DALE HARRISON: Good afternoon, everyone. My name's Dale Harrison, and I work for AECOM. I've been with AECOM for 13 years, and my primary discipline that I work in is structural so anything associated with buildings, infrastructure, I generally do. I do have a Twitter account, @infrabimgis if you want to know. Follow me, look me up, as well as I do have a blog page and I didn't put it up, but it is on my Twitter account if you want to link.

During this class session, I'm hoping you'll be able to gain an insight, how to do a technical project integrating BIM. I'm going to cover using a Common Data Environment using BIM, using Dynamo for construction tasks by setting out and modeling, and a couple of other things. The benefits of modeling complex reinforcements, because traditionally we're on-prem, we don't do it. And then just the exchanges the data's of formats of other files formats predominately, I'll say. So, the project that I'm talking again today about is Stadium Station. I'll get into a bit more data on what the Stadium Station is, but I'll first just explain where it's all come from.

PRISM Alliance was an alliance formed by the public transport authority of Western Australia, that where they are now. I come out with the designers, and then laying a rock that were the contractors that built it. So we're all formed under a partnership, and became an alliance. This meant we had an integrated project delivery, and it just made things a lot easier in terms of contractual requirements.

Traditionally in a designing construct we had hard guides in terms of delivering. This just blurred the lines, we were working over the top of each other, trying to basically make the delivery, and I'll show you in a video when I do it come up just expose. There was no missing the milestone, the milestone for construction to be completed was fixed.

The project is located in Perth, and that's where it is. Perth is the capital city of Western Australia in Australia. Literally if you could go the other side of the world, that's where it is that red dot. I sat on a plane for 24 hours to get here. Yeah three flights. The only time you can fly somewhere and see the Sydney Harbour Bridge and Golden Gate Bridge in one flight. So just a brief overview of the station's location relative to the new stadium, and as well as the Save the Date So the new stadium is being built in Perth here, all the supporting infrastructure around her, and they're building a new station here, which is nestled in, and it is Brownfield side and there is Perth Save the Day.

So the function of the stadium on a game day is to remove 28,000 people from the game. And the way this was done is by building six platforms, two concrete course bridges, so people would just be quickly distributed from the station away from the game. So there's just a 3D isometric view of the station like I said before. We had a Western concourse covered bridge, and Eastern concourse, and the six platforms adjoining in them.

There's a nice pretty grounded view of looking at the Western concourse, and in the background you've got the Eastern concourse. And then what it actually looks like inside the stadium when it will be finished. I won't speak for this, but I will basically play this video too. So this is a construction process the Alliance put together with SYMMETRY and Laing O'Rourke, so there's the stadium in the background.

I'll play this video again and I'll actually talk through it, because sometimes I know it goes quite quick, and I just want you to first see the sort of appreciation of what it was. We basically put this together, we picked the project up at 85% design, and it was completed boy another consultant. The consultants original option was concrete bridge deck system, and what that meant was with the tier kind you can actually lift the tier offs.

So what's being illustrated here is the platform area is being built, so these are a series of pile caps going in, platform being built, the pier being erected, base of the platform walls. So there's 1.2 kilometers of pre-cast panels that form up the platform walls. The Eastern concourse being built, and we've talked an abutment here, up here, here, and again the original design was for pre-cast stirrups where we rationalized design and made it a steel structure.

So we had steel steel girders which reduced the overall weight of the construction, so we're able to reduce the amount of pause in the construction process. Additionally by making the structure lighter, the supporting piece went from originally six columns, and in the final design, once I started construction, we had it down to two. It was constructed in two half's. So the first half was we had live rail here, and the videos already jumped through it. Then the alignment was realigned and put through. So that's just a brief overview of the process.

This is the actual Navisworks image of what the project was, well actually looks like in it's digital form. We built the project twice, we built it first digitally, and then we built it physically the second time, and the way it was done was with multiple platforms. In Australia we use 12 day solution, and 12 day did all the Sephardic elements, anything that was less than 100 mil was

modeled.

So there are all your linear elements. So for example, all the trackline and all the track design, all the earthworks, all the in ground services. And then I suppose what we're hear to talk about is using Revit for infrastructure, and anything that was vertical we modeled in Revit. So all the elements you can see here, so you've got all the overhead power lines, the signaling, the platform walls, the station structure itself, which is a covered bridge. There was an existing bridge because there was a Brownfield side. So anything that sort of had a vertical element, we modeled in Revit.

Part of the program, and I really did miss on that video, the trying line did switchover. So there was a fixed point in time where we had a deadline to make, there was no sort of missing delivery date for construction, it had to be done. I was put in a difficult situation where laying our [? rocks ?] philosophies to [? FMA ?] so it's designed for manufacturing assembly, and the way they work is they literally work in a model live. So we ought to come up with a solution which was cloud based that allowed multiple parties accessing a single Revit model from multiple locations. So in this instance here, you got the contractor site, AECOM side office, people around Perth, and subcontractors accessing a single file over the network.

We went with ProjectWise integration, and the reason we went for ProjectWise integration was collaboration for Revit wasn't available as on the project outside North America, so we had to use ProjectWise. Revit server didn't make company policies in terms of having external partage sharing in, we didn't have auto infrastructure to support it where we had ProjectWise and it just seemed a simple solution.

What this meant was just a change in workflow, everything had to be planned, lot of setup before. We had Laing O'Rourke's the EC guys working live in our design model at the same time, and their roles and responsibilities were the only inputted data, where we basically produce the model.

So what this meant was, we had to granulate the model down and produce work sets. Everything had to be planned, hence I'm showing you a document from a white paper from release six Revit. And I just talked about work sets, setting up work sets. There was no boring elements, just the way ProjectWise integration works. You've actually checking page chunks of the model out, working on it, checking it back in. And that actually meant even down to users checking out works sets, including views. So not only model element work sets, but going

further down. If you were to work on a view, or a shape, you check out these work sets and take ownership, make your challenges, because then you had a ownership on it.

It's a bit different, I suppose, compared to everyone else in the world where the distance from Perth to Melbourne is almost equivalent of Vegas to Washington D.C., and internet connection that we've got isn't the greatest. Again, using ProjectWise meant there were network latency issues, so each morning users would have to come in and we've have to do things like copying, caching out the model. Instead of just opening it, you get the user to cache down to their C drive, because that's why ProjectWise works, it caches the central file to your C drive.

You work your way and then your just exchanging dat files backwards and forwards. Because if you went through and just opened up the model in the morning, and you hadn't cashed it out, we're talking about one gig of data, it just locks everyone out, and sort of screws everything up for everyone. So there were sort of limitations when we were working with ProjectWise.

On the server, limitations were turn to [? rig ?] models, and maximum users in the model. But with a model that size you're never really gonna out use this, and again roles and responsibilities were divided up where we had people modeling, and then other people doing data entry into the model. These are just some of the settings, well now this is just the work sharing settings.

So again, the whole point of this was to limit network lag and latency which was preventing anything really being exchanged over the network. So this is just under an options in Revit, you set that down to work sharing frequency update, and it just pulls it down to 60 seconds instead of every five seconds. If it's five seconds it's basically going from there to there every five seconds.

We just want that to slow down in terms of that, because again the network lag, latency was-- It varied between ya people, but from 400 milliseconds up to 55, and it depended on who convened 400 milliseconds where we were 55. And that's just an example of when things sort of-- you open and close files you were locking, checking the falls in and out of a ProjectWise.

What IU presentation wouldn't be without shade coordinates, and the importance? This is a document produced by Brian Renehan from BINFix, he writes a blog and that's his blog down here. I helped him with the input too it, so it just sits through a framework that you can basically establish coordinates.

And this project, [? mainly, ?] infrastructure, not like a building, we didn't have grids where everything was set out from grids. We had to set everything through the coordinates, and it was driven from coordinates. So, this document has all the possible workflows from initial set up, getting a survey document, basically even down to the point of making sure your model starts off with the origin point in the bottom left hand corner and creates a all your numbers positive in that sense. So yes, it's well worth looking it up.

These are some of the requirements that were driven to produce our model because we had to basically build to model as per construction methodology. I know in the past when I first started using Revit, I used to produce a model for documentation instead of a model for construction, and I just meant changing the way we actually modeled. Now I want to form work areas out of all the concrete elements, as well as all the casting INSITU elements as well that we had to put in. And then as well as some of the other requirements were data input for downstream workflows so they could then tie the model to Primavera so then then can tie them on it.

This is just how the model was gradually broken up, and I suppose the key thing that we did here was a combination of nested families to a first level, as well as den elements that weren't nested using parts. And I'll let it flick through and I'll just talk through it. So this is just the center pier, and everything that was associated through it.

So we had the pre-cast piles nested into the pile cap, Plinths are then nested into the pile cap as well. So when you place them, you play some once. They were located in the track position. Similar again we had holding down bolts nested into base plates, so you place the base plate, all the holding down bolts were in the correct location. I'll just wait for the next bit to come up.

Here's the column, so the column would have been continuous with them because we are integrated with the [INAUDIBLE] team, that'd come to us and go. We want to pull that column. In two sequences, can you split it. So instead of just physically splitting the column we just use parts, split the column up, and there abide still for us. Within our design documentation it's a single column, but for the [INAUDIBLE] team, because they're working live in our model, it was split.

And I'll wait for it to come through again, I did mention formwork areas as well, and I'll show you what I like doing as well with it. You'll see some [? callows ?] just between each poll, and what while we're doing is extracting out of the model if it was a bunt to that bonding agents

that would have had bonding agent, modeling bonding agent in, and then as well as curing agents as well.

And again, I shall explain it a bit later how we are pulling out formwork areas, and then now we're using [? amper. ?] So though leveraging the model to produce schedules where they were [? pre-curing ?] directly out of the model, and producing work packs. So work pack documentation is basically a cartoon drawing just demonstrating how the model went, basically not in how the model, how the construction sequence would got together.

This is just more of an example drilled down of using nested families and subcategories as well as materials all broken up. And I made a pre-cast platform wall, again we had 1.2 kilometers of it. Within it it, it was one family and we had the holding down bolts nested into the top ties to tie each pre-cast units together, as well as the platform edge angle, all nested into it. The benefit of that is, you place the object once. The holding down bolts are now relative to where this goes, you know they're in the correct location, and the edge angles. And then again from that, you've got all the quantities, and you know you've placed them correctly.

Similar again, this is just the pile cap blown up where the piles were nested into the pile cap. You can say that we've had three different materials. We're curing concrete that we cured directly out of the model, and because we had the materials correctly, and so on to each element within the model, they are able to then schedule that out and [? pre-cure, ?] it and so on. And even the holding down bolts again again.

I did mention Form Work Areas. So the model requirements were anything that was a concrete element, not one of the Form Work Areas. I would just use Dynamo here to illustrate the actual, if you will, use plywood and give you a more visual representation of what the Form Work Areas are. Well that just shows you sort of the extent of some of the things where you had the concrete base, pile cap, and then the plinth on the top. And as well as you can say the plinth had a hole in it to allow services around up the column, because the services were concealed.

So Revit just doesn't have a simple solution to extract Form Work Areas. Now a couple of third party applications are due where-- there's a reason sort of war we used Dynamo because we'd get the Form Works Area's out, and then there's a sort of another downstream knocking effect that we get out of it as well.

This is just a donor of my scripts. I don't know if you've seen some of the others where they created graphs and that. But it's fairly-- It looks far complex, but in reality I've got it now, it's simple. This just gets all the categories, it builds lists, and then it gets each element of that list. And then this is a custom node that I'll explain to you in a second.

Here basically, splits the surfaces out of a family, and then it just goes through the process of creating sums of it, and then just-- I've got a shed parameter within each family that just gets populated. And I don't know if you can see, so that one, I think, says surface area. It should say-- I don't have my glasses about, I can't see, but just say that's top side and bottom, all right?

And in effect, all this, that custom node that I had was, if you had a concrete element, and the way it worked is, every face has a vector associated to it. And if you took the vector of the face in relationship to Z, you could split it out, and it filters out quite easily.

Your top face was 0, anything that was a side-- let me start again. Top face was 1, so Z was up. Z was 0 for all the side faces and again, quite simple, Z was down, and all that did was-- you put the surface through, worked out where was, crowded the list-- I'll just go back a slide-- and then I just split it out there, there, there, and then I would go through and populate it.

So this is just the example of, within Dynamo, once you've done it, it's pulled out all the surfaces. You can't see it here, but it has categorized the-- so as Walker said, where we hear surface is. So we have the bottom surface area. And then we've got the solid surface area and as well as the top surface area.

Now what I'm showing here-- I had explained it to you before-- this is the base, and what we are actually looking at is just the base there, and that's the associated areas to that, where this is a nested shared family within this element. And if I had to click on that as well, I'd have the same areas as well.

So it's not going on-- these are all the sides for my areas, it's basically going-- calculating the bottom, popularizing the shared parameter values in here, and as well as calculating the ones in the top, there. So again, this was given to the base they got us [INAUDIBLE]. And on our formwork area we require, they could then go to the sub-trades and go, OK, and [? pre-cure ?] it in that methodology.

And that's just an example of showing it as if you were putting the framework in a-- I've

actually got it back to the Dynamo script at the start here. It's just that-- it's not [? total r ?] but in the handout, all the samples that are given and additional material, I do have that to basically generate that formwork area for the sides. All right.

This is something, again, because it was a linear project, we didn't use-- we use grids for, I suppose the conical structure was quite simple, but all the elements associated with the track were set up via coordinates. And again, they need to be reported back. So we went through and we created, again, a Dynamo script that populated all the easting and northings and its relevance to rotations to true north. So to be set up-- and that was for everything within the project that was basically in the ground, even down to the bot-- yes, mate?

AUDIENCE: Did you guys self perform the formwork, or was that modeling order mandated? Basically [INAUDIBLE] area.

DALE HARRISON: Well. That was just an example to illustrate it. The reason they want it is because they wanted to quantify it. So then we could go to the sub-trades. Then they could go to their concrete [? goer ?] and go, OK, we've got this much formwork. That was the purpose.

AUDIENCE: That's a requirement, right?

DALE HARRISON: Pardon?

AUDIENCE: It was a requirement?

DALE HARRISON: It was a requirement, yeah. As well as-- they've got the top area, so they want it as well, because that would-- procuring curing agent for the top. And they'd paint it on and they'd know exactly how many square meters. And it'd just be a mathematical equation where they go, OK, had x amount of square meters for this work pack area. We're going to do and we need this much curing agent. Similar with the bonding agent between the pile cap and the plinths. Yeah.

AUDIENCE: OK, so you can [INAUDIBLE] that was facilitated elements between your subcontractor and say, yeah, so to perform more of what you guys get-- to a better value?

DALE HARRISON: To a better value, yep. So again, we use-- it's online to put it through and create, again, a shared parameter that had-- let me go back. These are shared parameters that are simple-- just true easting, northing, Z is just the top of the pile, and then it's cut off. We had rotation to true north as well.

So again, that information was given to the surveyor. He can input it-- and I'll show you further down the track just something different as well as we go through this. And I'll run through.

Again just a series of collections of categories that are fed through a list. And we obtain beyond this location here. And then what this does is just split it out into each point, so this is point X, Y, and Z. And then we go through the magic of a matrix transformation rotation. And I'll explain in a sec what that means. I've got a custom node as well. And all of this is just a series of shared parameters that it's all fed in a box that populates the family.

I'm trying to think of the best way to explain it, I always find this difficult to express. I was halfway through creating a video to illustrate, share coordinates, Revit, and all its relevance. To sum it up, so Revit uses the base point within the project. And what a what it is is that is like a PSE, PSM, or a benchmark. Anything you put in is relative to that benchmark and it subtracts the values away from real world coordinates.

Because Revit really-- when you put any information into it, it's just a graphical database. it has a reference point, which is a big number, and then from that reference point, it goes through and then sets everything out within simple Cartesian point numbers.

So what this script, and I know you can't quite see it, but this just goes through and grabs your project base point and then splits it out to go east, north, Z, rotation to true north. And then it uses this form in here, which is a matrix transformation rotation, because you've got something that's out there and you want to bring it into Revit and put it down here and then rotate it to your project true north rotation.

And that's what it does. It grabs your perameters that set out your project base point. It goes through, and all the other points that you're going to bring through. And just subtraction, and basically takes it from up here in real world coordinates, and brings back down here, because your project base point is already set to true world coordinates.

So that's what that node does. And then this is element to true north of rotation. I Could have wrapped this up in the first slide, but this just, again, illustrates where it goes through and collects all the elements within your project, puts it through, finds its rotation to true north-- sorry, its rotation on its axis, and then this will just set up to basically get the project rotation to true north. And then it just subtracts it from 360 degrees and that populates that value.

And then again, because we're using-- it's a infrastructure project-- nothing's [? Pi r ?]

squared. The rail line did have a huge arc in it, so when elements were put in. They were faceted and rotated, and you had to have the rotation to true north. So when you supplied the information, this and that, there you have it.

And then from that, we had the data set. So we've got the base plate caplet, and within that you've got true eastings, true northings saying we're it's basically located. And similarly again, this nested bolt that's within it does have eastings, northings, its rotation to true north, there, and just some other things I suppose that we had as well was the shaft length, [INAUDIBLE], bolt projection and things like that. So again, we gave all that information that the VDC guys had to set it out for the surveyor.

Additionally to this, the surveying team I said in Australia that were using 12D that were recreating synthetic models of-- synthetic models are just sort of 3D line work. So we were providing them 3D line work of all the concrete and model elements.

So to do that, you physically have to go around and try out each element. Or you could just export 2D plan, and that then gives a 2D DWG.

So this is just an extension of that formwork node where we located the top surface of all elements within the Dynamo node for formwork area and just added surface perimeter curve-- so it just draws a line-- and then we just push that line into the model. So what it did is, it went through and drew the top perimeter of every concrete element and-- for this guy back one, this is an example-- so it's drawing on the top of the plinth and the top of the pile cap there.

And that was a 3D file that we gave to the surveyor that [INAUDIBLE] to a plugin and then goes and sets everything out as well. And that's just is real cost example of that line work that was given to him.

Another thing we had to do was we had the overhead Gantry crane and all the other associated infrastructure stuff that would sometimes need be removed through clash detection. And trying to physically move that in Revit, where it's in real world coordinates, is pretty difficult, because someone would go, I want you to move it to coordinate X, Y, and Z and it was difficult. It's not like AutoCAD where you can just type and move. Punch in the location and it'll move to it.

So again, the solution we used was Dynamo. So this is showing the location of the overhead Gantry for the electric overhead powerlines.

So this simple node, when you go through it, you select the element you want to move. You put in the coordinates that you want it to move to, so it'd be 9. This was just do the matrix-- 2D matrix transformation where I had to get those nodes, work out where the project base point is within Revit, go up to their mover, into it's location defined here. Once it's been moved, you want to update those parameters, because again, they aren't a field that gets updated, so you sort of push it back into from here all the way down, and go through the process of recreating its location and then putting it back into the custom node.

I'm pretty sure-- it took me a while to understand this-- not over everyone's head. Does everyone understand what I'm saying? Just with the accent?

OK. We used the-- Dynamo set out the pre-cast platform walls. There is, in this video-- and they're showing you the family before where the entire crane springs around and drops it into place simply like that. It wasn't quite as easy as that, but it was to a sort of point where-- in the route, we had, on some of the platforms, a horizontal and vertical curvature. So the platform wall was kind of doing like that, and then to go through and model that was not as simple as, all right, where you go, that's just a simple flat platform wall, you create an array down the platform, job done. It wasn't quite as simple as that.

What was actually happening was the platform wall was all the stepping up and then rotating as it was moving, or would be doing the opposite, going along, diving down, and then rotating to suit the track alignment.

This is an example of the platform foundation as [? employed. ?] And then from here, you've got these little, little black lines that you can see. And then with the holding down bolts for those precast platform walls.

And then this is a precast platform walls put in place. So to manually go through and model in Revit just took a long time at first, the first time I did it, until I worked out how to do it in Dynamo. So I suppose I should explain the input. The input we got was from the rail team. So they were using 12D.

So what they did is they gave me a 3D string, and a 3D string was the exact location of the platform edge angle. So it was an offset from the center line of the track based on how we're going to construct the precast platform wall, and they gave me a string. From that string, just in simple CAD and using a tool of points, I started the measure tool in AutoCAD where I just

went along and measured that line along that axis. Gave me a point at every eight meters, and all it did is went through along that line. And during a point, I used the data extraction tool to extract those points, and all I got out of that was X, Y, and Z along that line, so it divided that line up.

X, Y, and Z, used a dot extraction tool, put it in Excel, and then used Dynamo to bring in. The reason I didn't use-- bringing the CAD into Revit-- the line work-- or the tracking alignment had lots of spiral curves, and I just wanted to make sure the geometry that I was bringing in was true to the information I was receiving from the rail team.

So just to give you a quick rundown of what this node does. I don't know if you've seen other ones bringing in Excel into Revit. All it is is it goes through and opens up the Excel file, puts in the name, and then in here we've got basically fields on the top where it was X1, Y1, Z1. And these are just the indexes in the top of the fields, and this just sort it out, flattens it, removes the top column.

So now we've got X, Y, Z. Pushes that up and into, again, the node that I keep using, which is the transformation, because I'm taking real world coordinates back relative to Revit's real world coordinates and subtracting it. Creating points again. Creating a line from points in a list-- I'm sorry, reversing the line, creating a poly curve, and then closing it. And then just using this simple Create of Structural Beam family. So all those precast platform walls were just beam family. And the way the precast platform wall was modeled, and the next here.

From here to here was just your typical sort of block of beam family-- point start, end point-- and know where the X and Y values are based on. From here, creating a line and then putting it in. Simple like that. And because again, we had everything nested into the beam family, setting it out was easy.

Again, using the holding down bolt, yes, was nested into the precast unit, so it was like the chicken and the egg. You put the precast panel in the right spot, but the starter bar [? counting ?] before, they should put the starter bar in the correct location. You know the precast panel was going to go in the correct spot. And again, we're able to provide them all that information of it's the set at point of X, Y, and Z.

AUDIENCE: [INAUDIBLE]?

DALE HARRISON: No. No. So the precast panels-- so I said there was a horizontal and a vertical cross-grade.

There was enough tolerance between the panels, so when you were fastening along that alignment, you were able type that in.

So that's the actual precast panels getting installed. So there were 150 roughly that went in, and 350 of those starter bars, not one had to be cut out and redone. Every single one went in. And I was quite surprised myself that it all went in.

Additionally, this whole gripe, getting information from the rails team, they give it to you, but what good is it if you model it all? How do you QA it? So it's just a simple, simple node where what it would do, it'd go through, grab the edge angles, the edge angles sitting on the top of the platform there, you can see the horizontal and vertical curve.

And again, it was pretty cool to have all that set out in the right location. And this node, just when you go through and grab the edge angle, all these instances, because again, they're all name the same things, it's quite easy. Get its location as a curve, and I would just draw a line again in Revit.

Would give that line to 12D team, which is using-- so the rail team is using 12D. And what they were able to do is because originally they gave me a string to set it out. I'd modeled everything and I gave that string back to them, and now I were to run a report, and then from that report, just work out anything out in terms of that. And here, it was about one mil in a couple of locations, so you can sleep with that in terms of the tolerance issue.

So data input. Part of the very same time, what they were doing is they were inputting information into the model all the time to produce work pack documents as well as the entire [? data ?] to Primavera and then they're put in Navisworks. So their task was to go through and basically tag every element. And you can sort of see they had work pack ID, which meant the area that the work occurred in as well as the procurement ID, and that tied back basically the primary key that went into Primavera.

So the challenge that I suppose had was, originally, the VDC team just wanted every single element individually modeled, because they wanted to just input the data, because it was easier for them. I was like, no way. You can't have that. So again, not a solution. I kept banging on Dynamo. This is basically using fork nodes. And all it does is, you select the host family and it just splits it up by inputting elements into shared parameters that we had. So we work pack ID and progress to count.

And what I would do is, you just select, say, for instance, that precast unit. Select that one there and you're able to then input the progress to count value as well as then, it would put through the progress to count value for the starter bar. It just meant, again, when I put it in-- Navisworks, and tied that to Primavera, it was simple, instead of someone physically having to go through each element using tabs, sorting through all those elements.

This is just a snippet out of the video where-- from this, we generally don't model reinforcement in Australia, but part of the design was 50 year lifecycle, so there were no bearing pads in the bridge. It was an integral bridge, so there was no tolerance. We had to put the beams in within 2 mil tolerance. It just meant chicken and the egg, you had to put in the reinforcement in the right spot to suit the holding down bolts so that the beam can drop in.

So our original documentation looked at this, where we had the pier. We had the re-enforcement arrangement, and I suppose the section through the column and a section through the beam. Where in reality, when I went to build it, it looked like this.

We had-- it wasn't a lattice side congested. Because of working as an engineer, where the contractor would say, that's congested reinforcement, but it's not. It was-- we modeled the reinforcement for the pier. Not so much for scheduling, just so that it could be built. The platform for this pier was six meters up in the air. It was adjacent to live rail and it had to be, I suppose, just working in heights and safety. As well as complying to the contractor's philosophy of design for manufacture.

So we had the column. We had their rebar manufactured offsite. We had the holding down bolts that weighed roughly 100 kilos each. And then all the additional collision lighting reinforcement that went in inside around that corner. So the purpose, again, we modeled the reinforcement to ensure that it fit, the holding down bolts were located exactly, and that there would be no sort of issues on the site.

The formwork team said for them originally to set this up, it would've taken them six days to do it and I don't think they would've gotten the holding down bolts in the correct location. We were able to do it in two days because we sat there with them, illustrated to them, had a work pack documentation set out the show, this is how you're going to built it. This is how you're going to assemble it.

So this is just a couple of images when they were building it onsite. Like I said, you had the column, the main carriage in the background. Starting to assemble it with a holding down bolts

in place. And then this is sort of the finished product before they closed up the formwork where you've got all the reinforcement in and around tide holding it up together.

And that's, I suppose, just to give you a perspective of the size of those balls. Yeah, they're big, they're roughly bigger than my arm. All of them.

And that's an illustration where in Navisworks where we had the reinforcement and then downstream, because we had set the holding down bolts in the position. That information then was fed to the fabricator, because almost to a point where the bolts were put in place before the fabrication took place. And when I brought it out to site, the steel work fabricator couldn't believe that it actually just dropped into place like that video, cause you look at the video and go, did that really happen? Yeah, It did. [? On site. ?]

OpenBIM collaboration. I suppose what we had to do was pass on information downstream. So I was talking-- before that-- coordinates, and I think the majority of what I'm in are actually present is now superceded in terms of workflow. Because there's a couple of changes that have occurred earlier this year from Tekla as well as ArchiCAD.

So on this project, we had the shop data was using ArchiCAD and-- let me start again. The steelwork shop day towers we're using Tekla, where the precast fabricators we're using ArchiCAD. And so there's always been in the past issues about real world coordinates and IFC and associated. So what we were doing is we're running parallel coordinate systems.

So we had SR coordinate system, which was 99% of the time what we're using. The 1% that we weren't, we had IFC. So that was just zero-zero. So what it meant was the project base point was always generally true world with its rotation, where when we exported it out to IFC, you had zero-zero.

This has actually changed now, you don't need to do this. If you have the Graphisoft-ArchiCAD exporter, it does give you the option to export your IFC with zero-zero.

So I suppose Y can't be used. This is, again, it's why we got this project, but the schema makes IFC local placement relative to optional. And what happens is, [INAUDIBLE] s before Revit's project base point puts an object, the Cartesian points relative to those base points, and just makes the numbers quite simple and small, where using Tekla and ArchiCAD, if you want it in world coordinates, the Cartesian points associated are actually the real world coordinates. So if you exchange that information back into Revit, Revit's 20-mile radius, it's

beyond that.

So this is just the definition of local placement defines relative to the relationship of a product absolute. And this is the one that's sort of the optional attribute, where if it goes in and you don't have a world-- basically the base point in Revit, it creates, like I said, the Cartesian points with world coordinates.

This is a couple of examples of the different types of files. This is the IFC file created in Revit. It's a bit hard to see here, but that's an IFC. Cartesian point. And that value there is the world coordinate value, where this is the one where we export it and it's got zero-zero associated to it. And this is the file from Tekla where it's zero-zero. And then all the other-- you can't quite see it, but then the elements within that, their Cartesian points are real world coordinates.

One of the solutions that we didn't use but has been used after speaking to gym geometry. So John Mission, he's created an add-on to input IFC into Revit and export IFC out of Revit. And it gives you-- I suppose what's fundamentally missing at the moment when you import anything into Revit is project base point.

So this allows you to basically import and IFC file into Revit. It imports it into the correct location using your project base point. Does that so it-- like I was explaining it-- transform matrix rotation and brings it in the right location, as well as when it brings it in, you can bring it into a current file-- you don't have to open a blank new file and link it through. And as well, it removes bolts and assembly.

One of the things we did have to do, part of the job was step down the LOD, meaning this was-- we had still fabricated precast fabricator producing IFC files with a lot of geometry, where we had MEP service team that was still working away and still needed to be coordinating with the fabricator's models within Revit.

So to bring that model into Revit would take about eight hours just due to the amount of polygons that are associated with all the bolts, where all you really needed to do it within the project was just bring in, I suppose, step it down from LOD 400 down to 350, just have all your [? gas up lights ?] and all the things that the service guys that are still running the services needed to coordinate with.

So what we used, because it's not a simple import function when you import IFC into Revit, you go, do not import bolts, do not import this, do not import that. We used simplebim. It's just

an IFC editor where we opened up the IFC from the fabricator, filtered out the geometry that we didn't want to bring back into Revit. So we removed all the bolts and all the plates.

And even-- I suppose the fabric fabricator's bolts and that were all in different layers and they a bit all over the shop. There was no easy way to do it except using simplebim where we opened it up, stripped out the nuts and bolts effectively, recreated the IFC file, and brought that back into the Revit.

One of the other things that we used was an automation tool, because now we are using Revit, IFC exchanges, and NWCs for the [? yards ?] in Navisworks. So to do it, we're using, as well, three different platforms to check it. We were using RTV Tools, the automation tool. And what this allowed us to do was just do simple tasks overnight where it's run overnight, create all the PDFs, create the IFCs, create all the NWCs, as well as the drawing shows anything to be revved up, just sort of managed and handled that for us as well in terms of the automation.

So this is an image of the project where in-- yeah, as of October. So it's an aerial view looking at the station where the western concourse roof is partially-- the cladding is partially complete. The steelwork's up. The acing concourse is getting there where the main concourse coming up to the final track and-- what actually happened is-- that roof's finished, this roof's actually up now today as well, it's been all put up.

These are sort of the lessons that we took out of it. Modeling from the instruction and not documentation and just understanding what needed to be done, but to be honest, you had to have the construction team working with you to tell you what they wanted. And had to be honest, in terms of your modeling skills for use. And what didn't work was-- because we're using Revit, project-wise, Revit integration, work sharing monitor didn't work, element requesting-- so that was just the network latency-- and just communication.

Again, to be collaborated all at the same time where we're using Lync and Skype where, obviously in my office or at home or in the [? Akiem ?] office, and we were just able then to coordinate with the contractor to guys that are on the VDC team that are working live in the model as well, we'd be, just Linked-- hey, what are you doing? Can you sort that out? And then to be able to resolve it.

So I hope from this you were able take away that Revit can be use for infrastructure documentation using Dynamo. Revit modeling techniques to support downstream workflows for construction management. And OpenBIM file formats used effectively in Revit for

coordination. Questions? No? Yeah?

AUDIENCE: When I did the formwork calculations, what happened to joining--

DALE HARRISON: Joining phase? The node that I've got there-- so let me start again. When face were joined? It wouldn't work. It'd basically give you an overall-- so it wouldn't take the difference away. So if you had a grand beam coming into the sort of a plinth, you would get the formwork area total for the plinth and as well as you'd get the total formwork area for the beam.

AUDIENCE: [INAUDIBLE]. Could you mention about what are the issues [INAUDIBLE], different types of [INAUDIBLE]. I missed that.

DALE HARRISON: You missed that. I'll grab the question at the back and I'll show you how we used-- yeah?

AUDIENCE: I was wondering how you account the uses of [INAUDIBLE]. How'd you find the staff to document these [INAUDIBLE]?

DALE HARRISON: I pretty much did most of that, yeah. So if I produce it and created a family did it all, then it would be other people using it. And that was the only way to mitigate it. As well as they've been down, so ensuring the coordinates were correct. If anything was done. Because it's static and you have to rerun it again to input that information, so if someone does go through and changes the model-- and elements do change-- you've got to rerun those scripts to input that information.

AUDIENCE: You mentioned at the start that the technology was at an earlier start, the [INAUDIBLE] wasn't working. If you had to do the same thing today, what would you do differently as far as the setup, with the technology that's available?

DALE HARRISON: Well, to be honest, nothing. Because we were on-- what that image before, when we were in Perth, that data center, OC3R's data centers in Sydney, so we still get their network latency. So until there's a data center built in Perth, yeah. Then it'll remove that.

AUDIENCE: How many people were involved in the [INAUDIBLE]?

DALE HARRISON: On this project? So in the design team, there were four. On the contractor's, it varied, because they had what you call work pack engineers looking at peculiar elements, and it varied between three and six.

AUDIENCE: Were you in control of the main [? fall? ?]

DALE HARRISON: We were in control of the main [? fall. ?] The ownership was joint, but we had ownership of the model elements.

AUDIENCE: What program was used to do this file sharing? Did you have to update the database sometimes from a sync or file?

DALE HARRISON: Sorry, say that again?

AUDIENCE: You needed a program to share your--

DALE HARRISON: Yep.

AUDIENCE: Is that [INAUDIBLE]? Is that an [? allotment ?] machine that updates your files or no? You just get on a file exchange or--

DALE HARRISON: No, OK. So I'll go back to your original question and we'll answer that same question at the same time.

AUDIENCE: What I had done, and I described recently is some [INAUDIBLE].

DALE HARRISON: We use Bently Projectwise as our common data environment where we shared all the information on. So the way the project works is it's security based. So for you to access the network, you get invited to it, you get assigned roles and permissions to it.

So with it, you'd have users would gain access to it. So I could get into Projectwise and work on the architect's model or the MEP's model or any model. So again, anyone, as long as you have permission to the folder--

AUDIENCE: Permission is the key.

DALE HARRISON: The permission is the key. Yeah. And a big stick. So it's file based, but it's live, and the way it works is it caches to your C drive, so all of those files cached in. If you do make a change, it does get back up into the cloud, and then it's distributed back down. But then there is a change register and it tells me or anyone if anything happened.

So if you hop in any of-- if someone goes, something's happened, this is being delayed or this has been out of wire, we're able to then-- it's got a audit trail. I could just have a look at the audit trail and go, OK, you hopped into the model, you are the person that caused or-- yeah.

So it's always sort of-- you've got that audit trail as well associated with it.

AUDIENCE: How would you [INAUDIBLE]?

DALE HARRISON: Yep.

AUDIENCE: So that talks about the new [INAUDIBLE].

DALE HARRISON: Yeah. We talked about it. So they do have a document in terms of the workflow with that. But what we found is, you granularly break down the model by work sets. Have strict rules on who does what. So you'll have-- the way the project was run, we were the consultants, so we did all the modeling and produced their design documentation.

We're relying on [? on role ?] produced their work pack documentation, but then also we had to input the data they required for construction. For them to do their forward sequencing and link Primavera within Navisworks, they were inputting information that way.

AUDIENCE: So the process now in problems--

DALE HARRISON: Yes.

AUDIENCE: [INAUDIBLE] right? When you did that, did that [INAUDIBLE]?

DALE HARRISON: We still had problems where-- I explained in-- so this one here. The issue to it was you had to cache your C drive in the morning. So it very typical is a gig of data for a file. And the way it works is if you went straight through the normal Projectwise interface, you opened it up, and started caching down. So then locks all of your users out of the file. So that was one of the key issues.

So we sort of said, if you're new to the project or you haven't worked on the file within a week or whatever or even that day, if there's been major changes, you cache that to your C drive and then you can open it up.

But you did have people open it up and then walk away. And then were like, it's locked. So then the file's locked and then-- all I had to do was refuse, so I had admin rights-- so I could just free that file, kick that person out.

It's like anything, we also had files getting corrupted on Projectwise and pulling them down recreating central files and putting him back up. So this did enable to work. So we've done it--

we're currently working on another train station and laying the rock as well, and doing exactly the same thing.

AUDIENCE: Now, is this normal [INAUDIBLE] construction?

DALE HARRISON: No-- yeah-- just one second, I'm going to go back to the first slide. We're an alliance. So cause we're an alliance, we have the owner as well as-- because we're an alliance, we were able to do it. Otherwise you wouldn't do it, because contractually, it would be too difficult. it created a few gray areas like when to start, when to finish, what was handed over. Hence why we were the custodian of the geometry modeling and now with the data.

AUDIENCE: Right. That's the project alliance. Is there [INAUDIBLE]?

DALE HARRISON: That was initially a project alliance. And then from that, that was successful and went to the next station.