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Crossing the Bridge – Mott MacDonald's Digital transformation

CES501642

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Presenters

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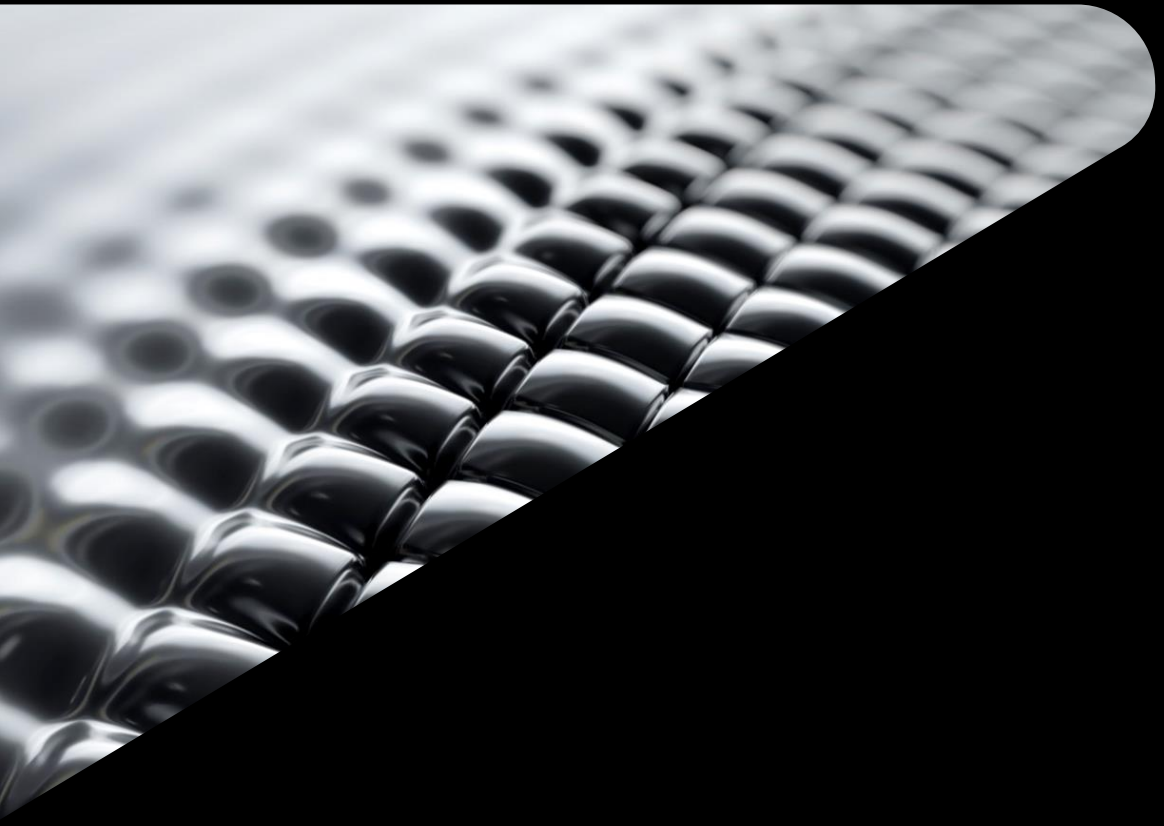
Working with Mott MacDonald for 4 years. Structural Engineer with focus on Bridges and Civil structures modelling and automation.
Based in Prague, Czech Republic

Paul Briedis - Digital Lead

Working with Mott MacDonald for 18 years, originally as a Highways Engineer and the last 6 years as Digital Lead supporting the delivery of Transportation projects.
Based in Prague, Czech Republic



Introduction

Why should you stay in the room?

Clients & Asset Owners

- Challenges and solutions faced by project teams
- Client Information requirements

Product Users

- Different solutions for different problems
- No two projects the same

Bridge engineering details not covered in this presentation

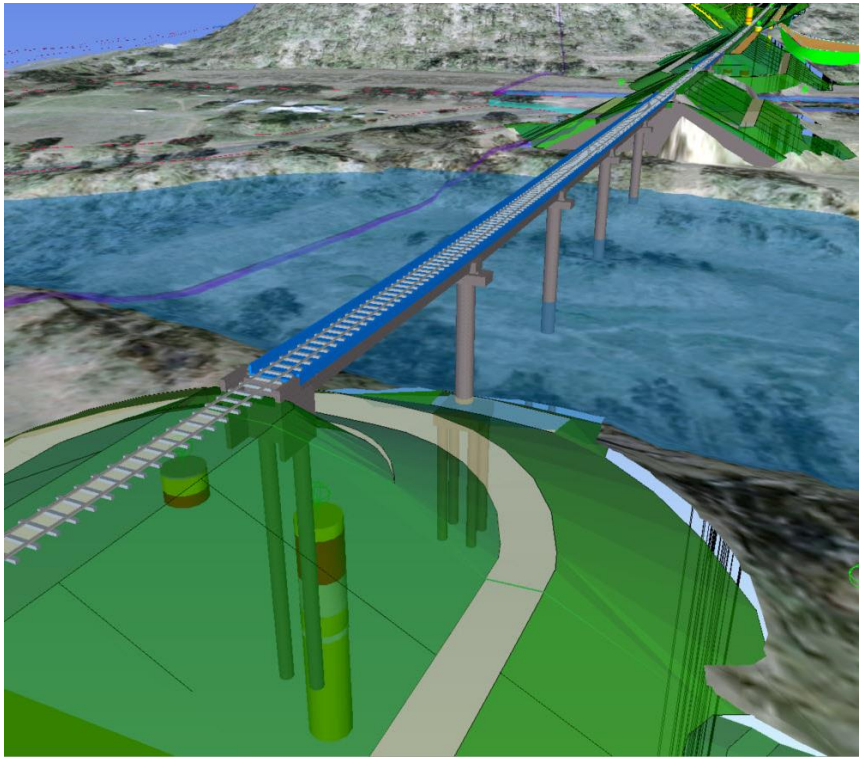
Content represents a sample of Bridge projects delivered by Mott MacDonald

Many lessons learned in 5 years

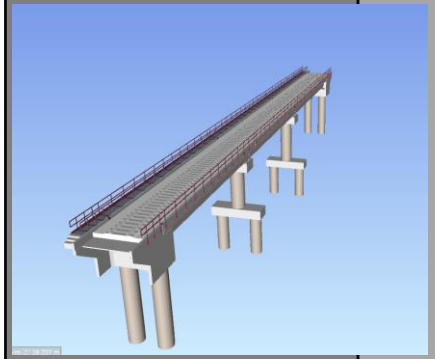
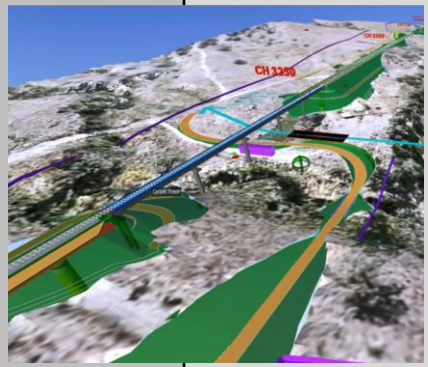
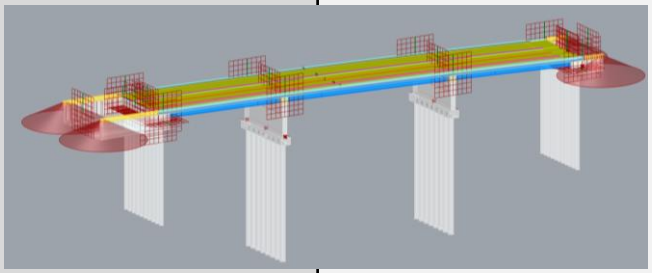
Delivering bridges on large-scale multi-discipline projects

2D AutoCAD

Collection of tools



Our Journey

2018	2019	2020	2021	2022
Rail projects, Australia		Rail Project, Australia		Tender Design
				Detail Design
	Major Highway Project, UK		Major Highway Project, UK	
				

Our key challenges… both then and now

Delivery

- Client requirements
- Responding to change
- Quality and consistency
- Single Source of Truth

Technology

- Capabilities
- Limitations
- Information Management

Winning Hearts and Minds

- Not just a pretty-looking 3D model
- Evolution not revolution

Your challenges could be different

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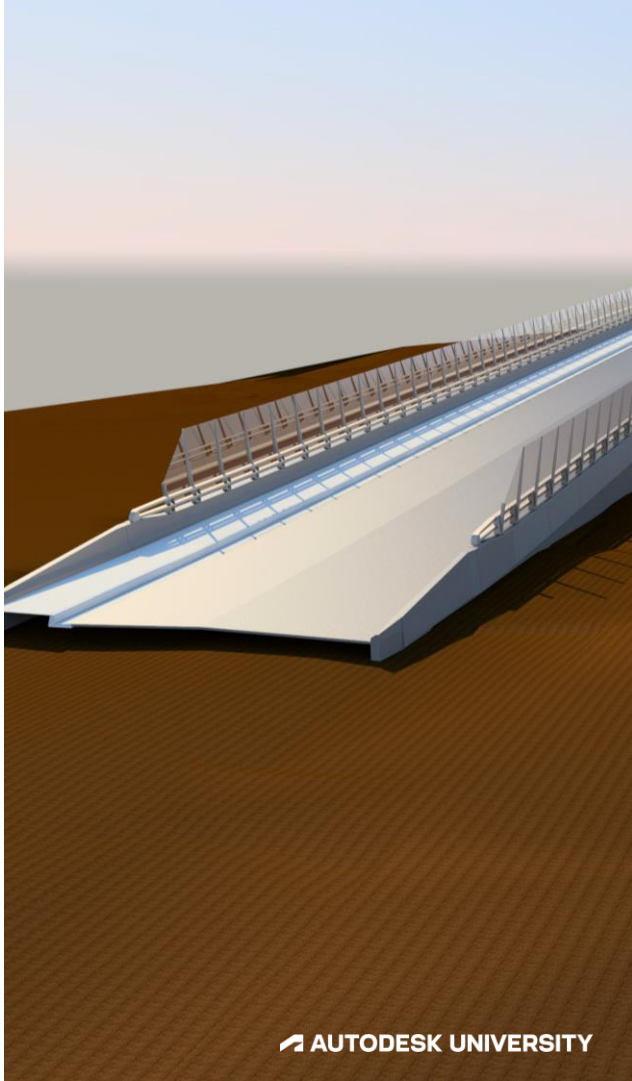
Rail Projects #1, Australia

Rail Projects, Australia

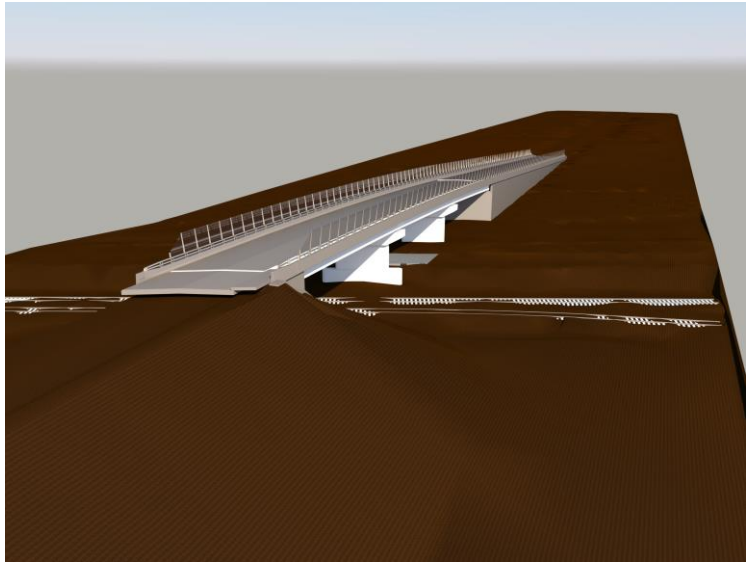
Project information

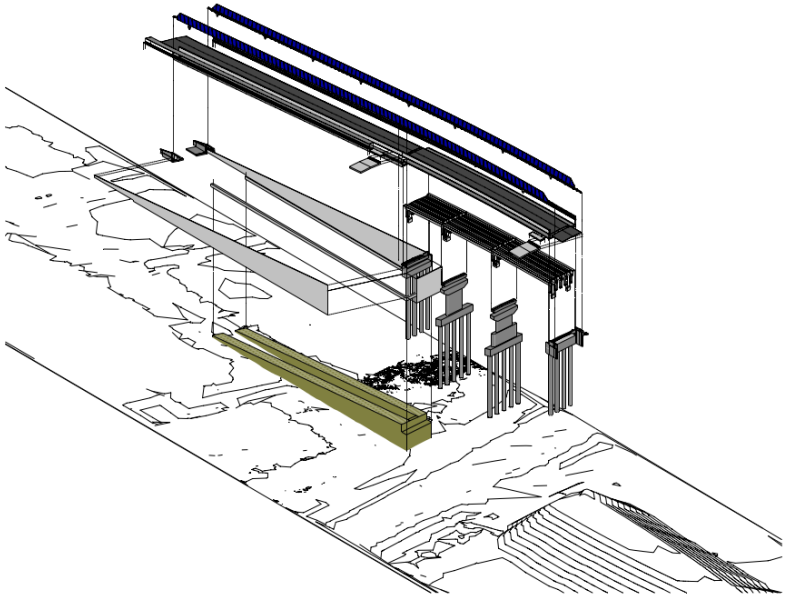
- Detail Design for major railway upgrade
- Design and documentation for 2 road and 3 rail bridges
- Client Information Requirements & Deliverables
  - Native Revit
  - LOD3 + minor attribute information
- Our first bridges project delivered in Revit.
- Revit 2017, (Dynamo), Bentley RailTrack & InRoads



What did we do?

Model Production



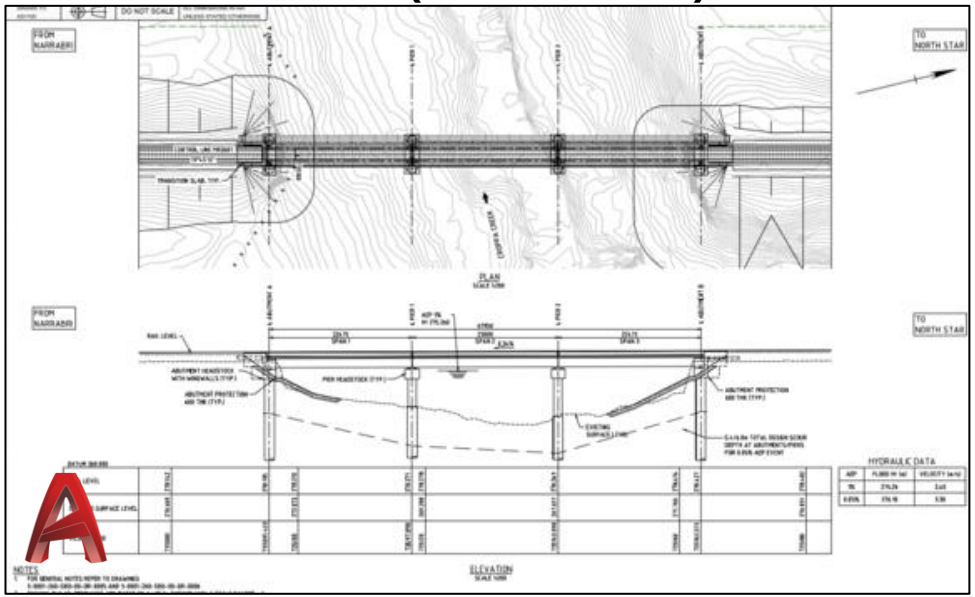


Understand time and effort to create the model – and the value it brings (*convince*)

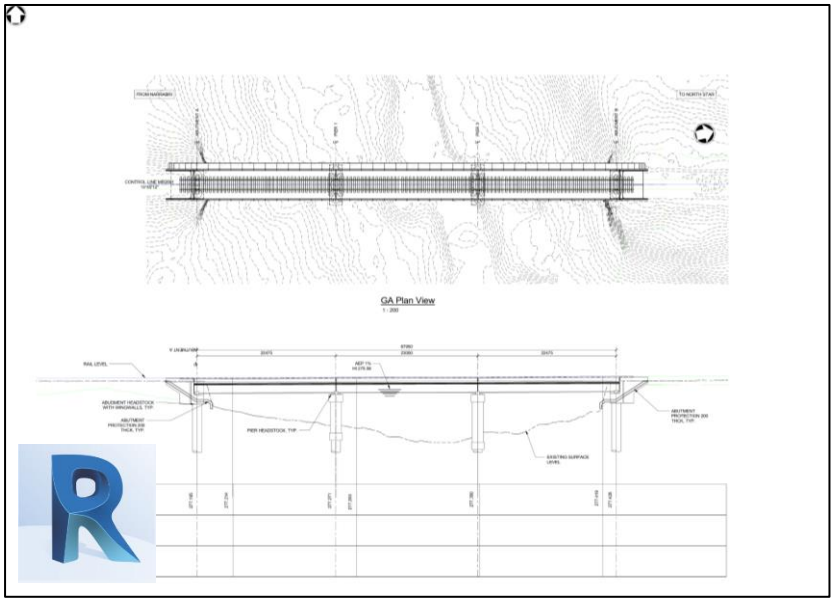
What did we do?

Drawing Production

AutoCAD (traditional 2D)



Revit



Understand time and effort to create Detail design drawings from a model (*convince*)

Project Summary

Challenges

- Limited resources available
- Drawing production
- Value from the model
- Limited engagement by the engineering team

Lessons Learnt

- Parallel delivery good approach for drawing production
- Early planning and engagement with team
- Expand our modelling capabilities
- Better Dynamo organization
- Understanding of time, effort and value that goes into modelling

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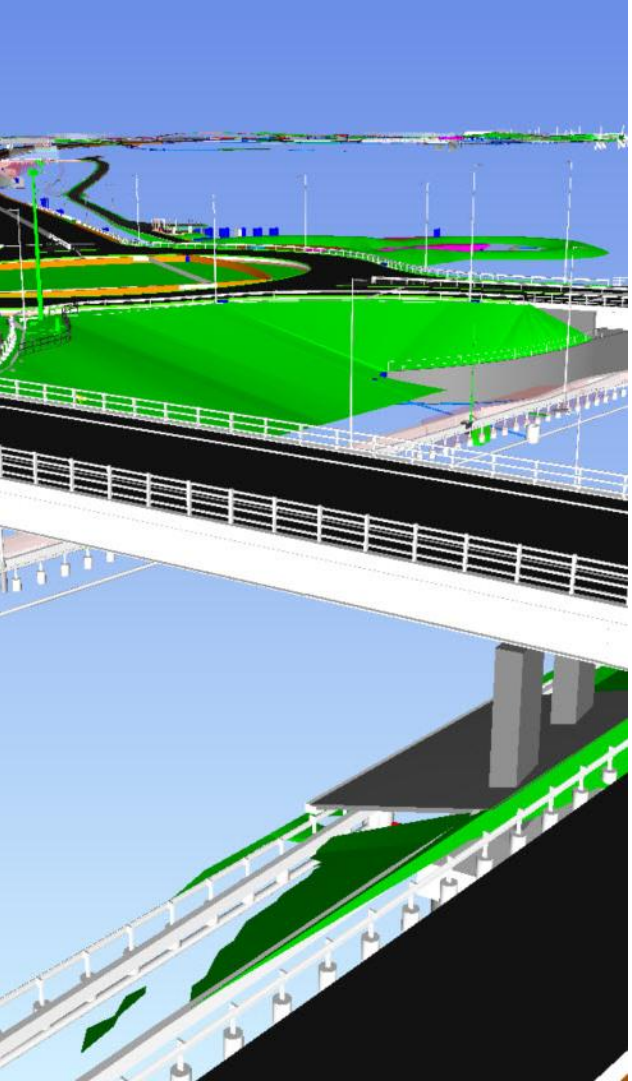
Major Highways Project #1, U.K.



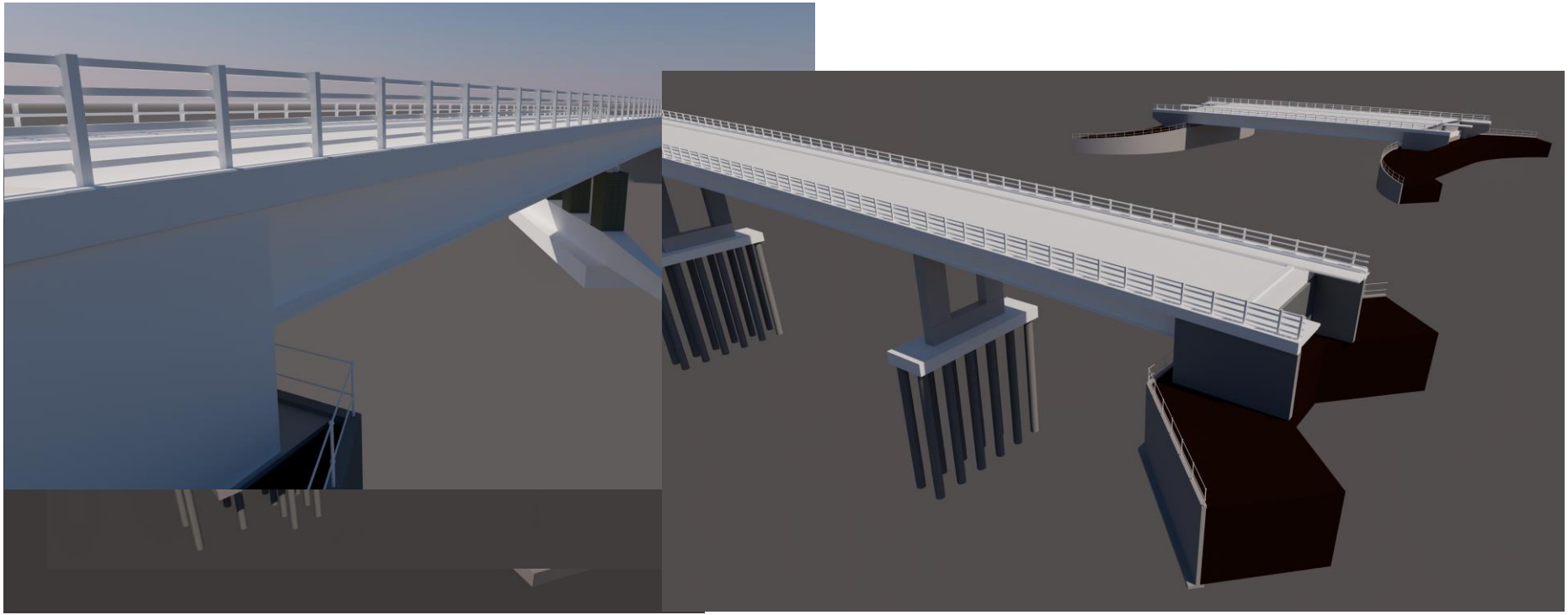
Major Highways Project #1, UK

Project information

- Major highways project
- Detail design
- Several structure types
- LOD4 + minor attribute information
- Digitally mature Client
- Revit 2020, Dynamo, Civil 3D 2020

What did we do

First Detail Design project fully delivered in Revit

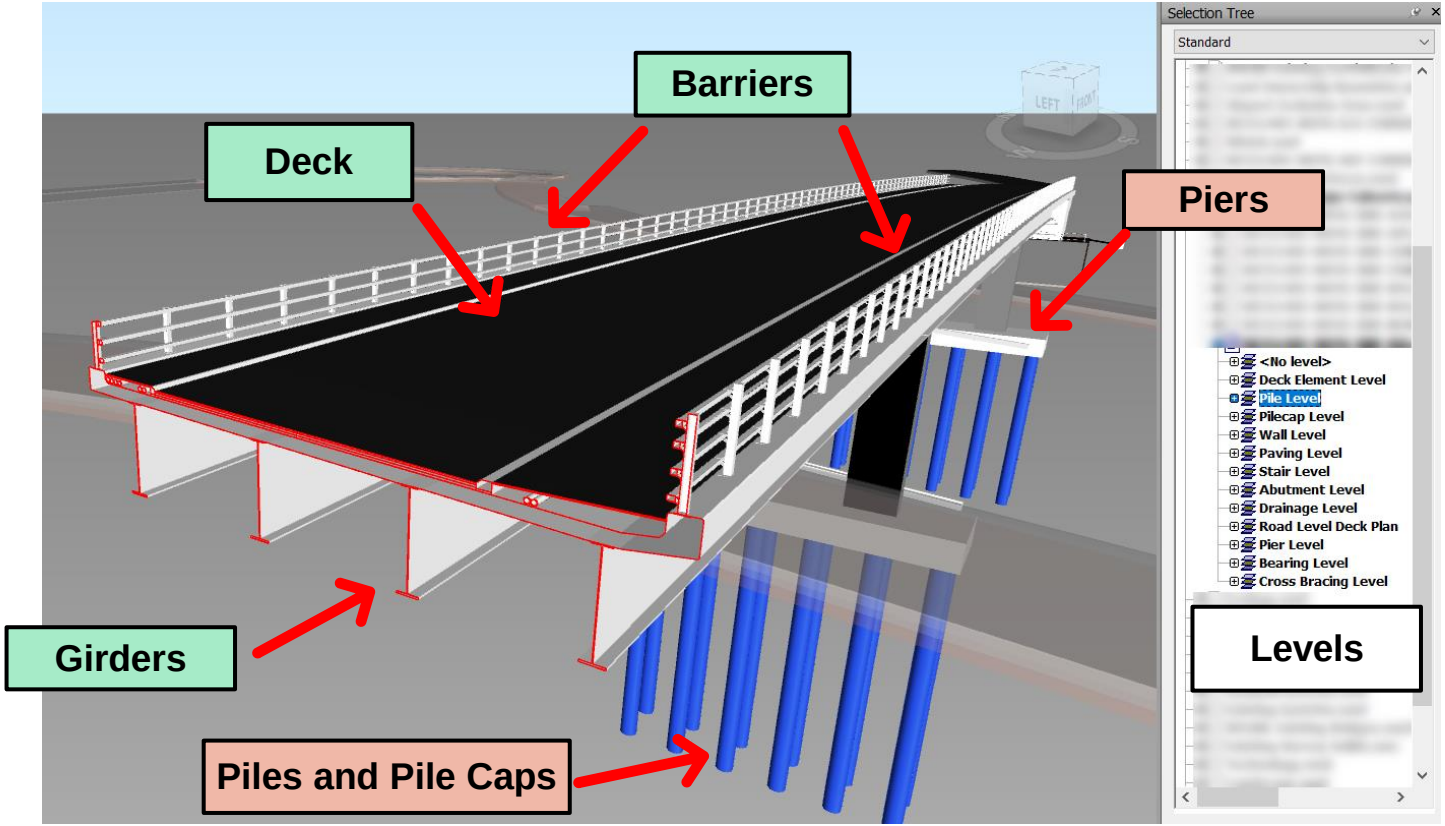


What did we do?

Breaking down the model

Placed Dynamo

Placed manually



Key challenge is responding to changing Highway geometry.

Modelling workflow needs to allow for this.

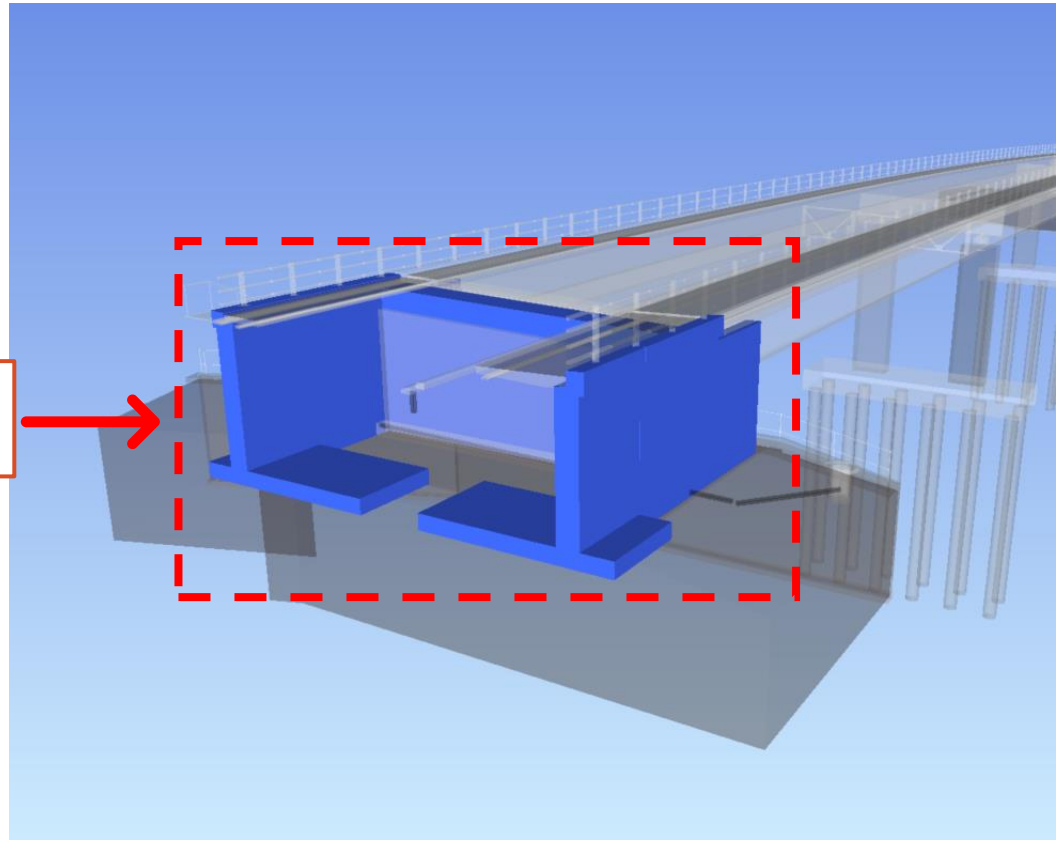
We kept our scripts small and easy to debug.

Understand value of accessible Content Library

What did we do?

Breaking down the model

Abutment
Model in place

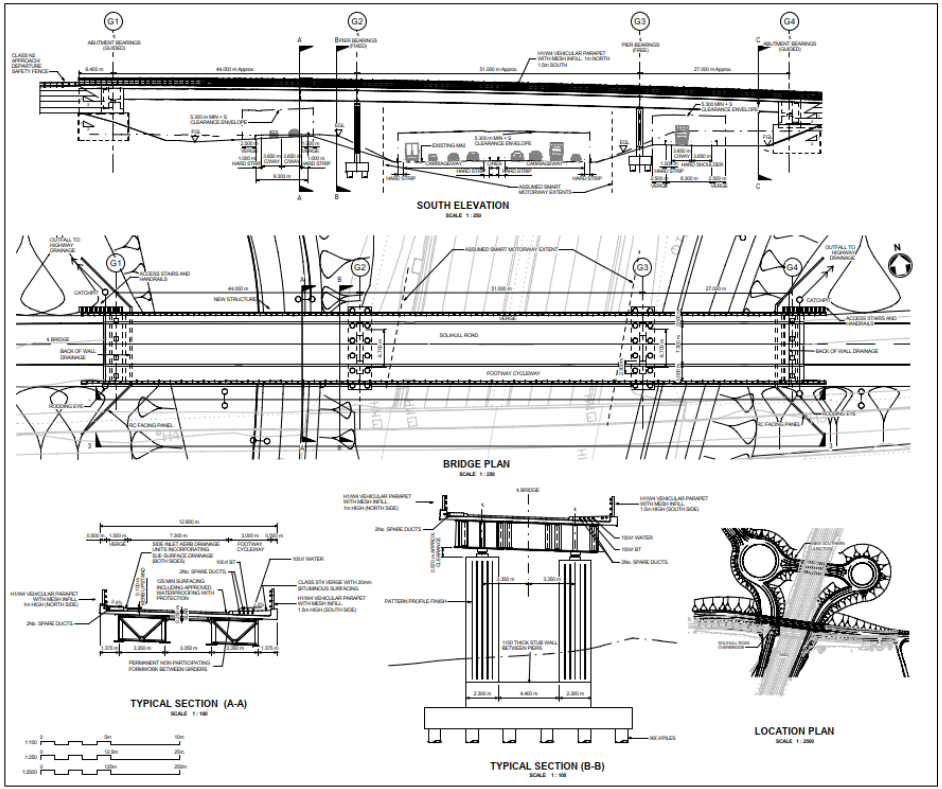


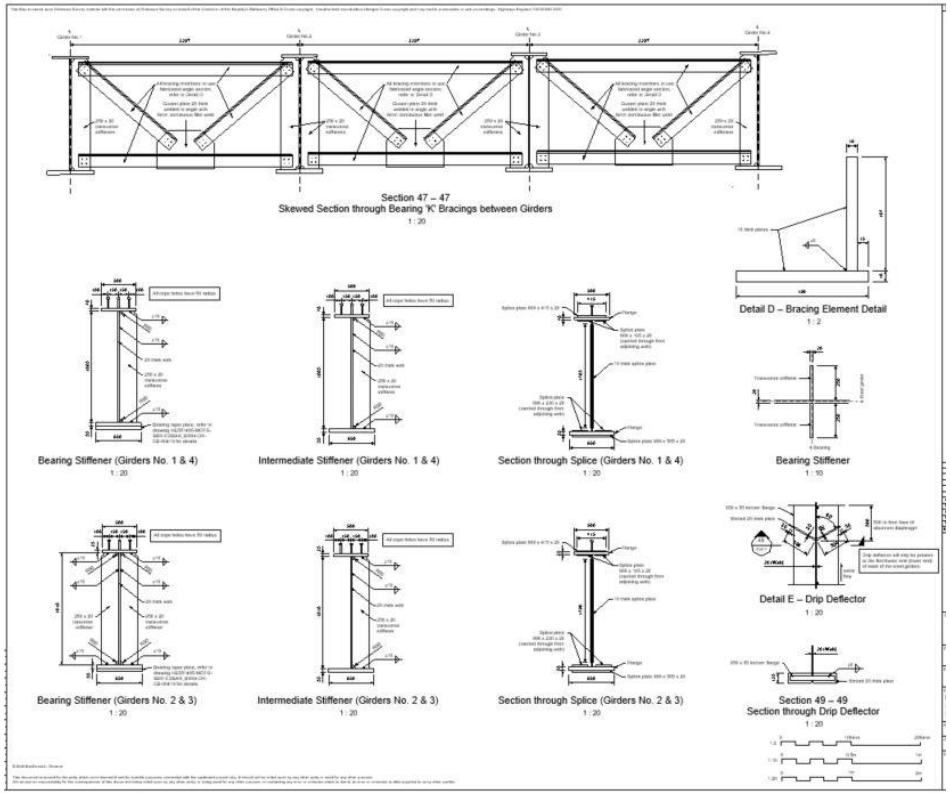
Good example of understanding the *why* we are doing something.

If staff are not aware, then we introduce problems

What did we do?

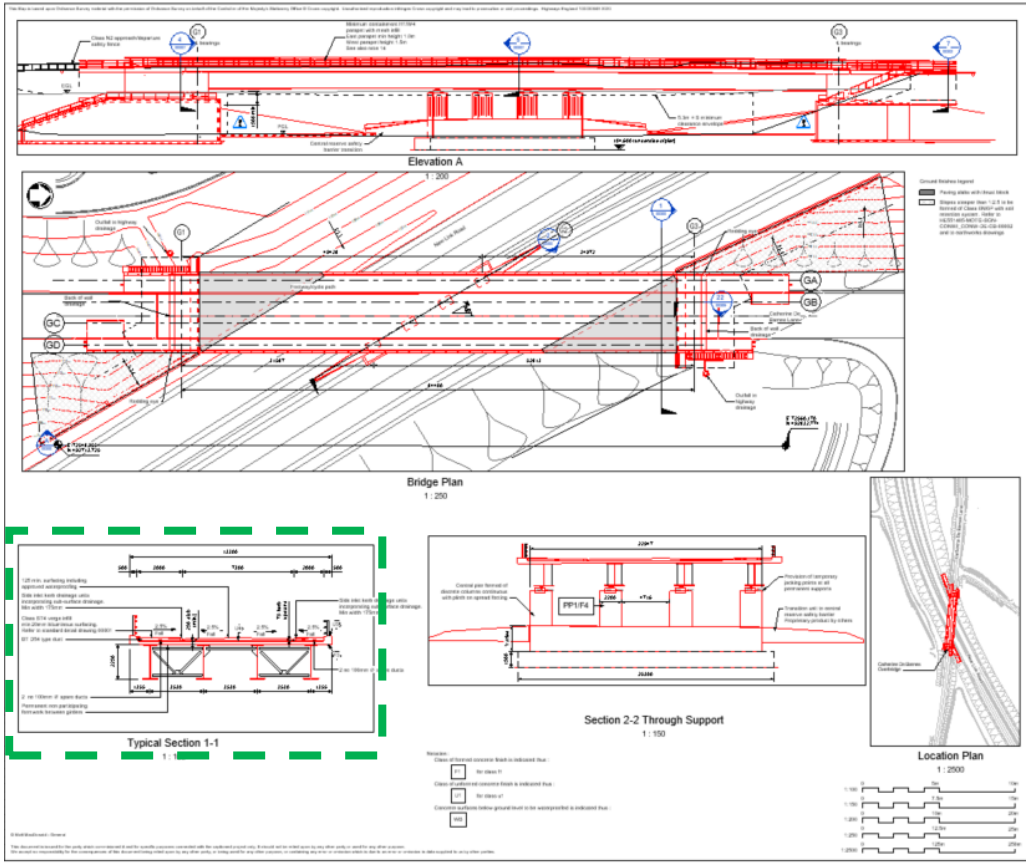
Drawing production





What did we do?

Drawing production

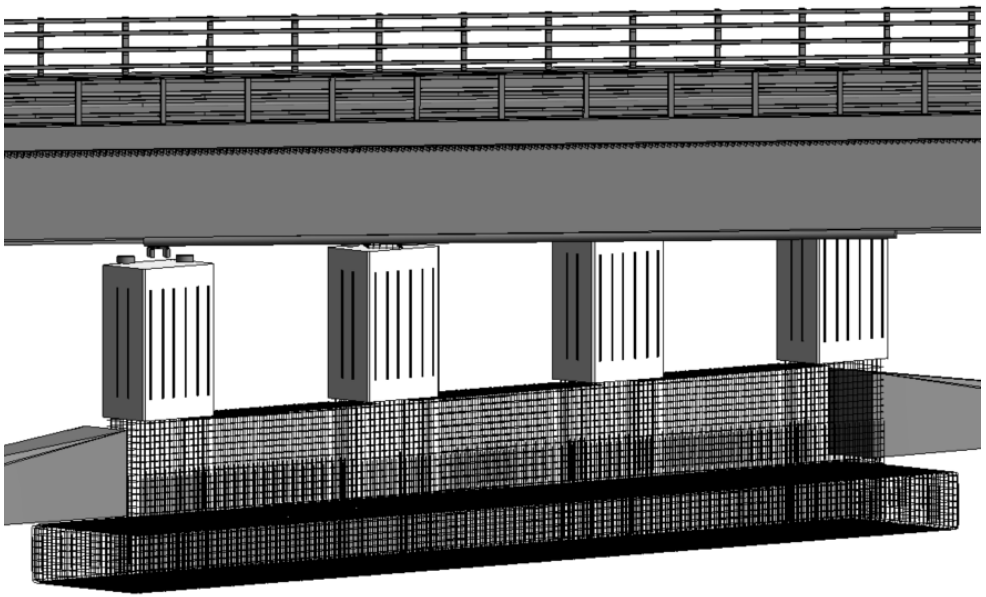


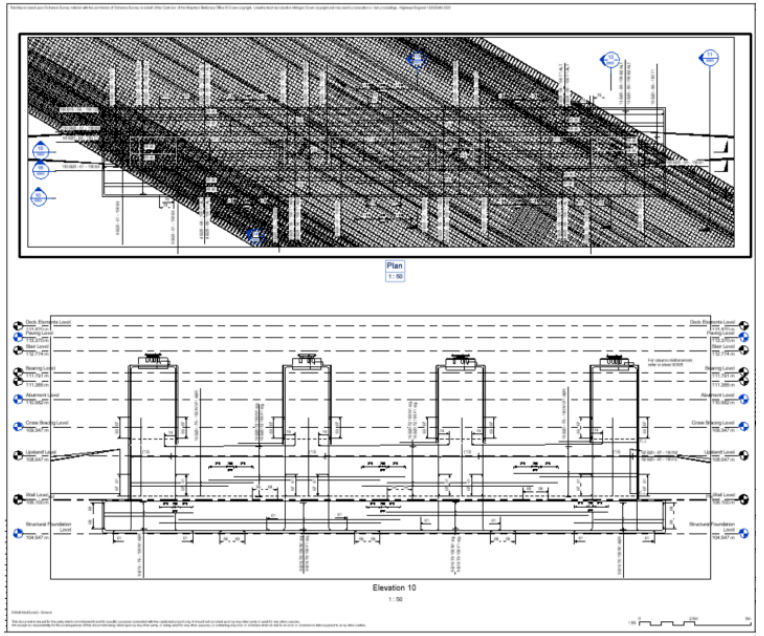
The model doesn’t lie!

The more time and effort modelling the detailed elements, the drawing production can be improved

What did we do?

Trialing 3D RC Detailing + Drawing

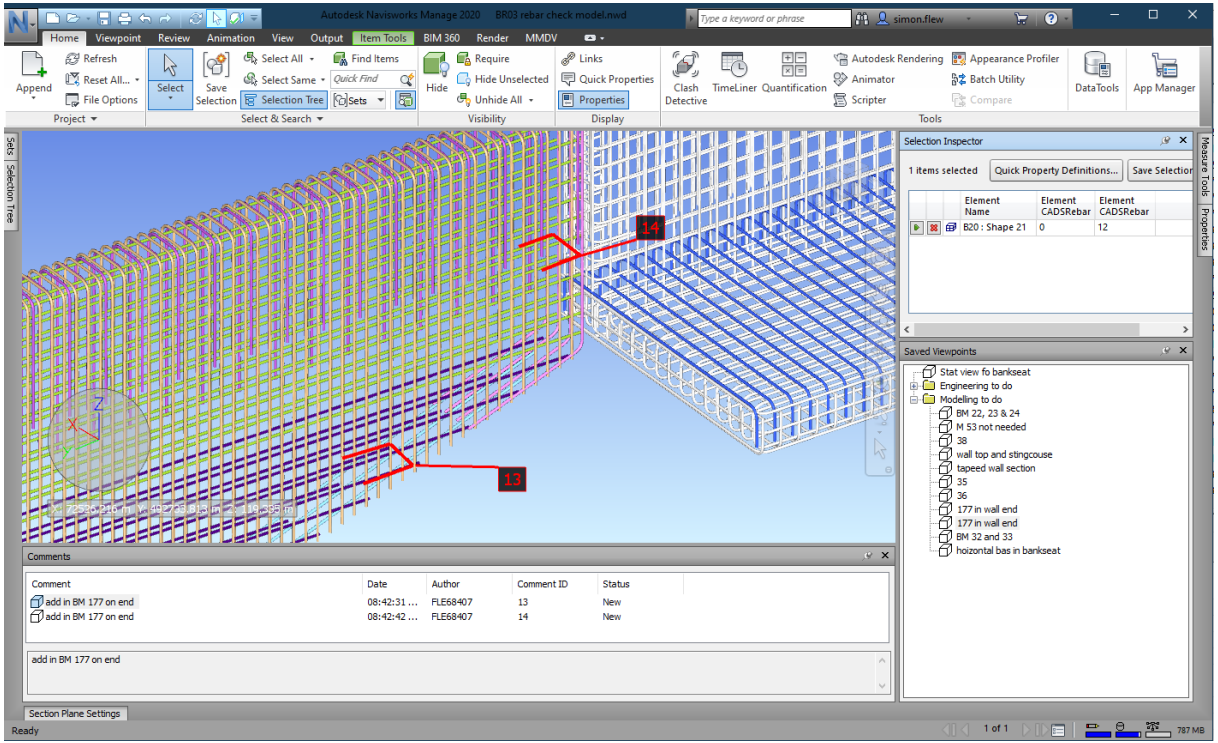




3D Reinforcement Concrete detailing consequently shows in the drawings

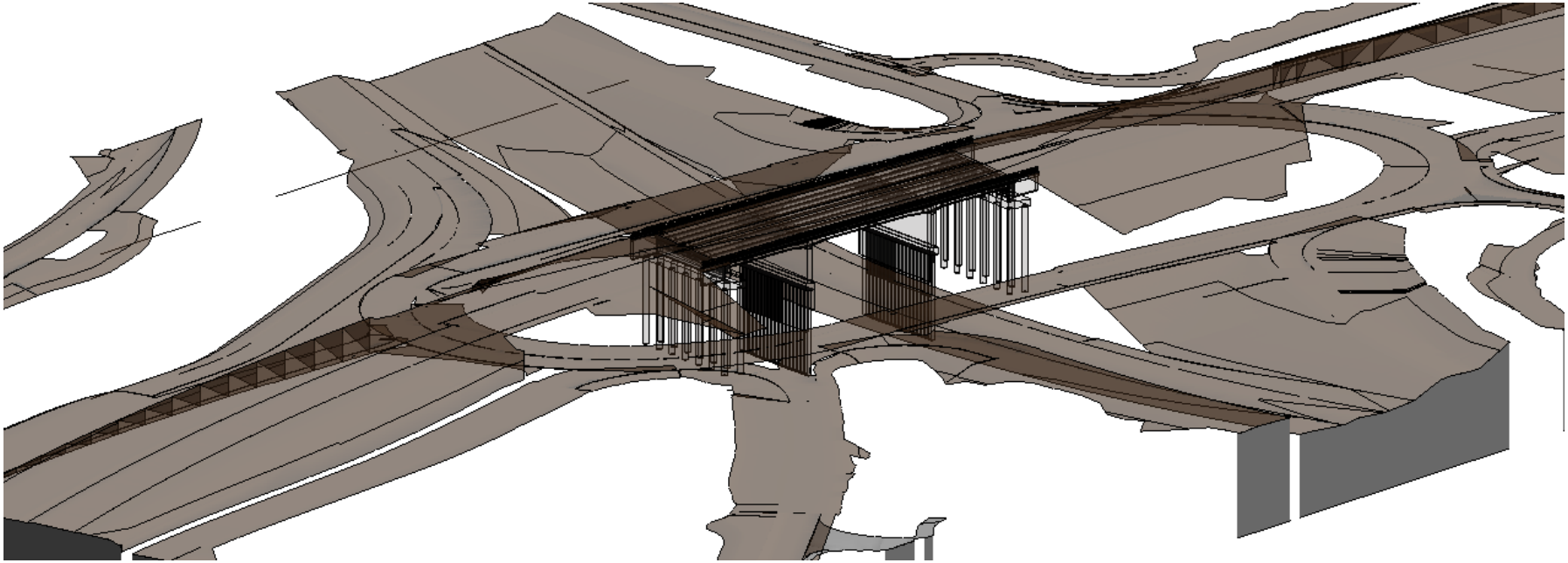
What did we do?

Trialing 3D RC Detailing + Drawing



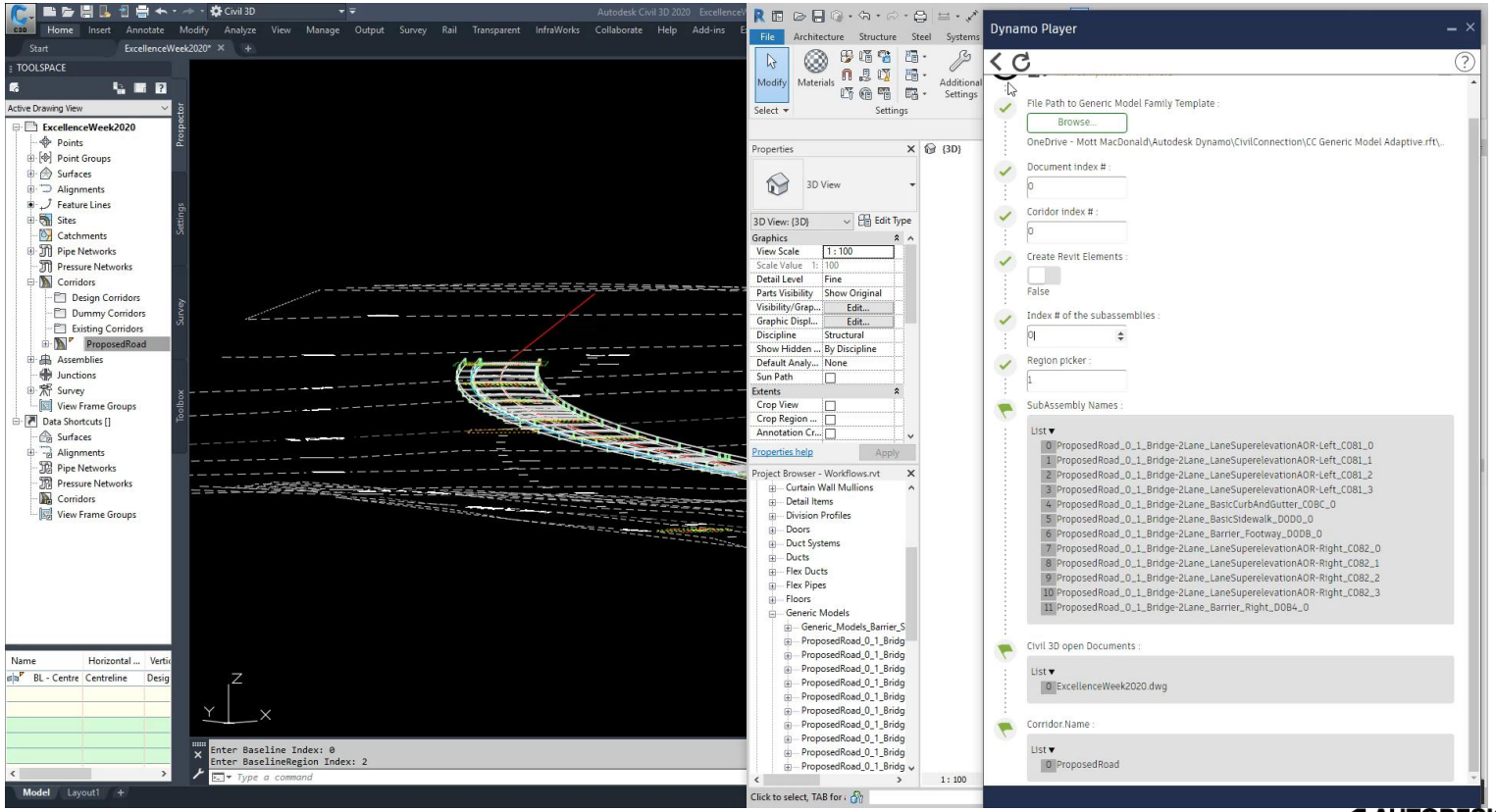
What did we do?

Published Surfaces – Important connection between Highways and Structures



What did we do?

Civil Connection – Dynamic link between C3D and Revit



Project Summary

Challenges

- Drawing production/RC Detailing
- Modelling complex geometry
- Dynamo expertise essential
- Consistency between Revit Families used by the users

Lessons Learnt

- Keep Dynamo scripts simple. Debugging far easier
- Standard content library
- Model breakdown (constructability)
- Staff knowing basics of Civil 3D
- Engineers using the model

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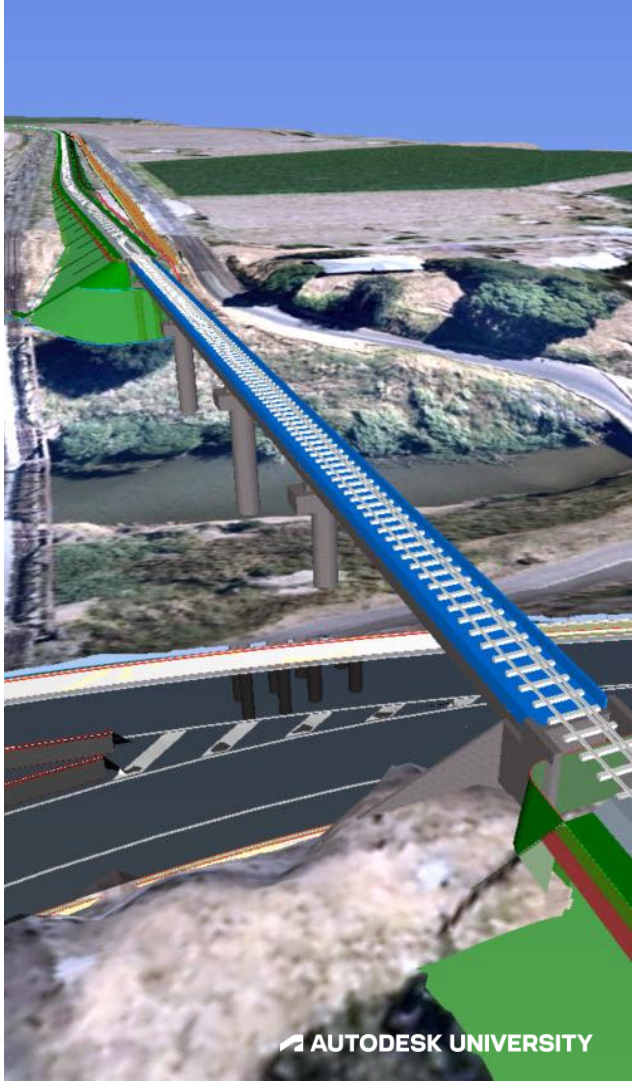
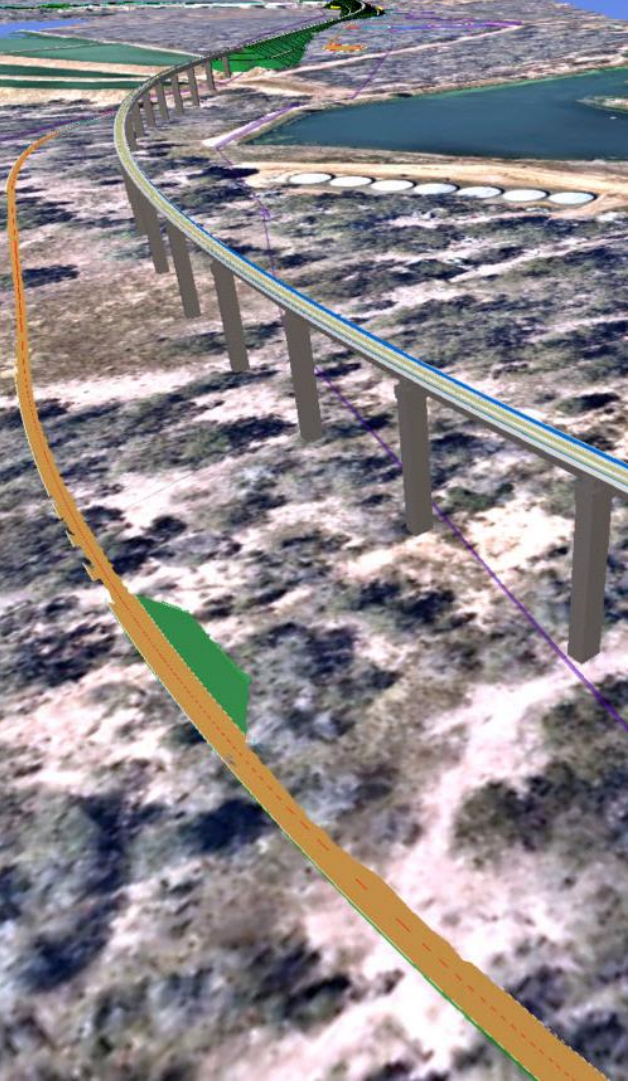
Rail Project #2, Australia

Rail Project, Australia

Project Information

- Tender project in a design joint venture (DJV)
- 130 km total length
- Design and Documentation 68 Bridges road and rail bridges & viaducts (total length of 15.5km)
- Very challenging programme
- Revit (2020), Dynamo and 12D





Rail Project, Australia

Project Information

- Continually changing rail alignment (12D)
- 50% of structures updated each week
- Innovative approach to respond to change
- Innovative approach to Quantity extraction

What did we do?

Step 1 – Defining Sub and Super-Structure Geometry

Revit Family Type Code

Graphical and non-graphical attributes

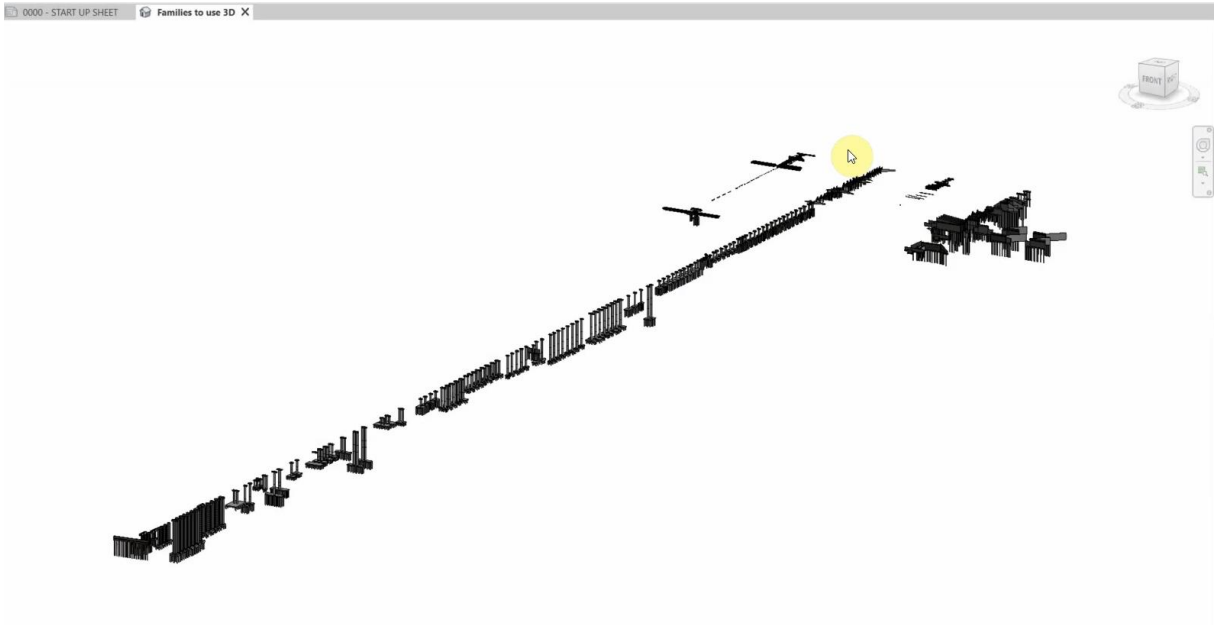
+ more attributes

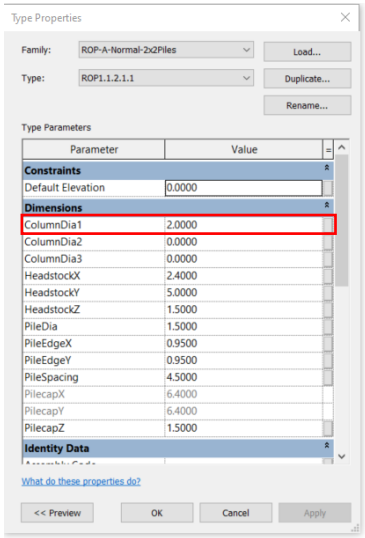
SubStructure	PileDia	PileSpacing	PileEdge X	PileEdge Y	PilecapZ	ColumnDia1	ColumnDia2	ColumnDia3	Headstock Y	Headstock X	Headstock Z
AB1.1.2.4	1.5	2.7	0.95	x	0	0	0	0	4.6	2.05	1.5
AB1.1.8.1	0.9	2.7	0.65	x	0	0	0	0	4.6	1.65	1.5
AB1.2.2.4-Eb	1.5	2.55	0.95	x	0	0	0	0	9.6	2.05	1.5
AB1.2.8.1	0.9	3.6	0.65	x	0	0	0	0	9.6	1.65	1.5
ABRU1.2.3.3	1.2	3.5	0.9	x	0	0	0	0	13.5	1.65	1.5
ABRU1.4.3.3	1.5	4.75	0.9	x	0	0	0	0	17	1.65	1.5
BW1.1.3.2	1.5	4.6	0.95	0.95	0	0	0	0	11	2	1.5
BW1.2.3.2	1.2	5.6	0.8	0.8	1.5	0	0	0	13.5	2	1.5
BW1.3.3.2	1.5	4.4			1.5				15.8	1.55	1
ROP1.1.2.1.1	1.5	4.5	0.95	0.95	1.5	2	0	0	5	2.4	1.5
ROP1.1.1.1	1.5	4.5	x	x	0	1.5	0	0	7	2.2	1.5
ROP1.1.1.1.1	1.2	3.6	0.8	0.8	1.5	2	0	0	5	2.4	1.5
ROP1.1.1.2	1.2	3.6	0.8	0.8	1.5	2	0	0	5	2.4	1.5
ROP1.1.10.1	1.5	4.5	0.95	0.95	2.5	2.905	2.905	0	0	0	0

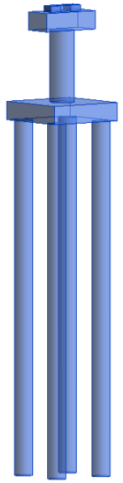
Matrix updated several times per week

What did we do?

Step 2 –Sub and Super-Structure components in Revit

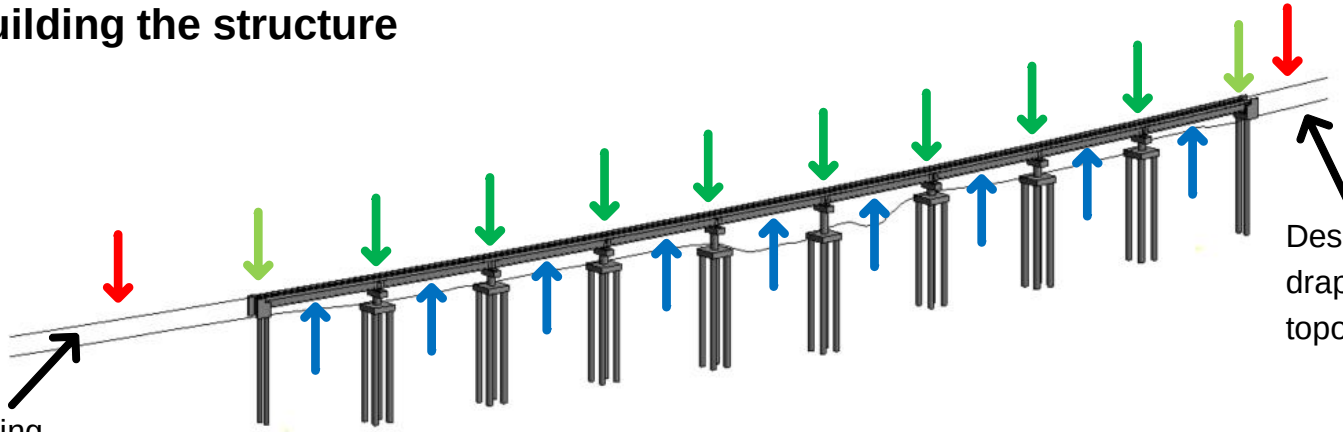






What did we do?

Step 3 – Building the structure



Design String draped to topography

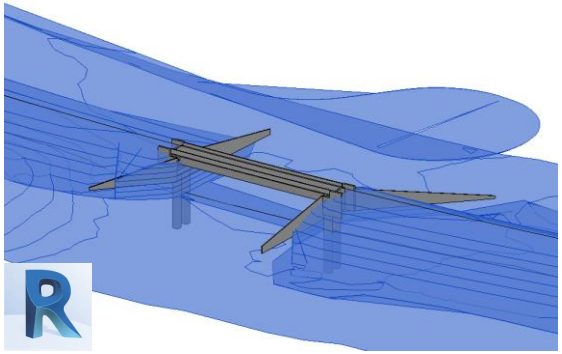
Rail design string

Structure Definition Matrix

Structure Name	Element Name	Length	Distance	Chainage	SubStructure	Sub. skew	PileLength	SuperStructure	PileCapMix	PilecapReinfRate
AU2022 Bridge Test	DWG Start	76.7	76.7	36715		deg	m	None	MPa	kg/m3
AU2022 Bridge Test	Deck Start / Exp Joint	0	0	36791.7	XJ			RO5.1.1	0	0
AU2022 Bridge Test	Abutment 1	0.85	0.85	36792.55	AB1.1.6.1	90	28	RO5.1.1	40	170
AU2022 Bridge Test	Pier 1	35	35.85	36827.55	ROP1.1.2.1.1	90	29	RO5.1.1	40	170
AU2022 Bridge Test	Pier 1 Expansion Joint	1	36.85	36828.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 2	35	71.85	36863.55	ROP1.1.2.1.1	90	29	RO5.1.1	40	170
AU2022 Bridge Test	Pier 2 Expansion Joint	1	72.85	36864.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 3	35	107.85	36899.55	ROP1.1.2.1.1	90	29	RO5.1.1	40	170
AU2022 Bridge Test	Pier 3 Expansion Joint	1	108.85	36900.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 4	35	143.85	36935.55	ROP1.1.2.1.1	90	29	RO5.1.1	40	170
AU2022 Bridge Test	Pier 4 Expansion Joint	1	144.85	36936.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 5	35	179.85	36971.55	ROP1.1.2.1.1	90	29	RO5.1.1	40	170
AU2022 Bridge Test	Pier 5 Expansion Joint	1	180.85	36972.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 6	35	215.85	37007.55	ROP1.1.2.1.1	90	27	RO5.1.1	40	170
AU2022 Bridge Test	Pier 6 Expansion Joint	1	216.85	37008.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 7	35	251.85	37043.55	ROP1.1.2.1.1	90	27	RO5.1.1	40	170
AU2022 Bridge Test	Pier 7 Expansion Joint	1	252.85	37044.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Pier 8	35	287.85	37079.55	ROP1.1.2.1.1	90	27	RO5.1.1	40	170
AU2022 Bridge Test	Pier 8 Expansion Joint	1	288.85	37080.55	XJ	90	0	RO5.1.1	0	0
AU2022 Bridge Test	Abutment 2	35	323.85	37115.55	AB1.1.6.1	90	30	RO5.1.1	40	170
AU2022 Bridge Test	Deck End / Exp Joint	0.85	324.7	37116.4	XJ			RO5.1.1	0	0
AU2022 Bridge Test	DWG End	29.5989	354.2989	37145.9989	na				0	0

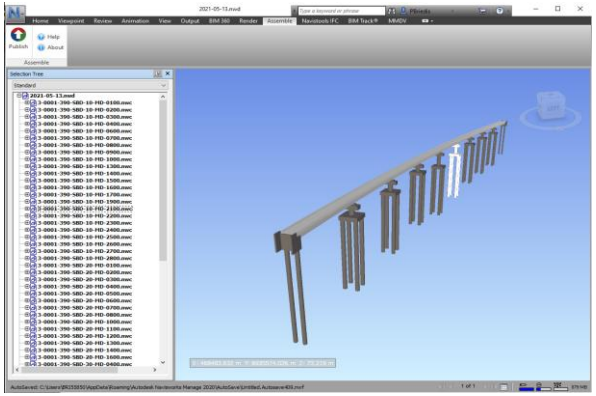
What did we do?

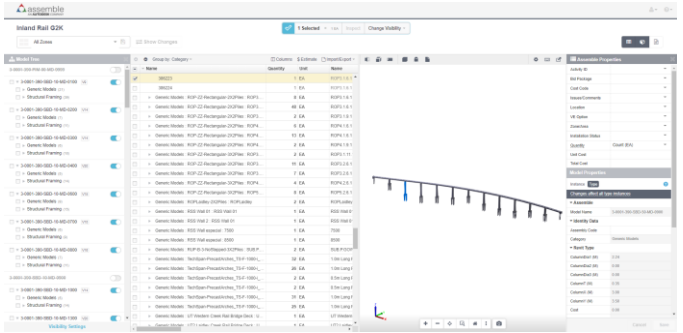
Extracting Quantity Information – Autodesk Assemble



Publish Directly to Assemble

Publish model to Assemble





Power BI

Project Summary

Challenges

- Tender design programme
- Responding to change
- Quantity Extraction
- Keeping Excel format constant

Lessons Learnt

- Early engineer engagement
- Higher LOD than required
- Understanding Model content invaluable. Confidence in deliverables.
- Assemble Power BI dashboard

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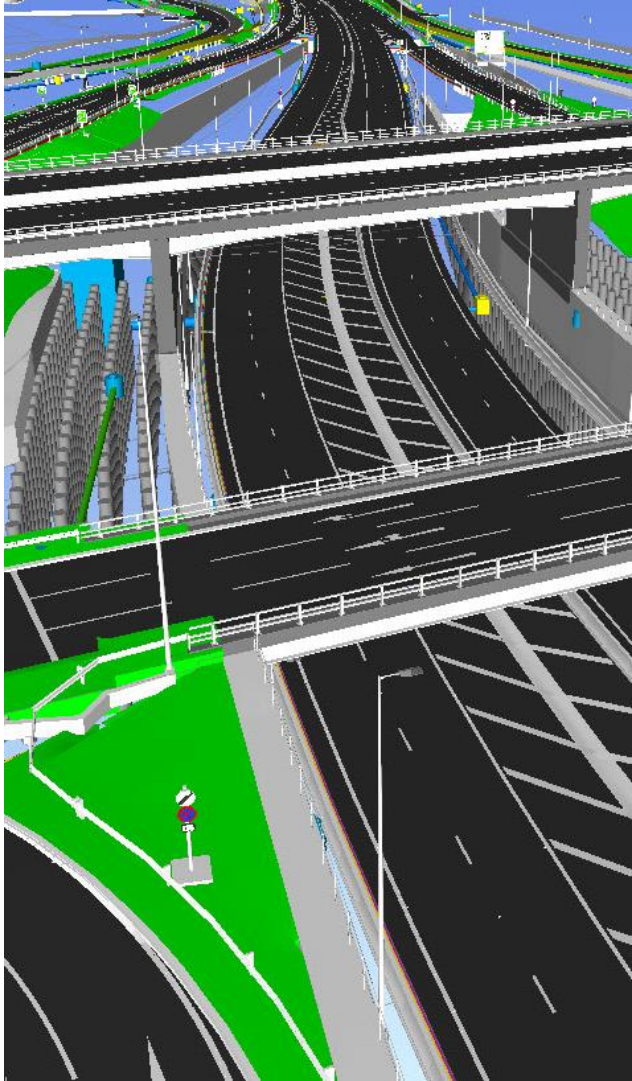
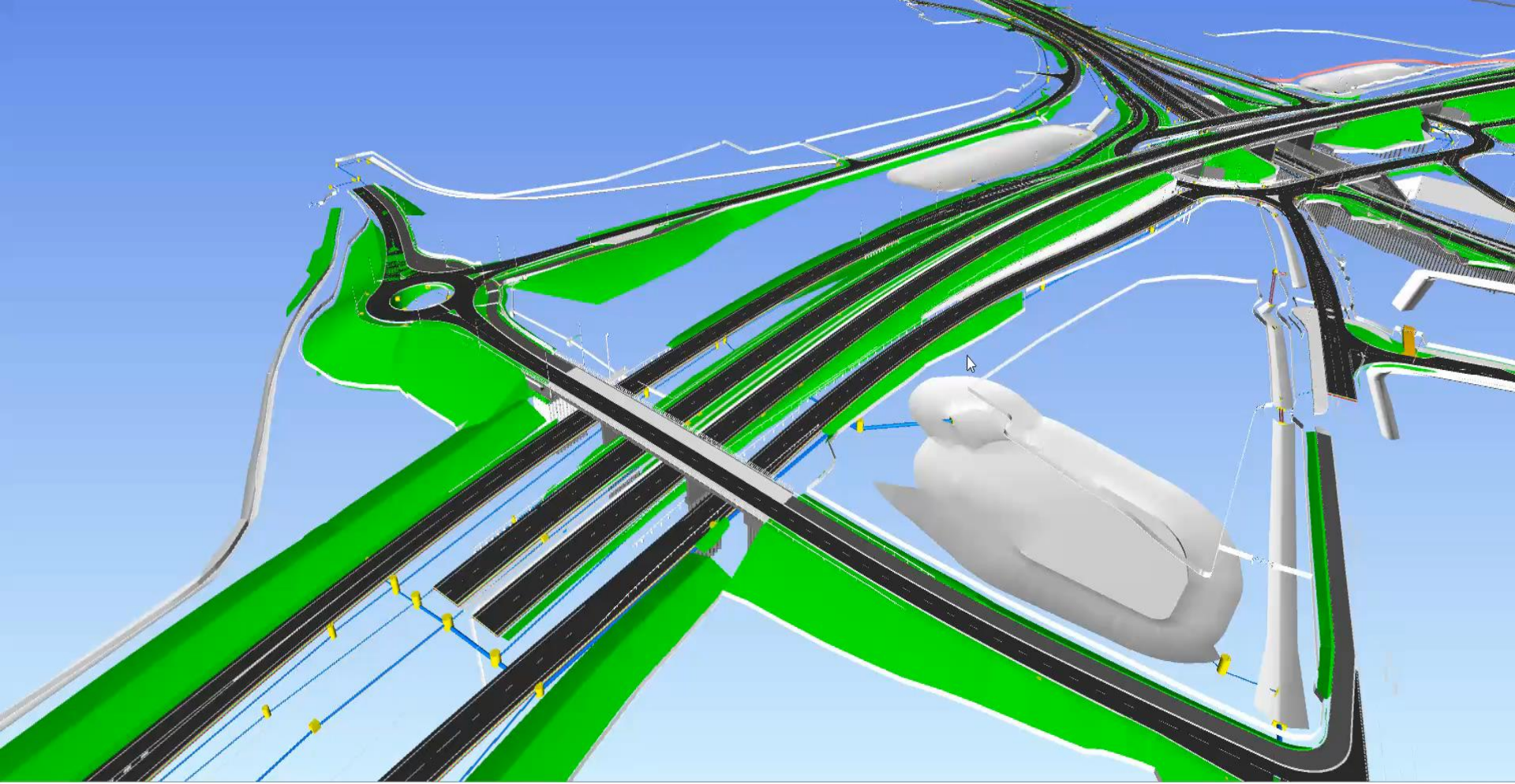
Major Highways Project #2, U.K.

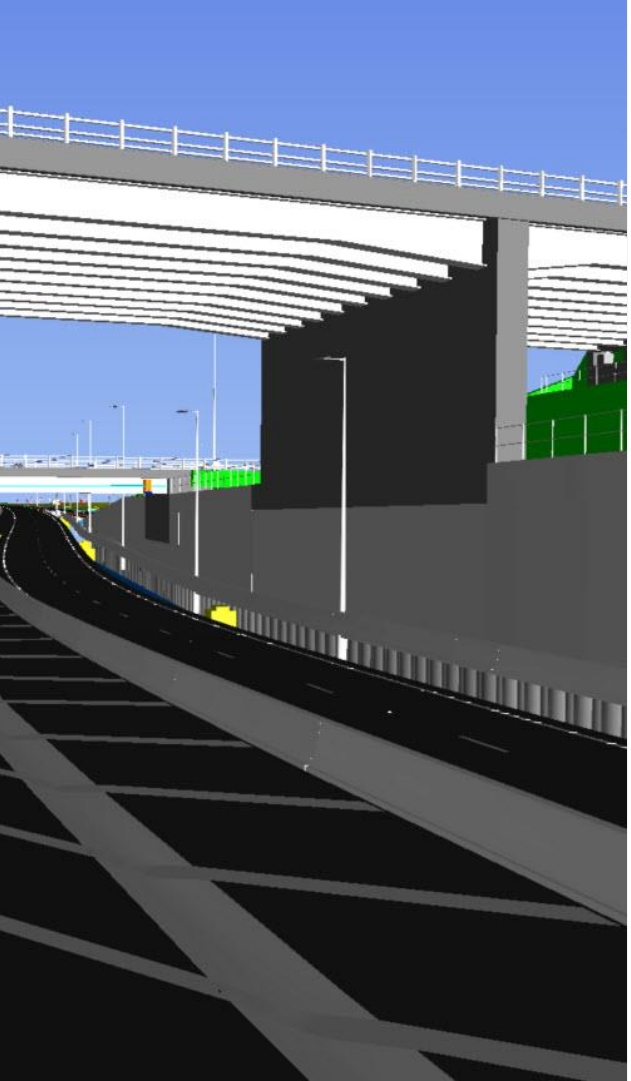
Major Highways Project #2, U.K.

Project information

- Major highways project
- Detail Design
- 18 bridge and viaduct structures
- Major and minor culverts
- Digitally mature Client
- Digitally advanced project
- Revit (2020), Dynamo, Civil 3D (2020), Grasshopper+Rhino







What did we do?

2 key changes from previous project

- Algorithm-based approach for Bridge design and model production

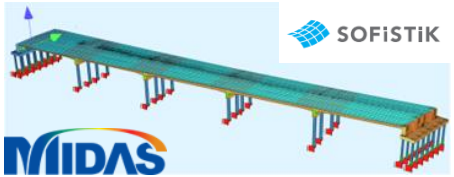
- Greater Model attribute requirements

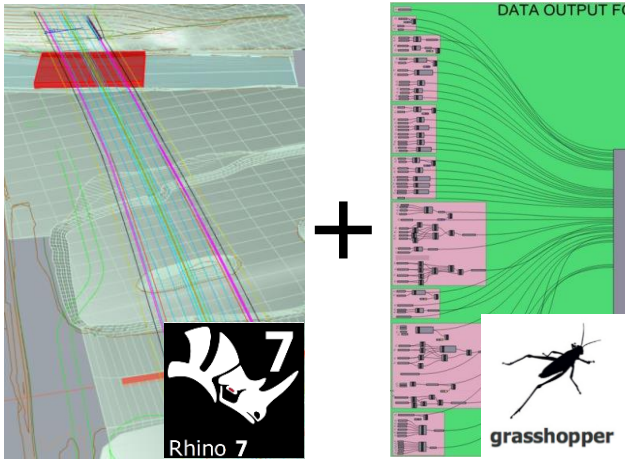
What did we do?

Algorithm based approach – Workflow

Highways 3D strings

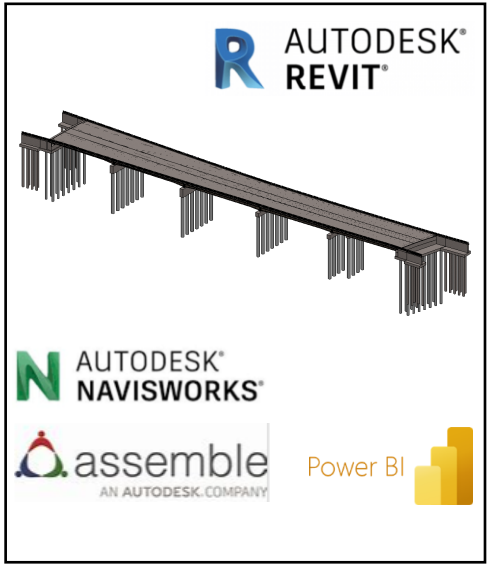
Analytical model





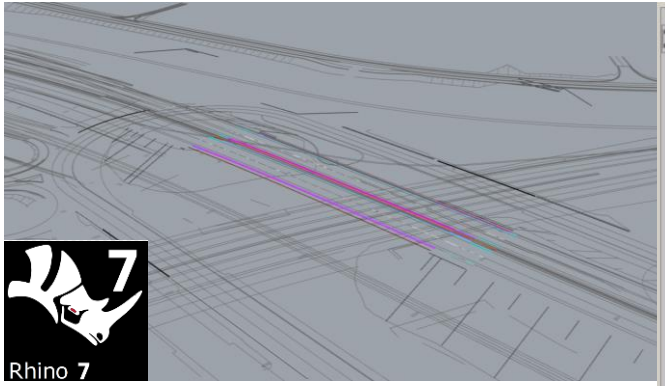
Define geometry and attribute information

Delivery model

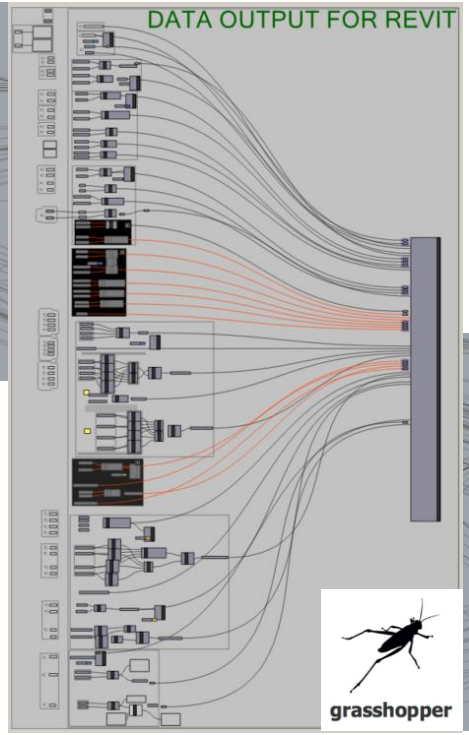


What did we do?

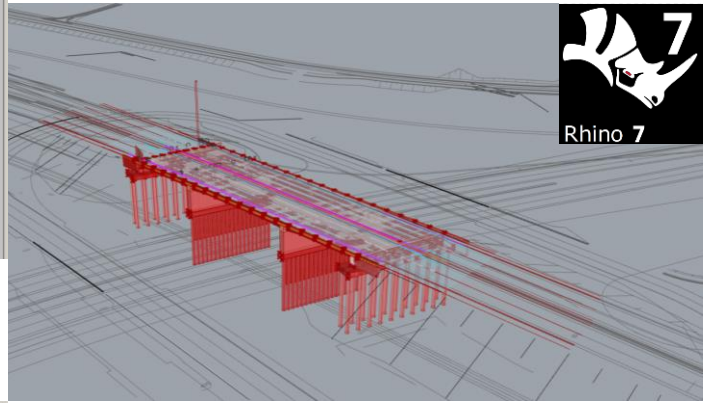
Algorithm based approach – Step 1 Create geometry referencing highway strings



Highways strings imported into Rhino.

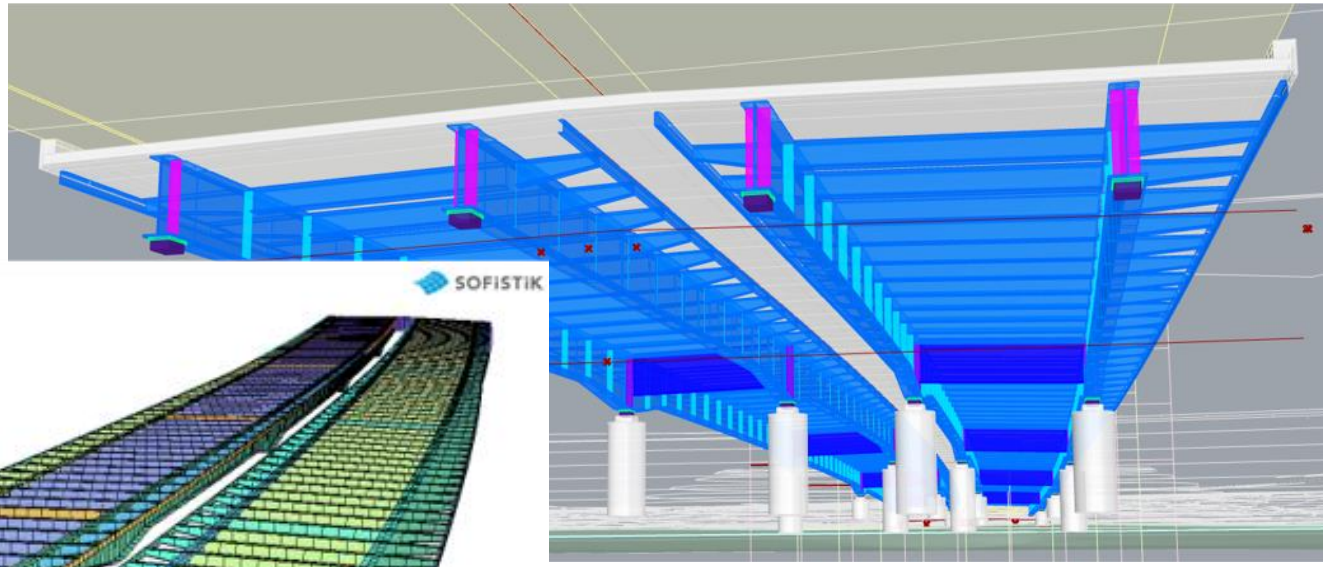


Algorithm-based modelling completed in Grasshopper



What did we do?

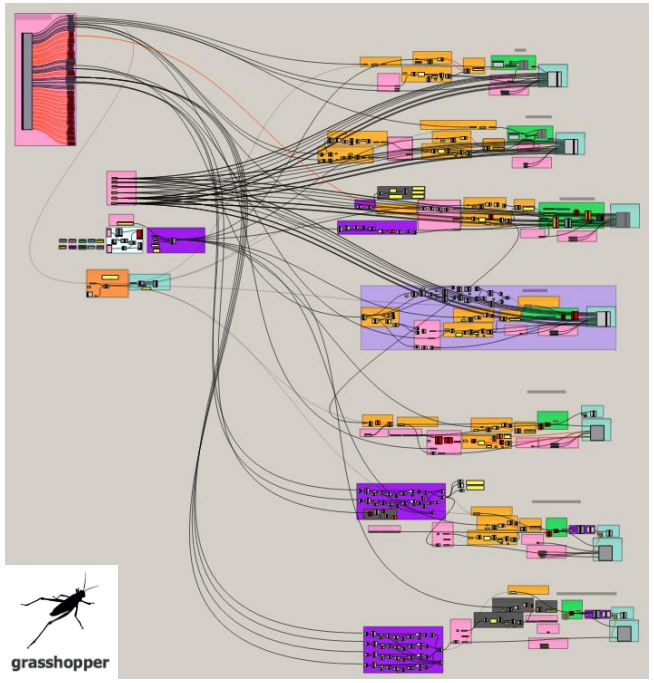
Algorithm based approach – Step 2 Export geometry for analytical model



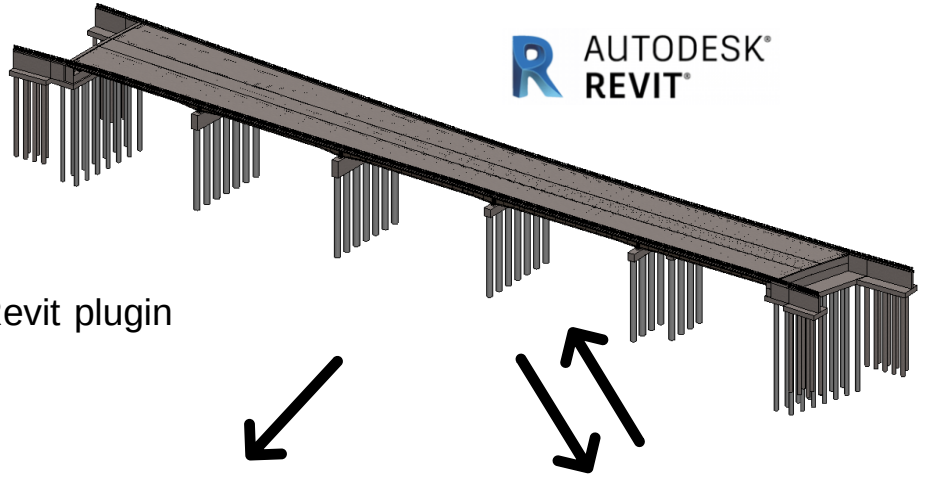
What did we do?

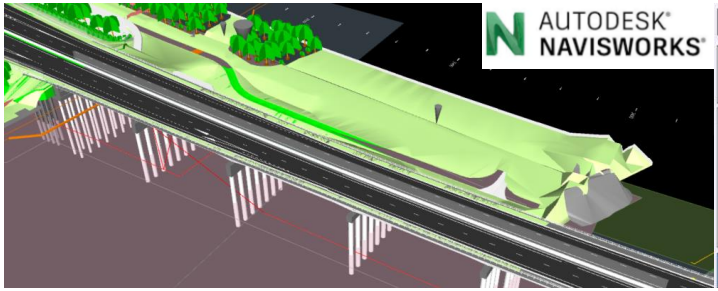
Algorithm based approach – Step 3 Export Geometry to Revit

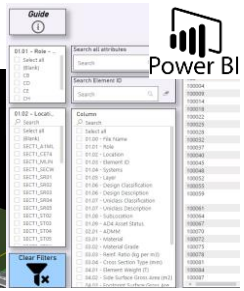
Revit export in Grasshopper

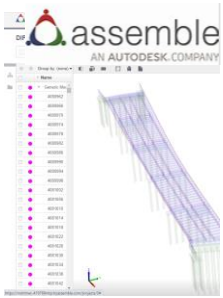


Rhino.Inside.Revit plugin



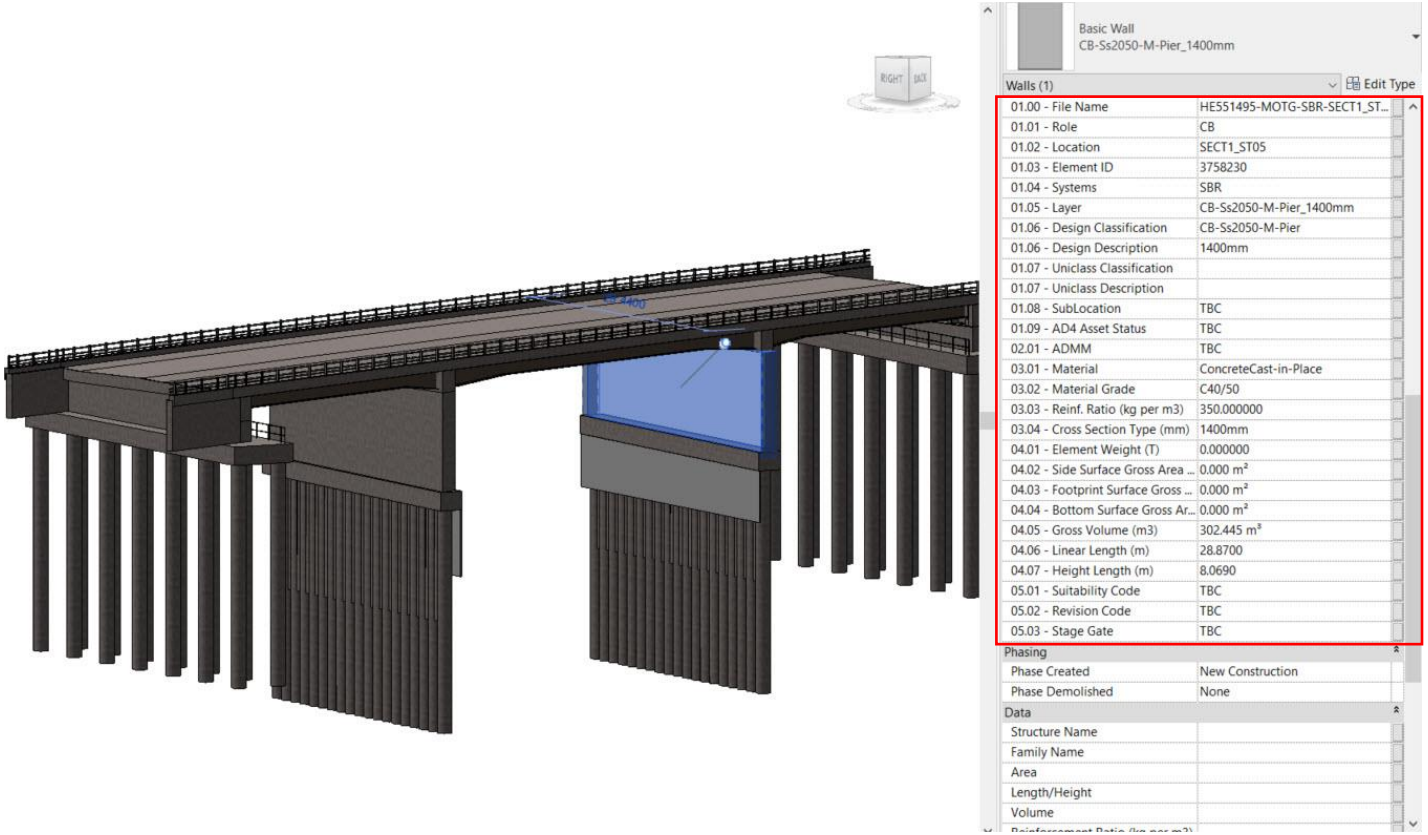






What did we do?

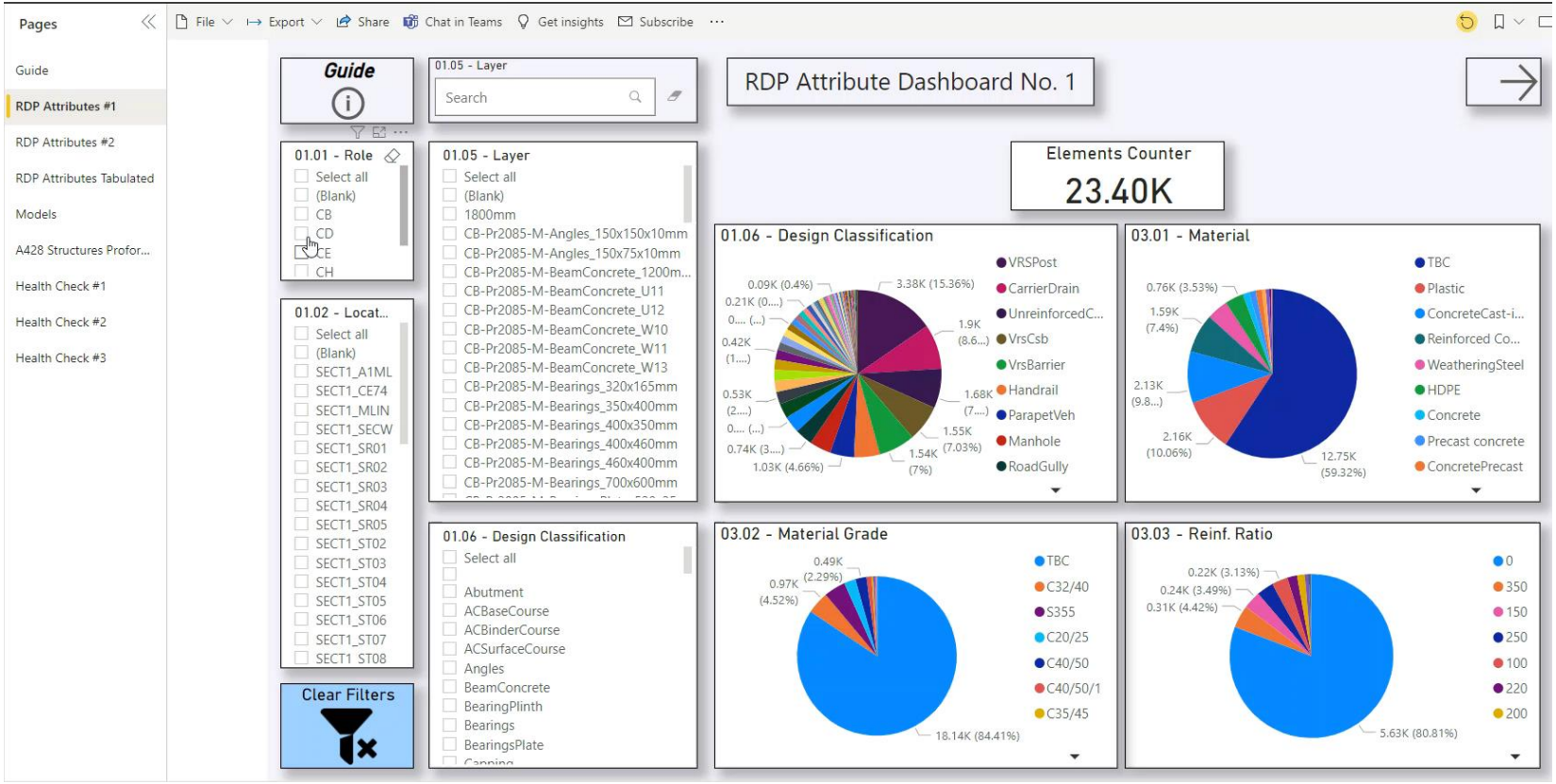
Managing the Attribute Information



Project specific attributes

What did we do?

Managing the Attribute Information



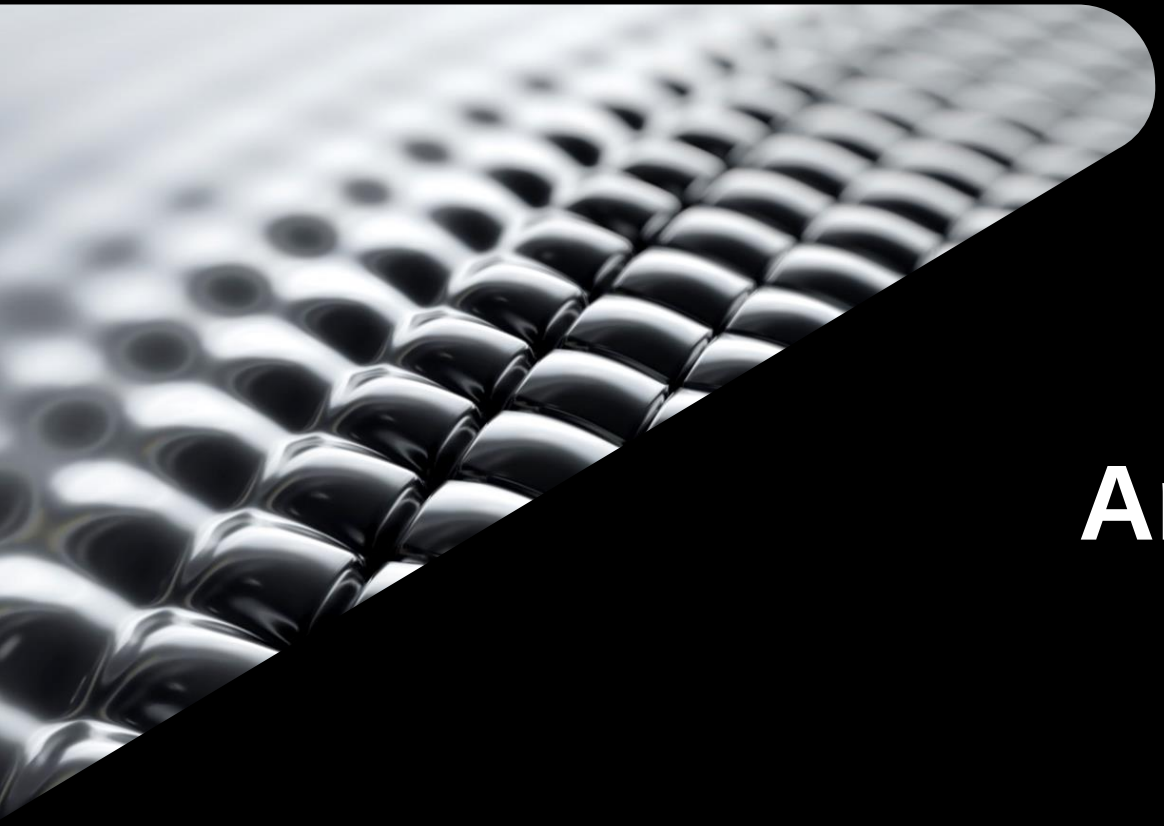
Project Summary

Challenges

- Definition of Highway strings
- Algorithm-based approach and those using it
- Completeness and consistency of attribute information

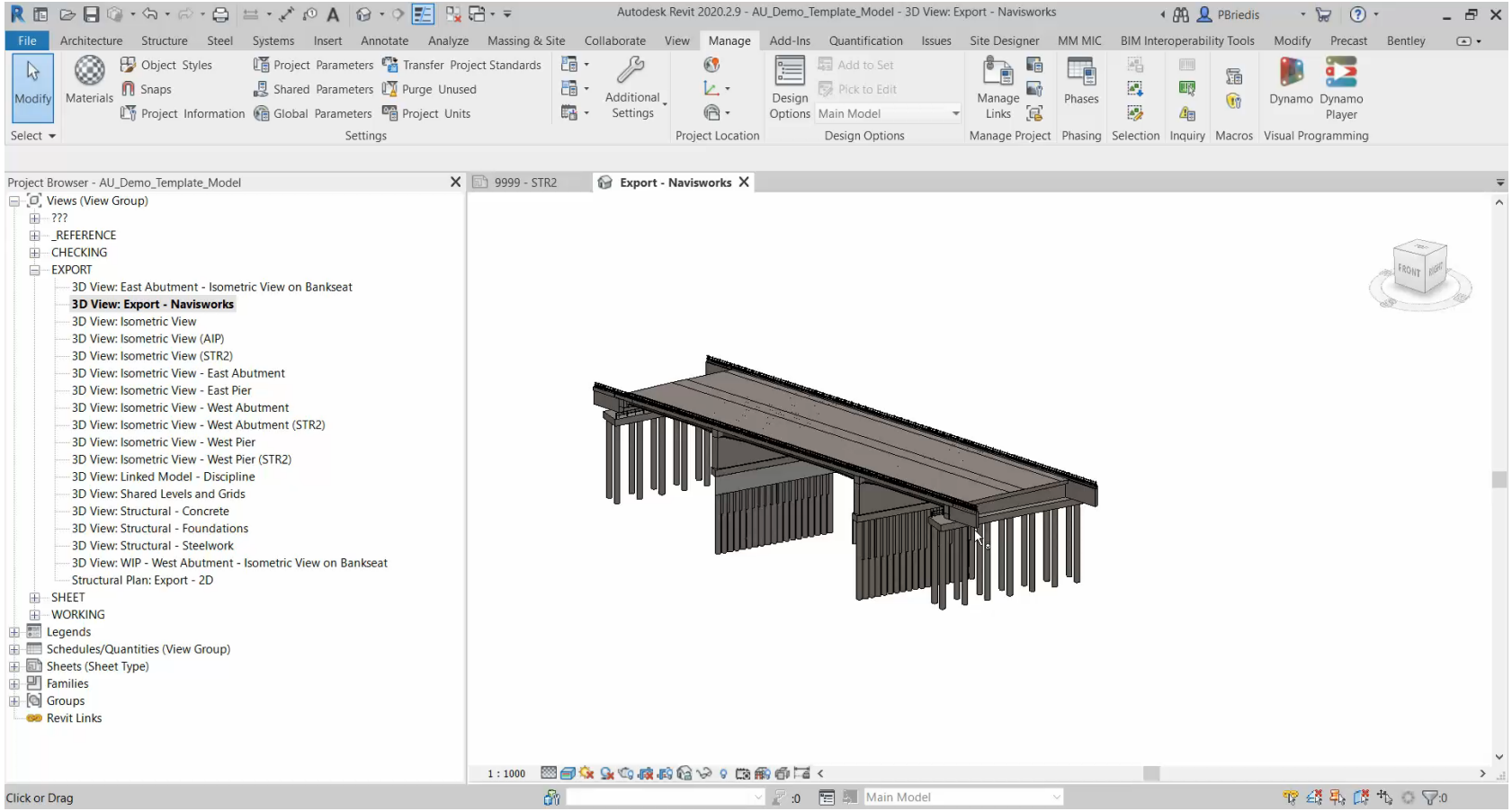
Lessons Learnt

- Communication between disciplines
- Grasshopper & Rhino to define complex geometry
- Model QA/QC and enhancing quality of deliverables
- The role of drawings

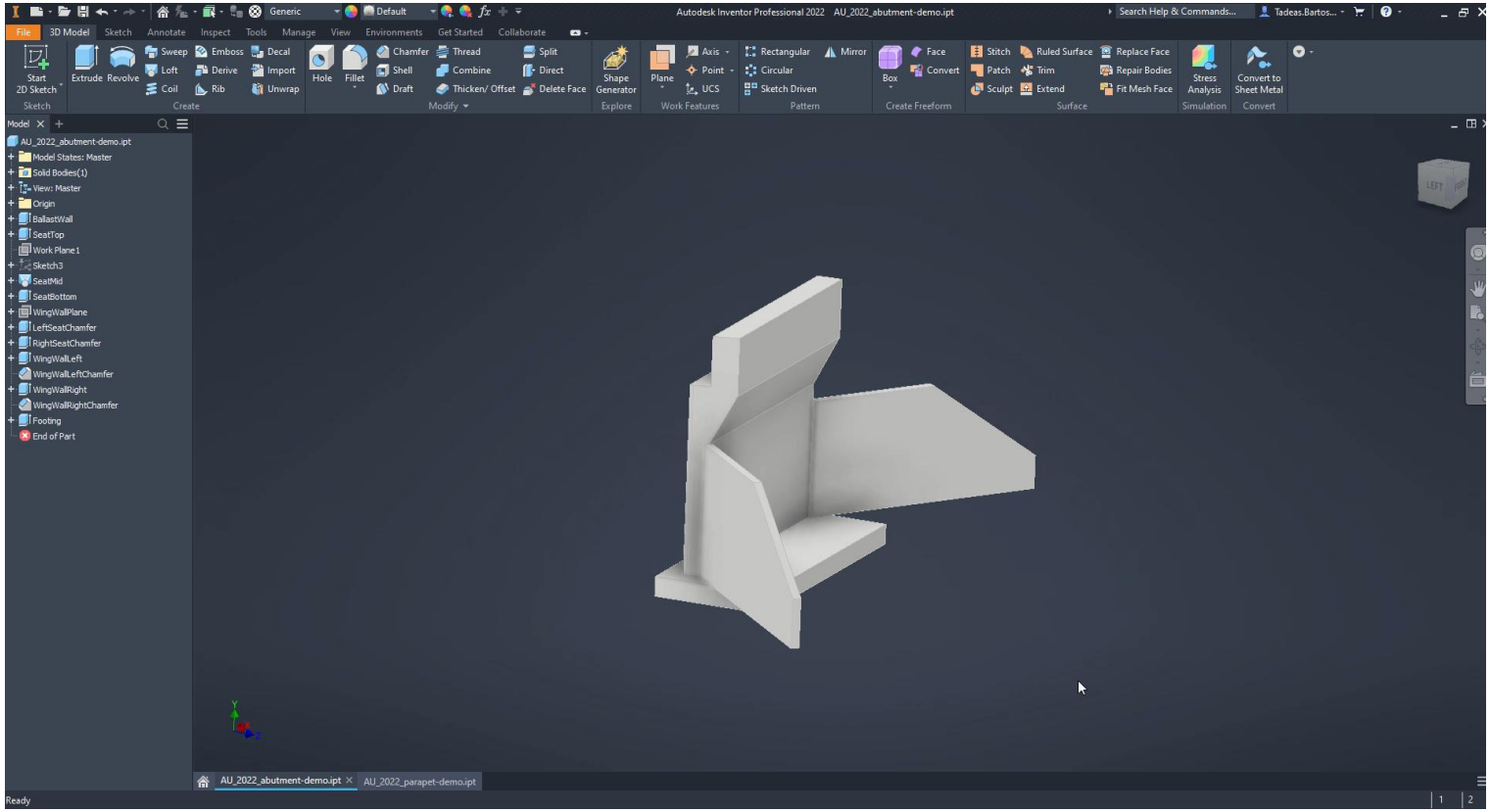


Anything else?

Moata Intelligent Content (MIC)



Autodesk Inventor & Infraworks



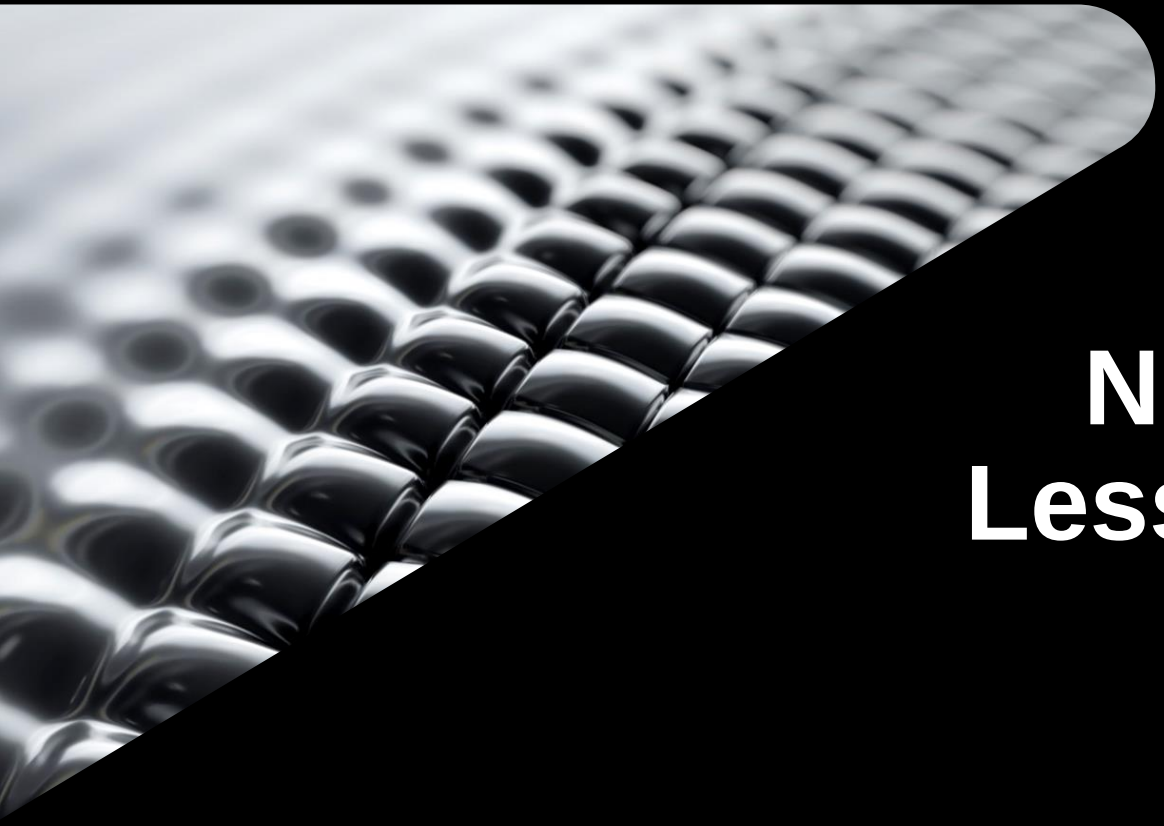
Knowledge Sharing

- Dynamo and Revit Ninja – Continuous training of the team

- PyCharmer – Python oriented training

- Ongoing technical demonstrations of the workflows and tools we are adopting

- Internal and External training



Next steps and Lessons Learned

Our ongoing challenges (The work is not done)

Delivery

- Client requirements
- Responding to change
- Quality and consistency
- Single Source of Truth
- Drawing Production
- Knowledge Sharing
- Improved team engagement

Technology

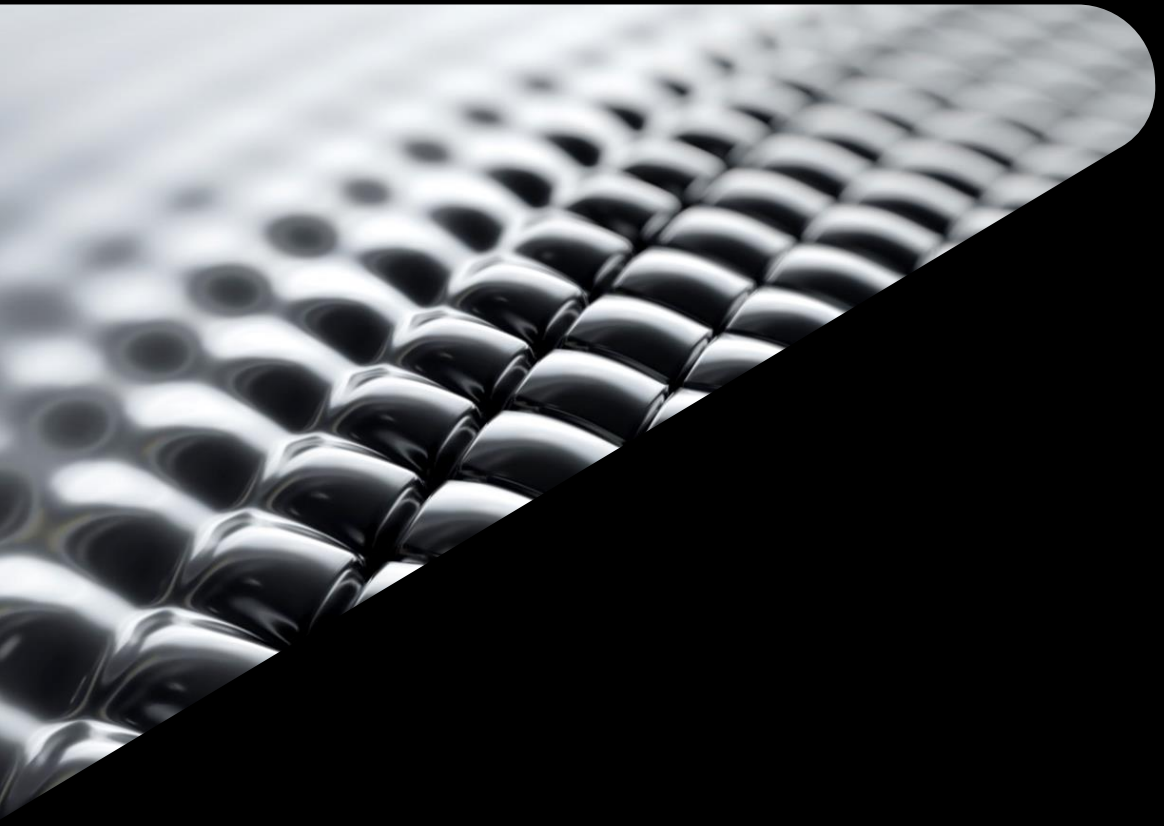
- Capabilities
- Limitations
- Information Management
- Interoperability model and data
- Reducing repetitive tasks through automation
- Keeping up with technology advancements

Winning Hearts and Minds

- Not just a pretty-looking 3D model
- Evolution not revolution
- Develop understanding in the value of digital delivery

Final Remarks

- It’s a continuous process – Evolution not Revolution.
- Challenge yourselves about the right approach and consider all delivery options.



Questions