do you want the--

ARA ASHIKAN: HDMI

ANDREW MANZE: The HDMI, yeah, there.

ARA ASHIKAN: OK, is that better? And this is the HDMI.

ANDREW MANZE: Once you've got it in, you'll have to press number six, of the keys on there.

ARA ASHIKAN: Number six?

ANDREW MANZE: Yeah, on the machine over there. OK, you're live now.

ARA ASHIKAN: All right. OK. So, Andy showed us what you can do in Infraworks 2017.2 We're about to release, in about two, three weeks from now, 2017.3 and we've added a number of enhancements. And this next video will kind of walk through some of it. I'll narrate as I go through, give you an idea essentially as to have more flexibility in modeling, more flexibility in

adjusting the models. So let's have a look at this. And then it's going to go onto to some of the stuff we're working on next as well.

So this is a model for a fictitious bridge and we're going to zoom in. And again, it's really important to note, in 2017.2 we added all the super elevated roads. I know Andy has shown this, but it's important to realize that the parametric deck object of the bridge is fully compliant to the road. So if it changes widths, and super elevations, and so on, it accommodates that. And we're exposing all the parameters of the key geometry of the road as well.

Now, when you click on the bridge, it doesn't matter how complex the component is, we can view the quantities and we can isolate the bridge into components so you can really see what's going on. It's sometimes difficult on a whole bridge to see. So there are all sorts of ways, and we're going to do even more so you can really focus on what you're studying.

Now, this is a steel composite box girder model. So this is using all the variable girder slices. So you can change flange sizes and so on, but also profile the girders. From the library, this is kind of going over stuff that Andy showed, but nevertheless, change any of the parameters.

And then instead of applying this girder or this pier to all the piers, we've added a lot more flexibility. You can selectively-- and this makes a huge difference when you're modeling a real bridge-- to refine the bridge in certain areas, not all the piers. So You can have all sorts of variation of the piers and quickly refine your model towards detail design.

And of course, when you're ready and you're happy with the geometry, the layout, create the Revit model. Now, this is relatively complex. It would be a lot of work to create this in Revit. Doesn't matter. It really doesn't matter how complex the geometry is. Now, we're taking it even further.

So we're introducing bridge templates. What is that? So we have parametric components, piers, abutments, girders, but what if you configure this super duper bridge and then you save it to your catalog. And you call it My Bridge Type 1, 2, 3, whatever, and the next bridge or next project, you reuse it.

So here I had a bridge, which was based kind of on the Confederation Bridge in Canada, which has these really complex pre-cast piers and pre-cast foundations to break the ice. But just an example, you can reuse a bridge and it will recognize where the piers are, the number of girders, but use all the parameters of the components. We've also introduced parametric

multi-cell boss girder, where it can follow super elevation. You have control whether the bottom is also super elevated or not. All sorts of refinement there.

Now, if we were to take this further-- this is not quite yet available, but it's using the same approach. So this bridge has slightly more complex components, but in other respects, it's no different than the overpass. When I click on this component, this Inventor component as an assembly that has pre-cast panels, edge girders, even the anchorages, all of it is parametric.

And then you can take this bridge, or any bridge for that matter, into the large model viewer. This is all the Forge Cloud stuff that everyone's hearing about here at AU. It's to collaborate, to take it to field, to work with a contractor, to let others on the team interact with the model or annotate the model.

And what if we go further and take the same technology into tunnels? So this is a model of the Massey tunnel in Vancouver. Infraworks today, doesn't have quantifiable parametric tunnels that you can take the Revit to add rebar, take to Civil 3D. Well, this approach does. So you can have any cross section, any kind of a section you develop in your Inventor catalog would be available here, and it would benefit from all the workflow that you have for all the so-called simpler bridges.

So these are really good enhancement to allow you to take the modeling further. Now, sometimes when I visit clients, I hear this told. Hey, we heard about Infraworks. It's kind of like SketchUp for really simple bridges. And so, some people haven't recognized and don't realize that you can actually not only create much more complex components, but model real world bridges in a scalable model. That's the advantage of Infraworks.

You have a large model with many bridges. Each which can be in Revit, but there is an advantage to working on a scalable model. It might be a whole P3 pursuit, or a ring road around a big city, and you have many teams on a big P3 competition all collaborating on the same project. So you need scalability. You need flexibility. You need all the little tools that we've shown to effectively model.

So let's have a look at this next video, and this is the answer to-- it's a bit more than SketchUp for simple bridges. So we decided to put together a model of Vancouver, that's where I live. But it has some really interesting bridges and all of these were modeled in Infraworks. So it's not imported from Revit or 3ds Max. It's a work in progress.

We intend to push this model quite a bit further, but even so today-- so you can see if we hover over this, it has all the parametric aspects, even the pier would expose all its parameters. You see the girder has a kind of widened web over the-- and this is a photo of the real bridge. So it's not fictitious. It's modeling a real bridge.

In this case, it's a whole LRT between downtown and the airport, that's some 20 kilometers long. But again, doing this in Revit, not an easy task, and you can do it right away from the Infraworks model, which you can do almost in real time.

This is the Arthur Lang bridge. It's a composite box girder, variable depth. It has unusual piers. That doesn't represent any difficulty. You can model that. Make it parametric, if you intend to use it. But you can see the same thing. The components, the piers, the foundations, all of that, you have real free reign.

Today, you have to use Project Chameleon Labs. Well, we're going to be graduating it and it's going to be directly available with Inventor and managed directly in Infraworks. That bridge had all sorts of weird piers because it underwent seismic retrofitting, so a lot of changes on that one.

This is the same bridge or same route of the first bridge, which is between the airport and downtown. This is an extra ghost bridge, but again, it just requires some different parametric components. We can scale up to longer bridges, bigger bridges.

So here, we're flying up the Fraser river, and we come across-- at that time, in the 80s, the longest composite cable state bridge in the world. So this model has all sorts of piers. The piers have all sorts of things, tie beams and different details, the foundations are also pretty evolved, and the towers, and so on.

In sense of modeling this, the 3D model, the parametric model, and creating the Revit model, there's not much difference between that and the overpass. The analysis, of course, far more complex. The staging analysis, that design checks, but in terms of-- and this is where we spend a lot of time looking at concepts, documenting concepts, and creating the construction drawings. This kind of workflow takes it much, much further.

This is a work in progress of the Port Mann, kind of unique towers in the middle of a 10 lane cable stay bridge. This would be a nightmare to do directly in Revit. All sorts of curves in it. And why don't we fly over to the edge of the model next, to see the Golden Ears bridge. This is

a four span, [INAUDIBLE] cable stay type bridge, with very unusual tower configurations. We can see here, the parametric road models alive.

You can make changes. You could play with the vertical and horizontal profile. Everything is alive in the model. Quantities are alive. Everything's there and if you zoom in, you'll see a certain level of detail in the components there, the towers, and foundations, and the real bridge next to it. So you can do quite a bit.

Not everything quite today, we're still working on some of the intelligent links so that when you-- in the future, if you do a cable stay bridge and you move the tower legs around, all the cables adjust and they update all the anchorage details and so on. That kind of high level linking we're working on, but all the components are there. So that gives you an idea of what's possible.

Now, just to finish off, I hope this works. I'm having internet issues here at times, but what I thought I'd do is when I came to Vegas, I noticed this monorail system all around the backside of the hotel. So I said hey, that would be cool to quickly model in Infraworks. Let's have a look at that. So let's do that. It's a few kilometers long. It has many, many piers. It has these variable depth girders, and so on, and so forth, and let's have a look at

Because it's one thing to see that the models parametric, and you can take it to Revit, and you can do all these different bridge types, but it's not obvious to a lot of people, what is a process to create that bridge? Andy walked through it, but the real power is you can almost design this in real time. That means you can look at a dozen concepts, or refine one concept a lot before you go further. So lots of advantages here. So let's have a look at what's possible.

I'm going to go and delete this because we want to recreate what I have here and do it from scratch. I won't do the whole thing just because it takes a few minutes to do certain things when I generate or go to Revit. But let's say, here I want to put this. You can see I hid everything else. I have the ortho photo and showing the alignment of the monorail.

So imagine this is your project. You have to investigate different arrangements of the monorail, or different alternatives to it. You have to create some plans, and elevations, and key sections, maybe, to submit to the owner, to illustrate your concept, or even more. So let's have a look at that. We're going to do pick a component road. I'm not too worried about the actual [? though, ?] I just took a two-lane road configuration because I'm going to focus on other things.

First of all, I'm going to set the speed to not so fast so that the curves that we get don't have big radii. I'm going to go and set a curved spiral, which is more typical of highways, something more recurved. So now, I can quickly go in here and basically-- of course I could spend more time and make it more precise, but in a few mouse clicks I have a kilometer length or 1,200 meters of road. Let's say the trajectory, or let's say we want this to be about 20 meters high.

So if we zoom in, this is kind of where we want this monorail to be. Now, I'm going to go in there and quickly place a default bridge. So again, you don't model every pile and pier, and stuff from scratch. It puts a reasonable bridge to start off with. Reasonable means span to depth ratios make sense, proportions are something that a bridge engineer would start with. So here, I just kind of roll this all the way out to, let's say, about here. This is just indicative, right?

So now it's going to come up with a default bridge. It's going to have boring piers and astro type girders. It's just a starting point. You might spend all sorts of times just moving it, looking at it in context. What does it mean to work in context? It means I can look at each pier, move them around, really finesse the layout. I'm just going to go in here and say I don't really want three girders. I really want a two girder configuration. And I'm going to go in here and just quickly apply this to all the girders groups.

Now, I could spend a few minutes, five, 10 minutes here, going to my catalog and picking a different type of girder, different type of pier and foundation, and varying all its parameters, and then continue with the rest of the bridge. But we introduced, what we saw in the other video, a slightly more efficient way. So I already have a catalog of these type of monorail bridges.

Essentially, I created the level of detail I want, and it's going to apply it and respect all the piers, and all the placements, and so on. But it's going to apply all the level of detail from my catalog. So here, I'm going to go in here and say, I want to use my favorite monorail bridge that I've really tweaked in the past. And it's going to go in and respect everything and create that model.

So this is, essentially, my starting point. I just placed the road. I said where I want the bridge. Instead of refining this bridge, I just went into my catalog. And you can see here, it came up with a configuration which respects the super elevation along the curve.

The girders are variable depth. That means if I click on it, it has multiple slices along the

girder, all that stuff that we showed earlier. I had played with parameters, but again, we have this. I could maybe continue, go to Revit. And in fact, instead of doing that, I'm going to say I'm going to switch this to more of a Vancouver style, light rail train configuration.

Really, the only thing I have to do is how many girders do I want and where do I want the piers. In this case, I want a box girder system. So I'm going to change that to one girder because it will respect the number of girders you have and apply the bridge template accordingly. But here, I'm just going to switch this to-- and I'm going to apply this to all the girder groups. And instead of going and changing all the bridge to make it like the Vancouver bridge that we saw earlier, I'm going to use, again, go into to my collection of bridges and reuse that.

So again, create your own components, have a library of components, use them in bridges, create your own libraries of bridges. And here, what does that mean? Again, we'll just do it again. It will juts take a moment. Pick this bridge, go into this catalog, and this is the LRT bridge from my collection. You'll see it has box girders. The ends of the box girders over the piers have different refinements and they're flared out over the bearings. It's a multi-cell box girder. So again, you have all this level of detail just came around.

We've been what? Three, five minutes, whatever. We right-click on the bridge. It would take about three or four minutes to create the Revit model. I already did it. And here you go, you have a Revit model for this bridge. So this is the power of a fully parametric system. Imagine how many things you can look at. The level of detail, you can go to quickly. It's open ended. You can go to Revit and take it much further.

Andy showed some of the analysis code checking. We're going to be extending that a bit to handle other bridge types, and we're also going to be opening up the analysis so that if you have complex bridges, post tension, box girders, cable stay bridges, and so on, use third party analysis software. It might be Autodesk Robot, it might be LARSA, it might be SAP2000. Use what you want.

We're going to work with these partners so that we have a method to go from the Infraworks and Revit parametric BIM model, into a different way of descretizing the analysis model. But the workflow here, of allowing you to, as a team, look at many concepts really efficiently. Look at all the quantities. Take it to Revit. Look at it all. Easily submit this early in the bid phase and then come back.

And when you started in Infraworks, it didn't have that simplified analysis base, and toroidal models that you can't take the detail design. It starts off with a parametric model that is rich enough to go Revit to do construction drawings. That's really important. The pier is not some sort of simplification. It has all the detail, if you look at it, to place the rebar. And the reason this works well is because it doesn't take more effort from you. You just pick it from the catalog and it has that level of detail.

You can introduce super elevation and all sorts of control on it, but your starting point is geometry that is detailed enough, based on the super elevation of the road, and all of its own parameters so that you can add rebar to. Or when we get into steel bridges, it's going to be even cooler because we have plans to-- when you place this bridge, if it's a steel plate girder or composite box girder, the starting point between your mouse clicks is all of a stiffeners, cross-frames, variable flanges, field splices.

You as the engineer, will go and change all the parameters. Make it work. Make sure the Moments and shares make sense. But then, that model in Revit is going to be super rich. Rich enough to do construction drawings, and later on, rich enough to do shop drawings. So there's huge advantages to work in a parametric system that goes from concept, all the way to Revit, for a detailed design.

In the middle, there's going to be all sorts of cloud services or external third party analysis to help you validate Kojak and so on. But even if we had zero analysis, even if you have none of that, you'd still be far better off starting with this. Start your concepts, evolve your concepts, look at alternatives, and have Revit models waiting for you right there.

So that's kind of that's kind of it. And we're working closely with the Infraworks teams on grading and so on, because we want to introduce retaining walls, and we didn't get into so much. I'll show you one more video. We have a bit of time here. So we worked with Caltrans a bit on some of their different or unique bridges. Cass in place, multi-cell box girders, all sorts of complex geometries for piers, and so on. So we did an example, here. If I can find it.

This example shows complex abutments. These are fully parametric, and these abutments have all sorts of parameters, [? He wants ?] depth, wing walls, or not. So this pier is ornamental, not strictly functional, but all of that can be parametric and easily brought into Infraworks. So if you want to explore different things like that, that's possible.

And when you get into Infraworks, this is a three box girder variable depth configuration. Again, you have full control on all of this. This is not a trivial bridge to model or create in Revit, but with this workflow, again, it sounds cliche, but the level of geometric complexity is irrelevant because Inventor is really-- Look, Inventor can model a jet engine, it can handle a pier. And we can expose the parameters and you give-- in here, you can see the abutment.

And you can embed rules in it. So if you splayed the wing walls, maybe the corners don't chain. There's all sorts of things you can do with the Inventor model and we're going to make it multi-material. That means assemblies that you saw for the cable stay bridge. That means you might have piers that have pre-cast pier caps, and cast and place columns, and keep track of all those quantities. And then here you have the Revit model for something non-trivial in the same workflow. It doesn't matter. Just to emphasize it's a real bridge, it's in fact, a real bridge.

AUDIENCE: So at some point, the [INAUDIBLE] in Infraworks will be able to calculate all of these [INAUDIBLE]

ARA ASHIKAN: So the intent is-- Andy showed the line girder analysis, which looks at the superstructure and creates a continuous model for pre-cast girders. We're going to extend that to handle steel girders and do an FE model of the superstructure. But most likely, and this is what we're working on, is we're opening up the BIM model of the Infraworks slash Revit, because they're kind of combined, and then saying, OK, first of all, when you do a global analysis model, we want the engineer to dictate what type of analysis model they want.

Let's take the cable stay bridge, maybe you just want a 2D linear model, just to get a sense of foundation loads and tensions on the cables. So you say OK, I want a 2D model. Or I say I want a Global 3D model, and I want the foundations to be explicitly modeled down to piles, or not. I want the deck to be modeled with shallow [INAUDIBLE], with offset girders for the you edge girders, or not, or I want a volumetric model. You decide. So what we want to do is expose all these options, so an engineer-- and that's the important part. What type of analysis do I need and when?

At the beginning, you're far better off, really simple, so you understand everything. And as the design progresses, maybe go to more complex analysis and then say, well, I want this using LARSA. Or I want this using SAP2000. So we want to work with those partners so that they have API. This is through Forge. You'll see all this cloud microservice architecture. This allows our partners to traverse the BIM model, walk through it, and extract analysis model.

Now, what we have to do is we have to-- in the superstructure, and especially in piers and towers, we have to embed some metadata as a content author. Imagine it's a very organic pier. The analysis model has to understand how to discretize that into a BIM model. You don't always want a volumetric model. It's not really required. So we're going to add some intelligence so that the third party analysis-- or also, internally, robot and structural bridge design can extract the analysis models.

This is a big plan so that you use your favorite analysis software, but at the moment, we're focusing on refinements of the modeling, Revit workflow, and what we have here for the Revit workflow is you make all the big changes in Infraworks, and you create a new Revit model. But what we really want, and what you guys really want, is when you need to make changes in Infraworks, we update the Revit model.

So if you spent a month creating drawings, and putting rebar, and you-- oh, I'm going to move that pier by a meter, you don't want to lose anything you did in Revit. Right so, this is what we want to update. And then if you're in Revit, if you do big change like change number of spans, of course you're going to go Infraworks.

But if you're in Revit-- in Infraworks, it's the engineer who knows bridges that's playing around with parameters of the bridge. In Revit, there might be a whole bunch of BIM technicians that are placing rebar, doing the drawings, but they might be told, hey look, move that pier by 8 inches because there's underground something here. So you should be able to move that pier and the system reacts.

So the intent is that Infraworks, and Inventor, and Civil 3D will look at this change, and update the Revit model, update itself, and update Civil 3D. So the model is in the middle. If you're using Infraworks, it will update Revit and Civil 3D. If you're using Revit, Infraworks will update Revit and Civil 3D. So that's the intent. That's our main focus. We want to make the BIM model really alive so that when you make big changes anywhere, it responds.

At the same time, we're exploring what's the best architecture to open up the analysis so that the BIM model, you can traverse it with your partners to create analysis models that you want. Because it's not just it looks good, no, you have to prove that every single stress is good. Right? In the end, you still have to do that. But the amount of time it takes today to do concepts, to visualize, it's huge. And the amount of time it takes to do all the construction drawings and the rebar, it's huge.

That's irrespective of the analysis, but with this approach, that's a lot more approachable. A lot more approachable, and so we want to weave it in that way. We've come a long way. We know we have a number of things to work on in the modeling on the Revit side. We also know we're going to address some stuff on the BIM analysis side. So that's kind of the big picture. I hope it makes sense to you guys. I think we're right on time.

ANDREW MANZE: I think that's about it, yeah.

ARA ASHIKAN: All right, thanks guys.

ANDREW MANZE: Thank you.

[APPLAUSE]