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# Connected BIM Interoperability – Solving Real World Problems Modelling Infrastructure Projects (InfraWorks Led Workflow)

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## Learning Objectives

- Discover the workflow for using InfraWorks, Civil 3D, Inventor, Revit and Navisworks
- Discover the process of Transportation Modelling
- Learn about interoperability challenges and preparing data for consumption
- Learn from lessons learned: solutions

## Description

This class will cover the connected BIM workflow for using Autodesk AEC collection InfraWorks, Autodesk Civil 3D, Inventor, Revit, and Navisworks.

We'll show how this workflow can be used to take transportation design to the next level, and we will also highlight lessons learned while solving real-world infrastructure challenges.

We'll dig into various steps in the process, such as refinement and optimization in alignments and profiles in Civil 3D for better design in InfraWorks, customization of parametric bridge parts, and assemblies created and modified within Inventor, and how they can be easily utilized in InfraWorks - which gives more freedom and ability to fulfill design requirements.

We'll show how this workflow was used to overcome the various challenges for Transportation projects and BIM interoperability among different engineering software systems.

## Speaker(s)

**Tushar Talele** is a BIM Engineer and Tushar's goal in BIM is to bring new technology into daily practice by creating procedures and tools that can be used by everyone. He assists team Parsons Construction Group for integrated BIM and Digital Twin delivery for BIM implementation on various Parsons Projects.

Tushar has over 6 years' experience in the Construction Industry. He has Master' degree in Construction Management from University of Texas Systems and Bachelor' degree in Civil Engineering from University of Mumbai. Prior to Masters, he has well experience with High Rise Building Construction with Larsen and Toubro, India.

Tushar thinks the work his team is doing will play a crucial role throughout the planning, detailed design, and construction stage of the Infrastructure BIM project. Tushar enjoys new modelling softwares and innovative construction technologies supporting Pre-construction, pull planning, estimating and utilizing innovative workflows from construction adding value to work what project is doing.

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**Sean Hulbert** is a registered professional engineer in the state of Oregon, and a Designated Support Specialist at Autodesk, Inc., (supporting AutoCAD Civil 3D, Hydrology and Hydraulic Analysis tools, and InfraWorks).

Prior to working at Autodesk, Sean worked in the civil engineering industry for over 25 years. He was always a key advocate for technological advancement at the consulting firms where he was employed, introducing concepts and workflows for laser scanning and multidimensional modeling. By capitalizing on already-owned software, he spearheaded the corporation's evolution into a multiplatform design environment. Sean also introduced workflows leveraging BIM Technologies the infrastructure design community.

In addition to transportation and land, Sean was responsible for CADD and Building Information Modeling (BIM) education, as well as for creating and modifying policies and procedures to keep up with ever-changing technology. Using his knowledge and practical hands-on experience, he was able to successfully introduce new technology and ideas to an existing environment, creating a desire to use BIM concepts and workflows on transportation projects.

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# Overall InfraWorks led workflow highlighting Autodesk Civil 3D, Inventor, Revit, and Navisworks (Flowchart)

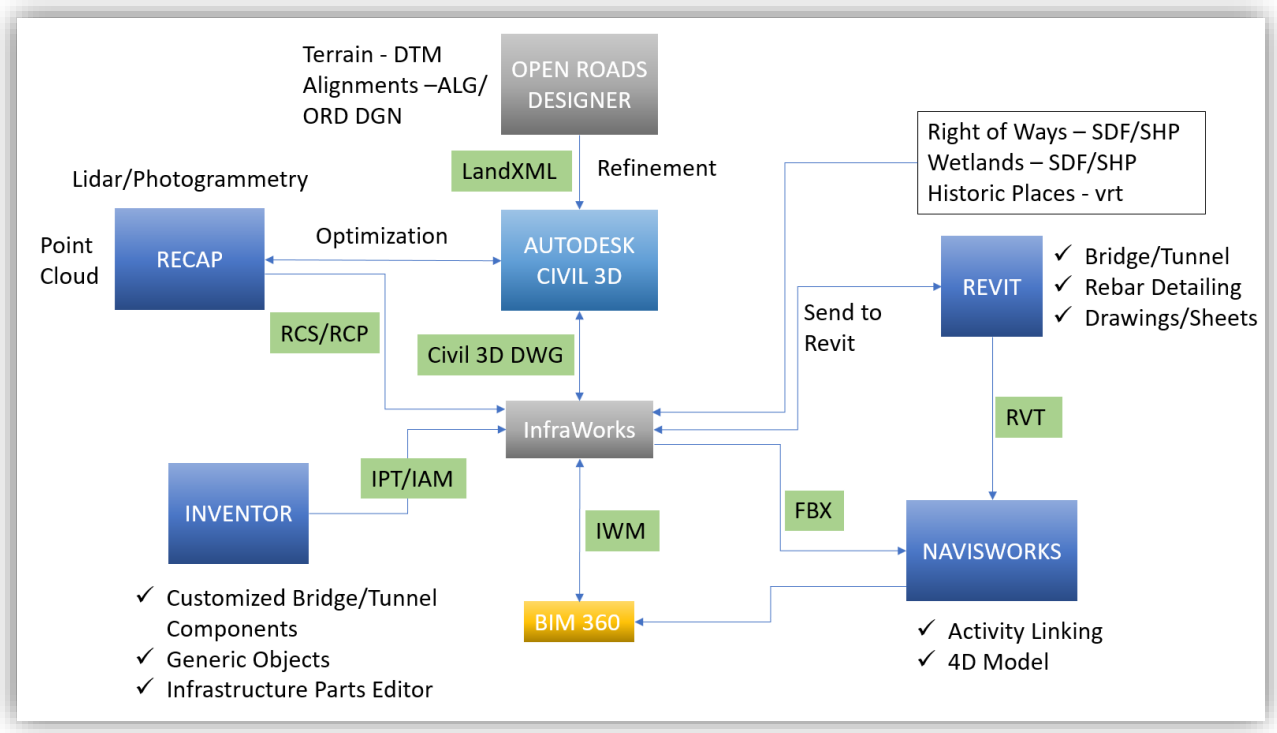


*Figure 1:Typical Model Centric Workflow for Transportation Modelling*

Based on contractual requirements for State DOT's deliverables, base design for transportation projects is done using different authoring tools such as In Roads SS2, Power InRoads SS4, OpenRoads Designer Connect Edition, and MicroStation from Bentley or Autodesk Civil 3D.

## Why decided to use this workflow?

Contractors point of view to use of InfraWorks:

- Easy to use Interface
- Conceptual iteration of design ideas
- Learning Curve
- Enhancing Meetings
- 3D Visualizations
- Leveraging available AEC tools
- Interesting Roadmap and Parsons Autodesk Collaboration

# Preparing Data for Consumption – Various Data Sources

InfraWorks Model Builder can be used to generate new project. Model builder uses various data sources mentioned below to build the model. Existing Data generated from model looks promising but the accuracy may not need the requirements of the project. In such cases the model builder data should be augmented with additional data sources.

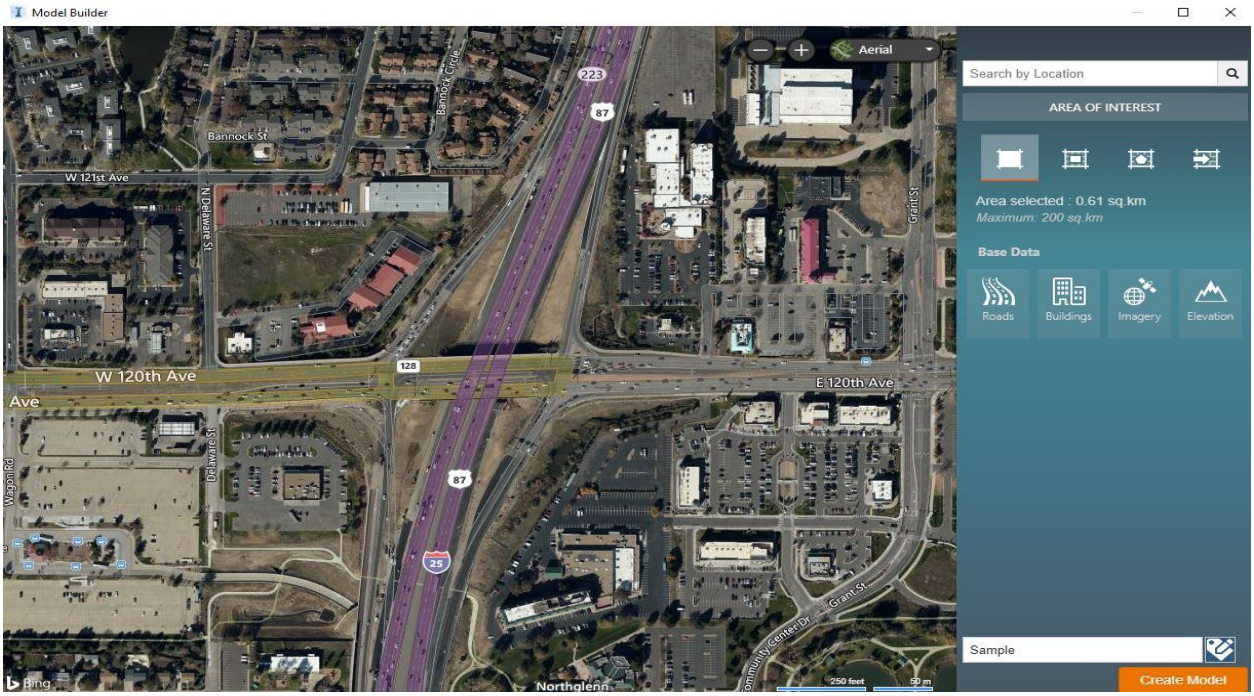


*Figure 2: InfraWorks Model Builder to generate new project*

*Figure 3: Existing Data from Model Builder Data Sources within InfraWorks*

(Autodesk Knowledge Network, n.d.)

***Elevation (Existing Ground)***

Global terrain data is available in 10 and 30meter DEMs depending on the geographic location of your area of interest. Terrain data for the United States and its territories uses USGS 10meter DEMs from the National Elevation Dataset (NED). Between -60° and +60° latitude we use SRTMGL1 30m DEM data. Between +60° and +83° latitude we use ASTER GDEM v2 30m DEM data.

Refined by more accurate survey Terrain model for existing ground– TIN/DTM/GPK – LandXML/Civil 3D DWG

***Roads***

Model Builder OpenStreetMap's Highway and Railway data sets can be refined by Design Alignments and Profiles Component Roads (Autodesk DWG/IMX/LandXML)

***Buildings***

Model Builder Building data is from the OpenStreetMap dataset can be refined by LiDAR/Photogrammetry Point Clouds or City GML

***Water***

Water body data is also from the OpenStreetMap dataset can be refined by Bathymetric Survey Data and @ MWL/HWL/MLLW/MHHW Surface Models. (Multiple Terrain Surfaces. Subsurface layers now supported)

***Imagery***

Satellite imagery from Microsoft® Bing Maps can be Refined by increasing the Microsoft® Bing Maps resolution, Photogrammetry, Raster Datasets, ArcGIS Data Sources

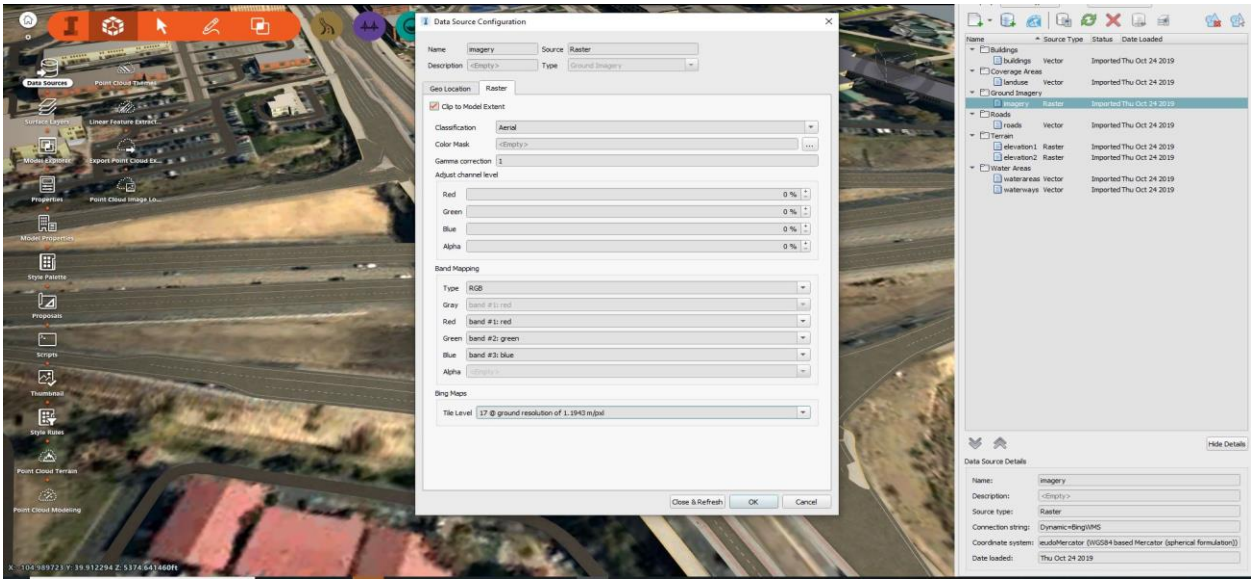


*Figure 4: Raster Datasets Configuration within InfraWorks*

### *Additional Data Sources – ArcGIS Data Connector*

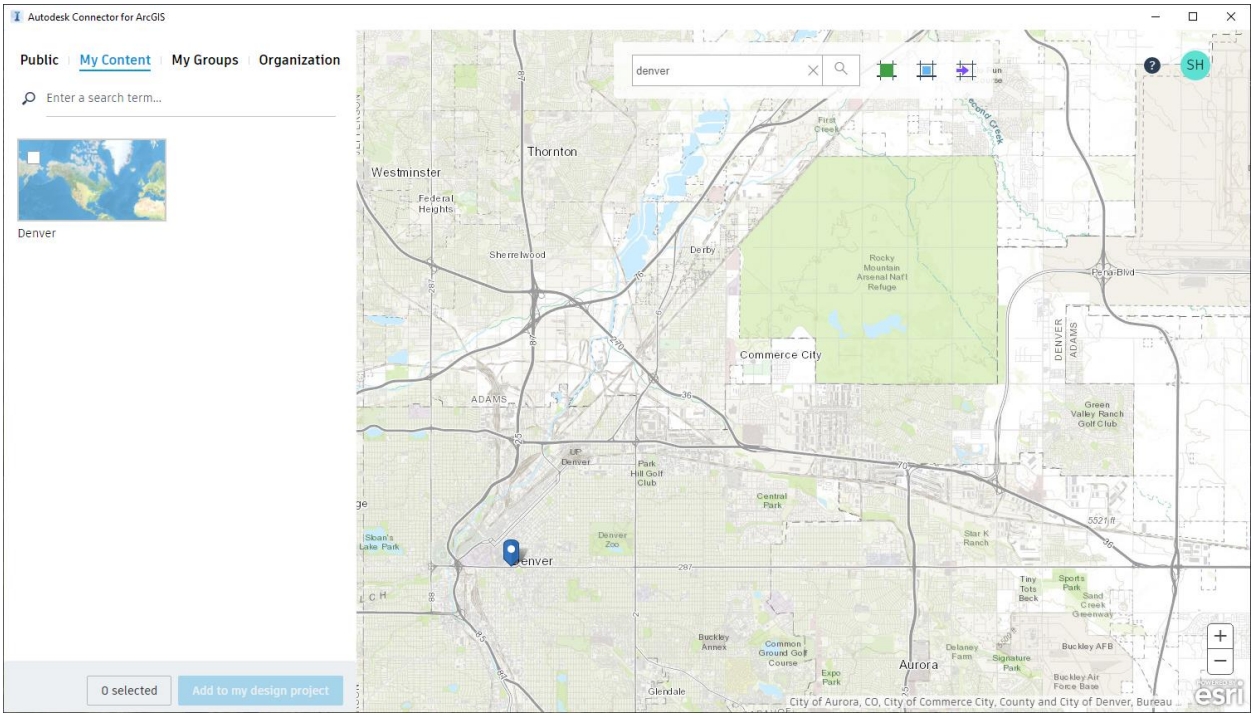


*Figure 5: ArcGIS Data Connector for Civil 3D and InfraWorks*

### *Autodesk Connector for ArcGIS*

The Autodesk Connector for ArcGIS allows you to import data from an ArcGIS database, as well as publish back to the ArcGIS database (only in InfraWorks 2020.1 or later).

# Data Translation - Design Data for use in InfraWorks

**Data Interoperability** - Exchanging Data between Bentley Power InRoads/OpenRoads Designer and InfraWorks

In order to consume Design Geometry Data from Bentley application to Autodesk InfraWorks, Power InRoads and OpenRoads Designer have the ability to import Coordinate Geometry data in ALG format and export it to LandXML file. This process exports both horizontal and vertical alignments, to a LandXML file.

Alternatively, Data Translation can be done through Civil Engineering Data Translator client dialog box within Autodesk Civil 3D to upload files to translate data from source file by using LandXML.

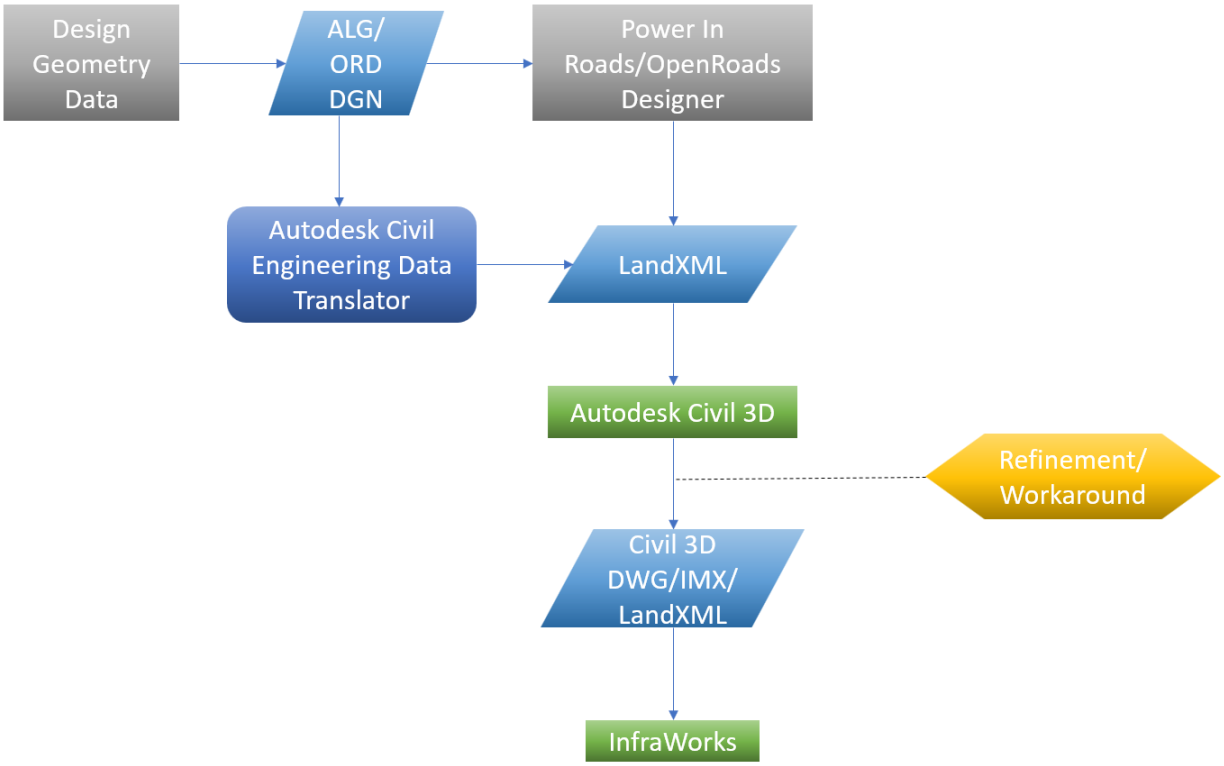


*Figure 6: Data Translation Workflow to consume within InfraWorks*

CDE/CDX challenge:

Every Revision/Design Iteration for the project, Re-do Whole Process starting from translating ALG file to LandXML and work-around in Autodesk Civil 3D before importing to InfraWorks. This is one of the shared pain points or challenges to updating the model for every design change scenario.

## InfraWorks Traffic Direction – How it Works? Why it is important?

It should be taken into consideration that alignments in InfraWorks are bound to Traffic Direction before importing roadway alignments to InfraWorks for correct intersections.

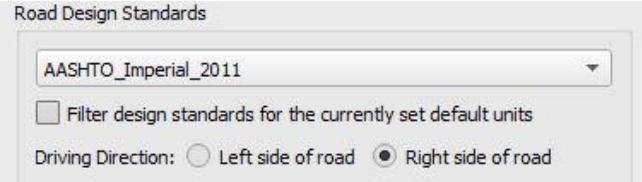


*Figure 7: InfraWorks Model Properties for Traffic Direction*

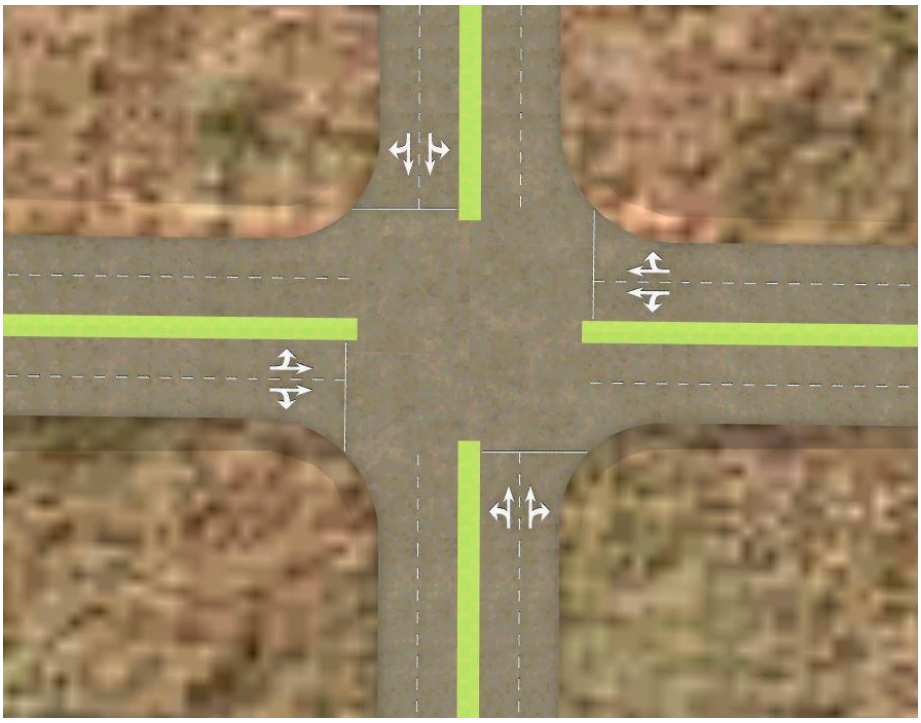

*Figure 8: Roadway alignments with Right Side Traffic Direction*

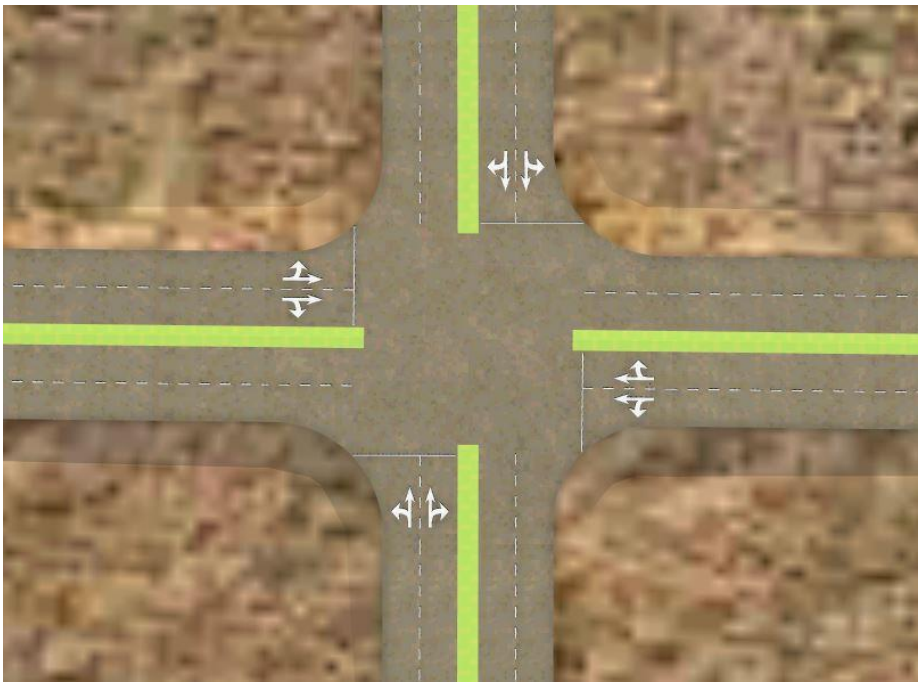

*Figure 9: Roadway alignments with Left Side Traffic Direction*

## Autodesk Civil 3D and InfraWorks – (How to consume the given design alignment data? / Workaround and refinement)

- Alignment offset for correct traffic flow and intersection design, if there are separate alignments for EB-WB or NB-SB
- Alignment at centerline if one alignment for both directions of traffic depending number of lanes on each side
- Ramps and interchanges alignments - offset alignments to move it to outer or inner shoulder based on traffic direction
- Ramps and interchanges Alignments – Create connected alignment – Ramp alignment should meet at a point to mainline to form Intersection in InfraWorks

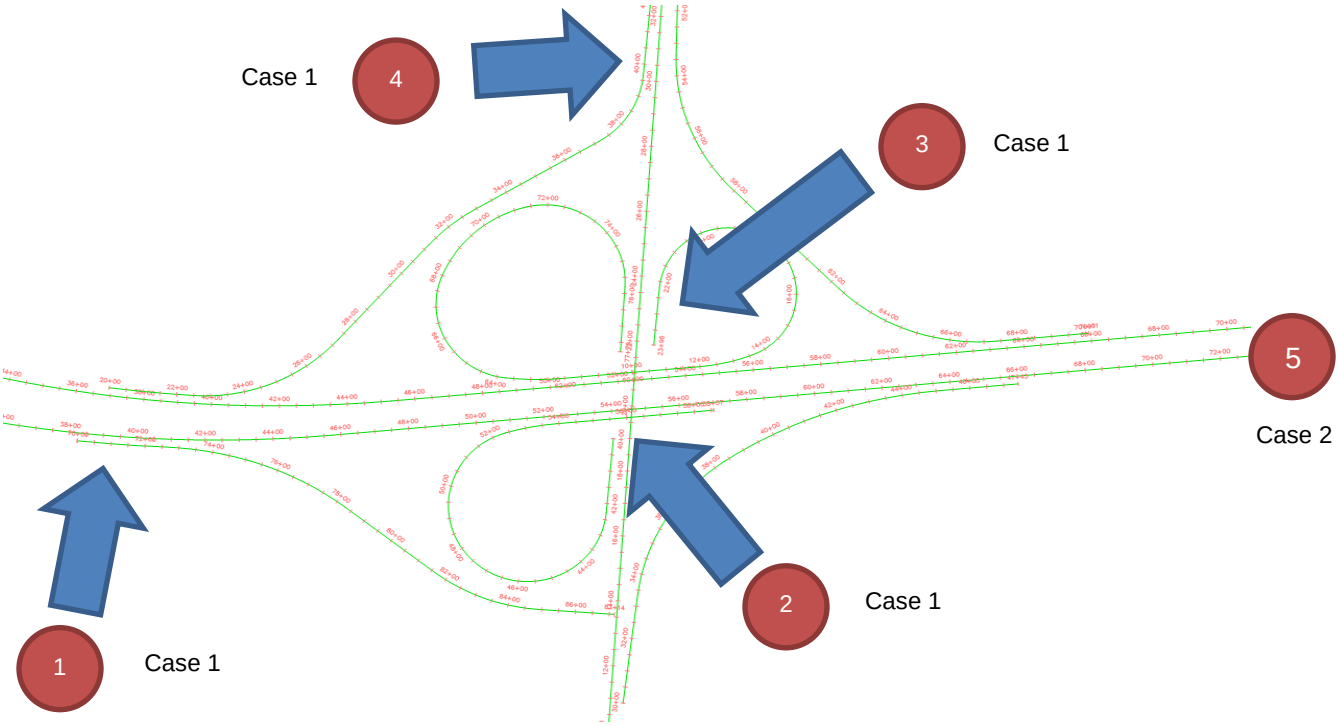


*Figure 10: Intersection Scenario within Civil 3D showing design alignments from translated LandXML*

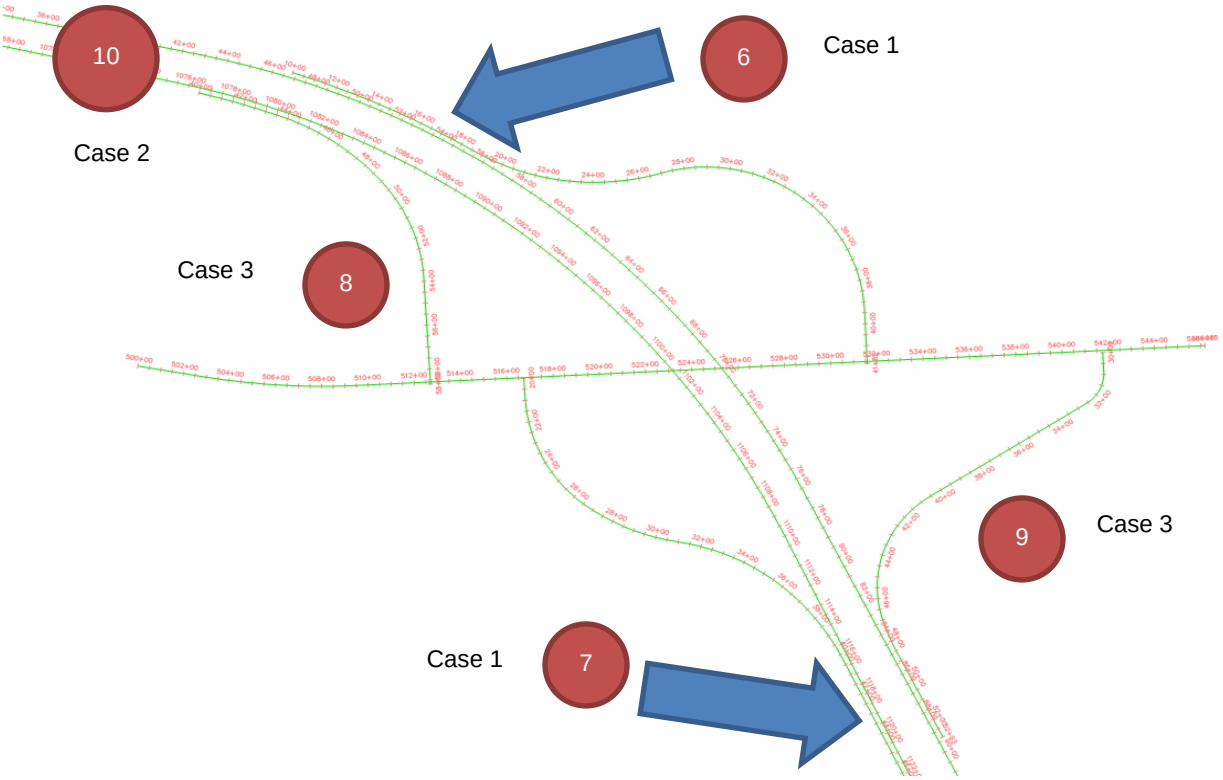


*Figure 11: Intersection Scenario within Civil 3D showing design alignments from translated LandXML*

Figure 10 and Figure 11 showing civil 3D alignments translated from ALG and pointing out some of the challenges for InfraWorks alignments.

### Case 1

Points 1, 2, 3, 4, 6 and 7 on-ramp and off-ramp alignment parallel to mainline will not form intersection within InfraWorks. It needs to be connected to mainline alignment.

### Case 2

Point 5 and 10 shows two separate alignments each of Eastbound and Westbound will not able to create proper median. It needs to be offset at center depending on number of lanes each side.

### Case 3

Point 8 and 9 on-ramp and off-ramp alignment creates problem depending on traffic direction and location of alignments whether it is at inner shoulder or outer shoulder. It needs to be offset at correct location so it forms right traffic flow at intersection.

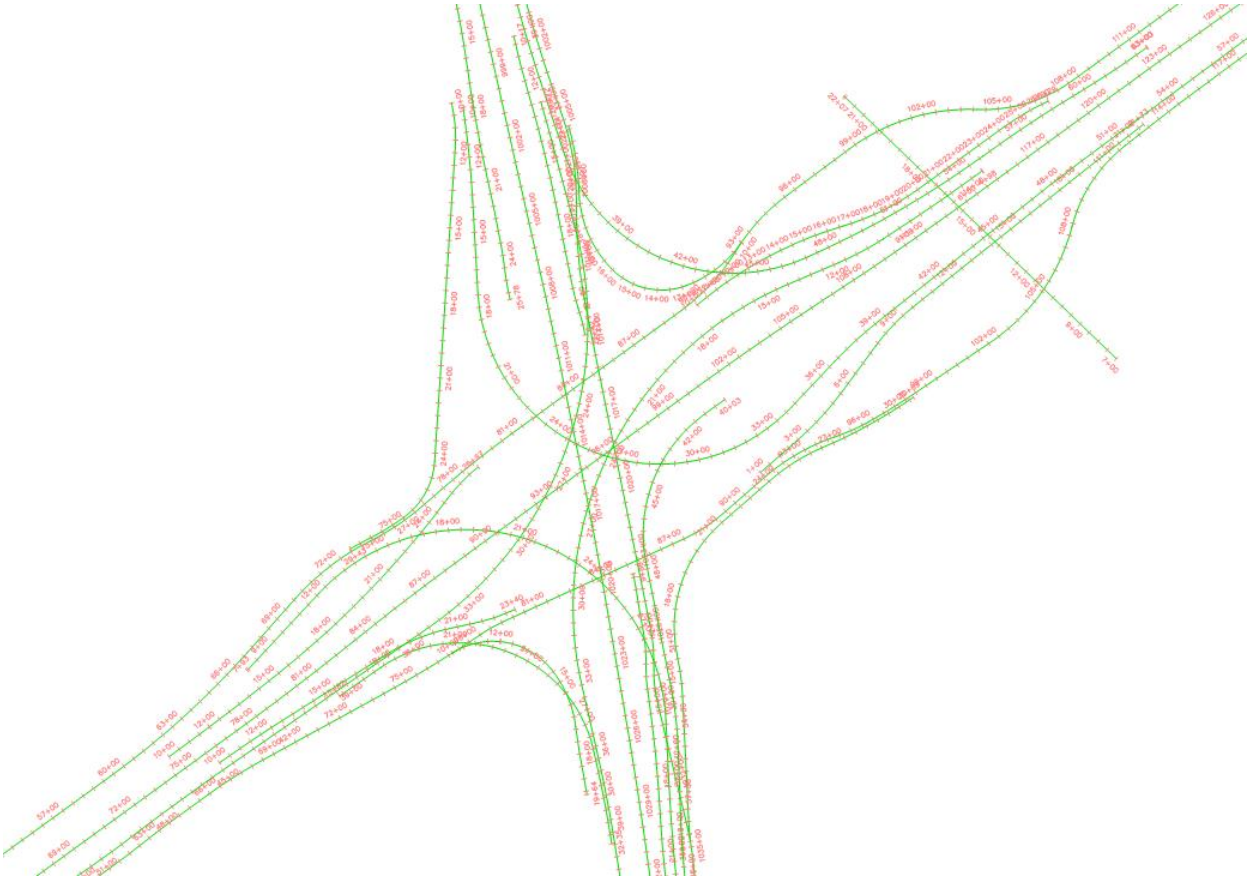

*Figure 12:Complex  Intersection Scenario within Civil 3D showing design alignments from translated LandXML*

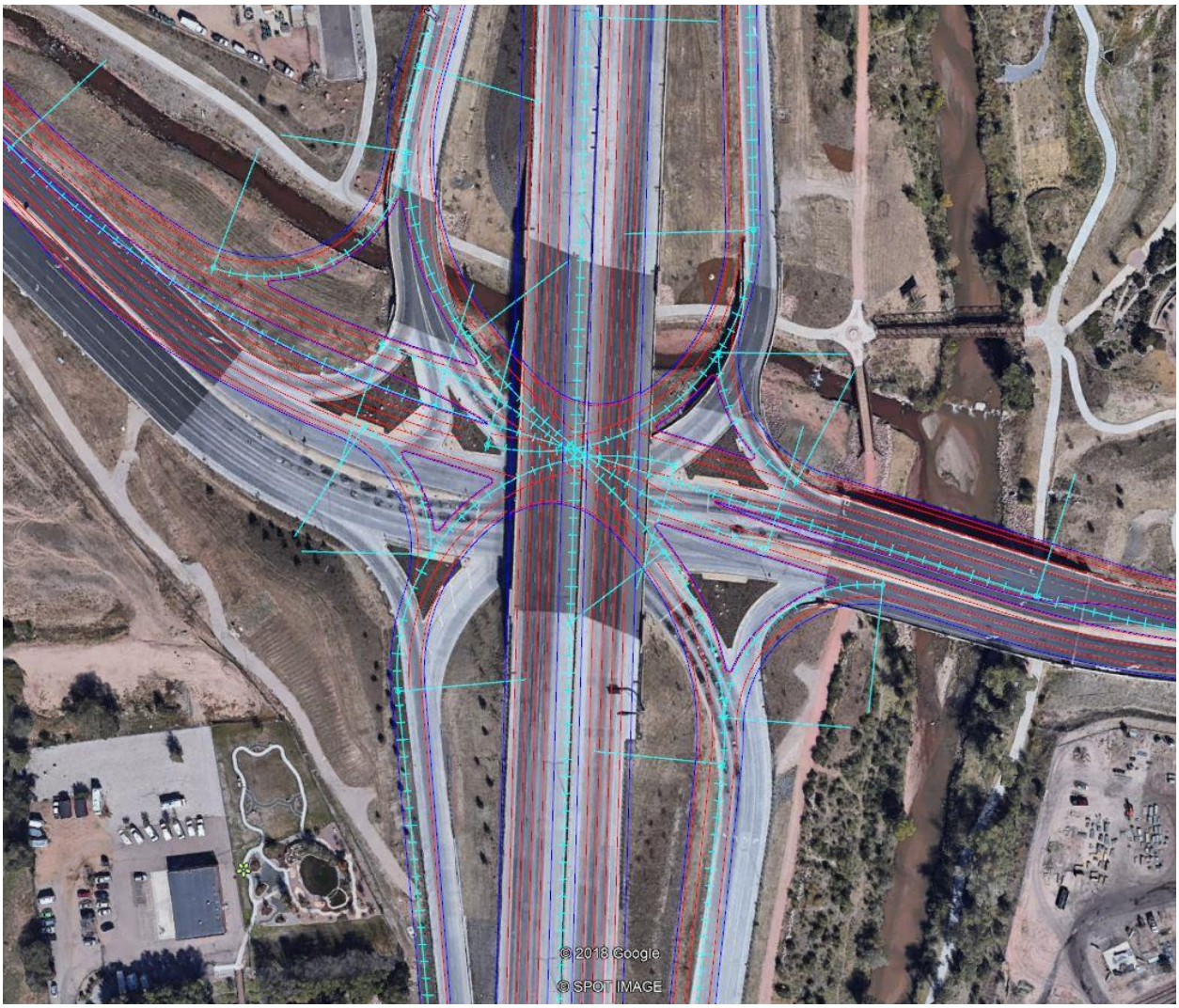


*Figure 13: Intersection Scenario showing design alignments with existing imagery*

What challenges we face when creating virtual construction alignments?

- Stationing
- PGL data
- Intersection attributes
- Transition zones – Accelerating and Decelerating Lanes

### Challenges with Vertical Profile Data within InfraWorks:

Civil 3D alignments associated with profile data do not give you the ability to edit vertical geometry within InfraWorks. Because of this challenge, we delete profiles in Civil 3D first and just import horizontal geometry and create vertical profiles within InfraWorks. This problem has been solved with InfraWorks 2020 or newer version.

# Modelling Custom Bridge Components using Inventor

Software Used:



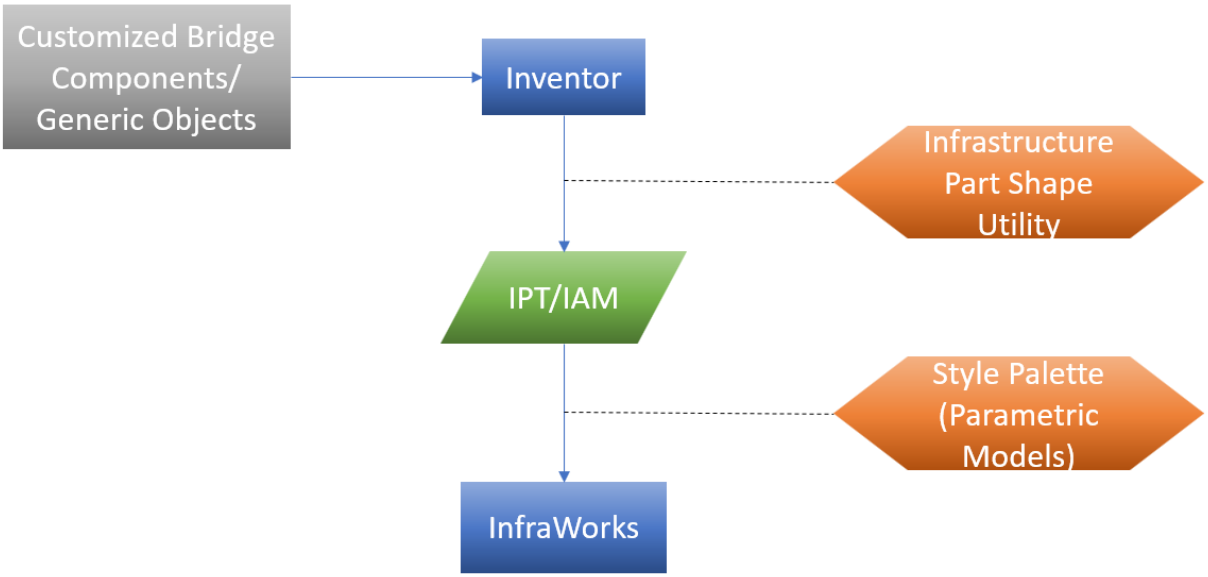


*Figure 14: Workflow showing customized parts from Inventor to InfraWorks*

## Bridge Components/Generic Objects Workflow

- Model Inventor Parts and Assemblies
- Add InfraWorks required Parameters – Case sensitive
- Publish Parts for InfraWorks - Use the Infrastructure Part Utilities in Inventor to export the templates for InfraWorks
- Import these templates into InfraWorks Style Palette (Parametric Models Tab)
- Assign the custom parts to InfraWorks Bridge Model
- Send bridge model to Revit
- Use Civil 3D to import the bridge model as 3D solids

## Import as Bridge Component

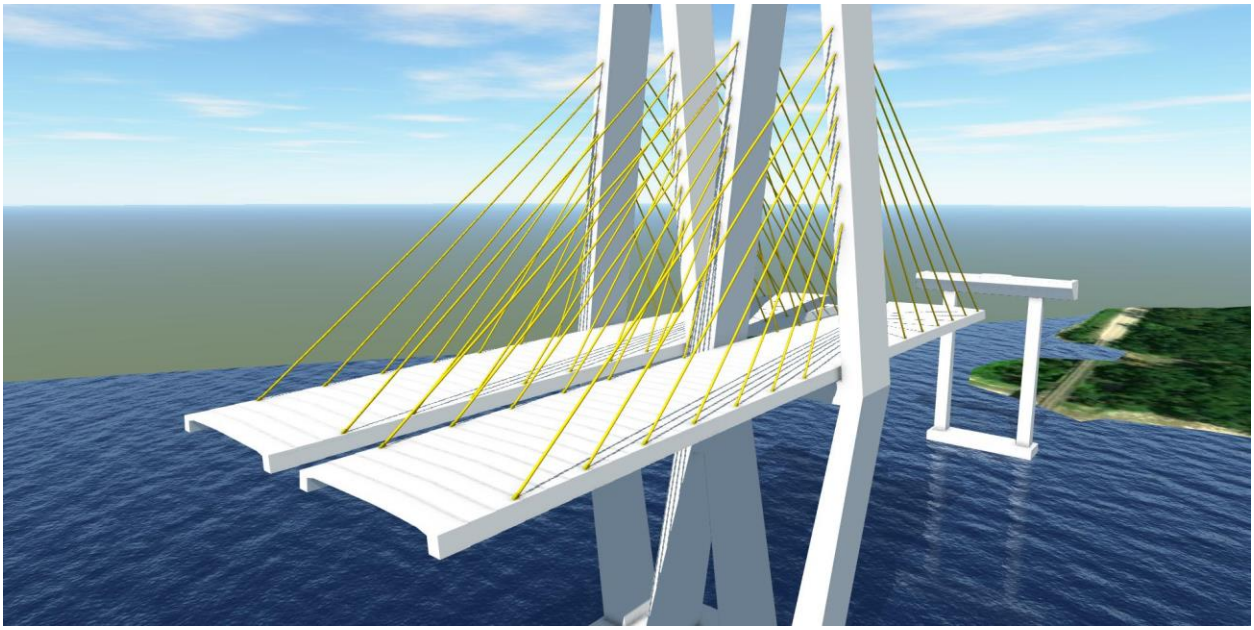

*Figure 15: Design Visualization Model showing Parametric Cable Stayed Bridge in InfraWorks 2020*

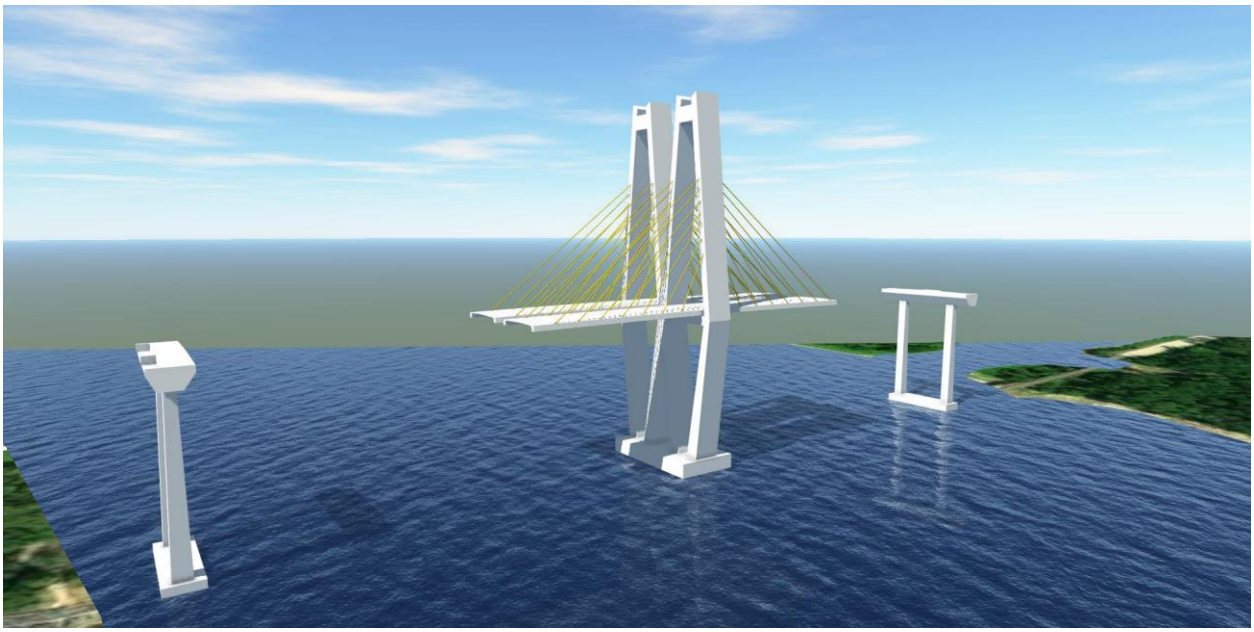

*Figure 16: Design Visualization Model showing Parametric Cable Stayed Bridge in InfraWorks 2020*

*Figure 17: Design Visualization Model showing Parametric Cable Stayed Bridge in InfraWorks 2020*

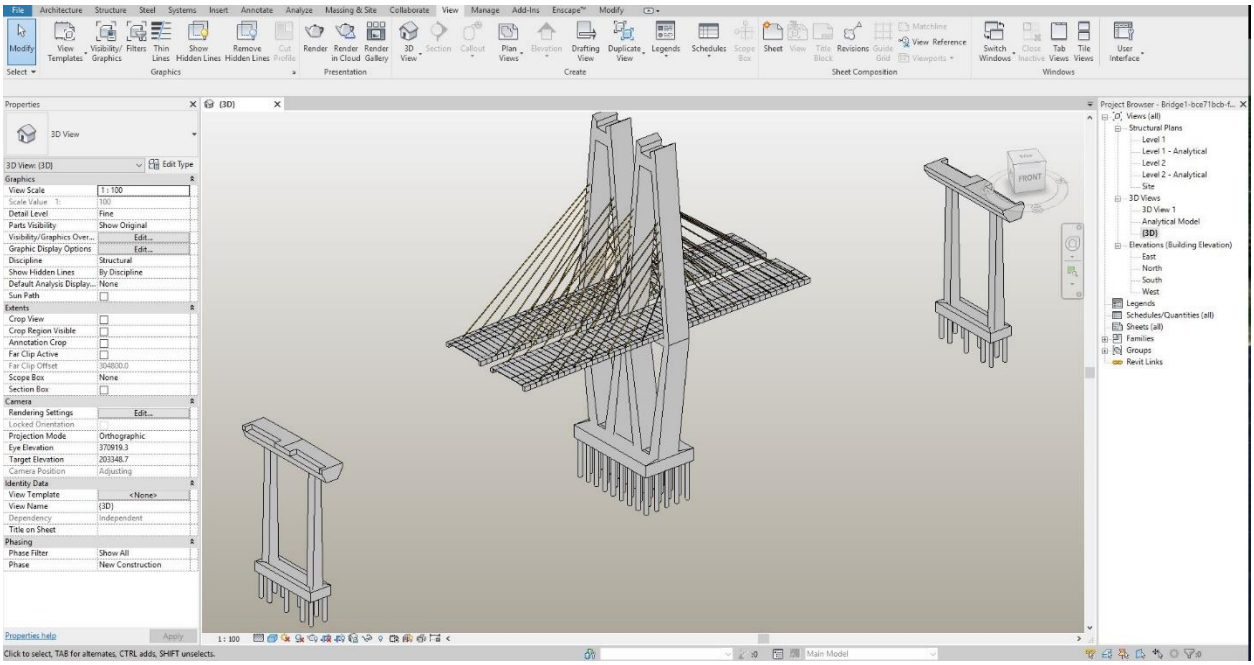

*Figure 18: Design Visualization Model showing Parametric Cable Stayed Bridge in Revit 2020*

## Import as Generic Objects

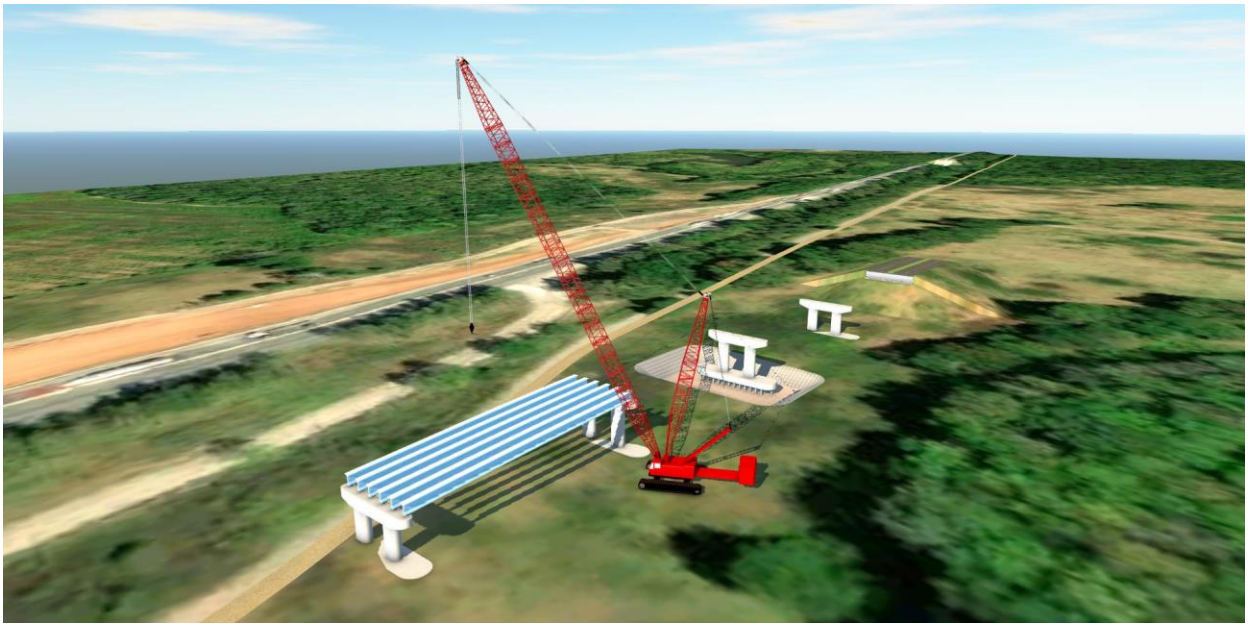

*Figure 19: Site logistics and planning leveraging Parametric Cranes as Generic Objects within InfraWorks 2020*

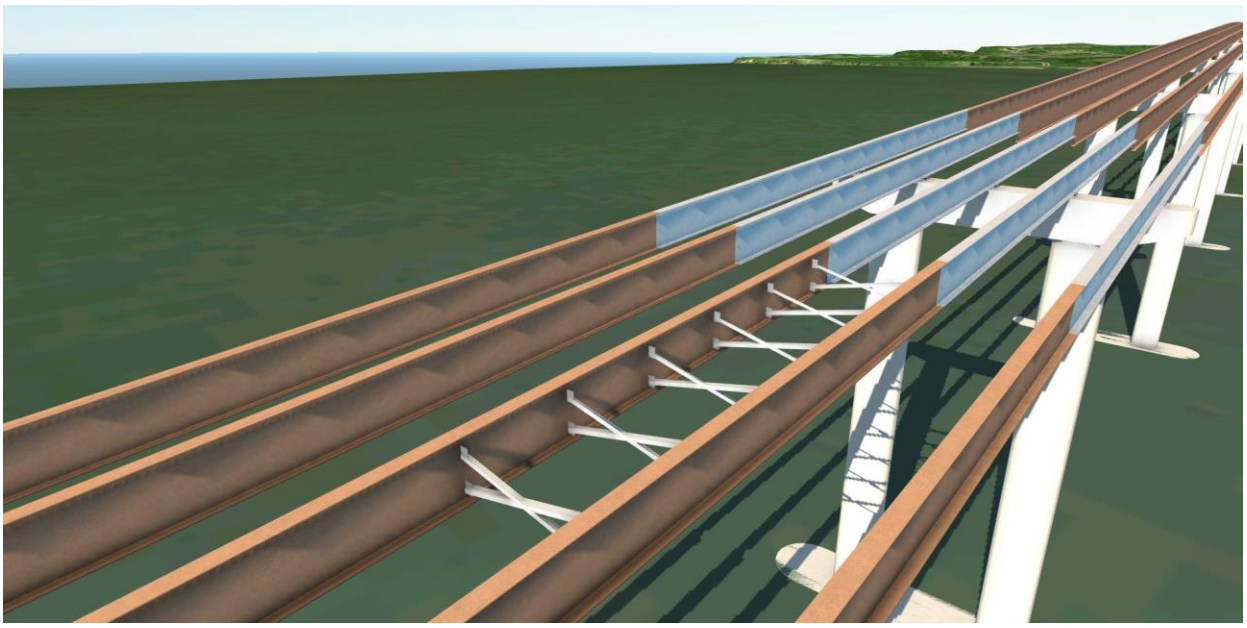

*Figure 20: Leveraging Parametric Cross Frames as Generic Objects within InfraWorks 2020*

# Detailed Construction Planning in Navisworks

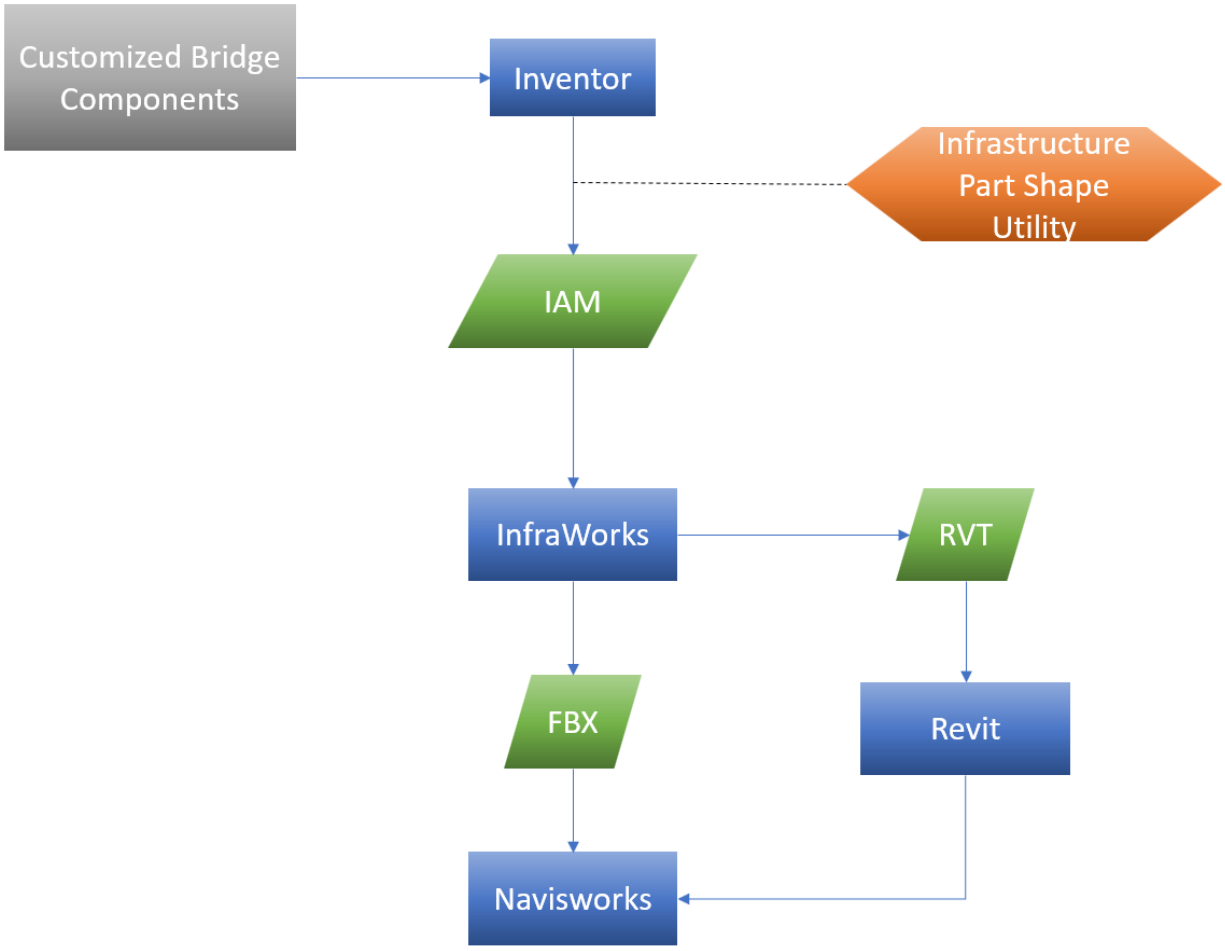


*Figure 21: 4D Model workflow leveraging InfraWorks Model into Navisworks*

Timeliner within Navisworks can be used to link the InfraWorks exported model in FBX or RVT format to the phasing activities of the planning.

InfraWorks default library components are Inventor parts (IPT file) don't give ability to select the separate entity for example pier cap and columns to link only required 3D object with specific activity. For detailed construction planning 4D Model, Inventor Part files (IPT) can be replaced be generating Inventor Assembly (IAM) which gives flexibility to select separate entity within Navisworks. Same can be followed with generic objects.

# Future Advancement Needs - Wishlist

- Automatically creates Intersection with alignments crossing each other – Should be able to select alignments manually to form intersection with
- More flexibility in Interchange attributes to achieve design requirements
- Three or more alignment meeting at Intersection creating problem – Ramp Interchanges
- Different types of interchanges creating problem with traffic flow the way InfraWorks Traffic Direction works
- Merging of proposals to have existing and proposed alternatives in different proposals and should have ability to merge them for Efficient MOT meetings
- Refreshing Civil 3D data sources creates new default component road
- Create pavement layers within InfraWorks – Sub assemblies for roadway sections like civil 3D
- More Default Pavement Markings
- Point Cloud Visibility on BIM 360 through published IWM model files
- Improvement in Point Cloud Feature extraction tools for photogrammetry generated Point Clouds