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Advanced visualization to improve communication for transportation design

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Learning Objectives

- Create an elevated transportation track using Civil 3D and InfraWorks.
- Animate parts of the visualization model using 3ds Max for better communication.
- Identify the main topics to consider for creating a convincing visualization.
- Export and use data for a high-end visualization through 3ds Max, use 3D model for VR/AR solutions.

Description

Max Bögl, a German construction and infrastructure company designed a fully automated urban mobility solution: Transport System Bögl (TSB). It is based on magnetic levitation technology and designed to provide a future-proof public transport for densely populated cities. Max Bögl approached Autodesk Consulting to help finding a quick design solution for their urban mobility systems and build 3D visualization models to communicate the proposed tracks more easily and convincingly. One of the key aspects of the whole design is the light-weight construction of elevated tracks, InfraWorks Bridge Design capabilities with its parametric modelling approach was the perfect answer. This class will highlight the main steps of the solution, the creation of the track and 3D visualization models using Inventor and InfraWorks, including animated parts, generated in 3ds Max to better demonstrate the TSB in action.

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Speakers

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[Claudia's Profile](#)

Claudia Zeh works as a Senior Implementation Consultant with Autodesk Consulting, based in Germany. With over 15 years working in the geospatial domain, she brings extensive experience from working on different types of infrastructure projects with customers in the area of AEC, construction, rail industry and utilities. With her broad technological background from designing and developing solutions, database management, requirements specifications, she provides consulting services to customers around the Autodesk Infrastructure and Autodesk Construction portfolio covering workflow assessment, customization, and solution implementation.

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[Mantas's Profile](#)

Mantas Smidtas is an expert in GIS, BIM and 3D design technologies with more than 19 years' experience in the design space. In his current role as an implementation consultant, Mantas specializes in helping customers build workflows that integrate GIS, BIM, 3D modelling and visualization around tools including Civil 3D, Revit, and 3ds Max. Mantas has worked across diverse industries throughout his career, including road, rail, and airport infrastructure, urban design, buildings, and media and entertainment. He brings an extensive cross-industry knowledge to all his engagements, allowing him to connect inter-industry components of major projects and cross-pollinate solutions from other industries.

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Introduction

This document describes different levels of visualization for track design using Autodesk technology and how it can be used to improve communication.

Max Bögl is one of the largest construction companies in the German construction industry with many years of experience and competence in high-precision precast concrete construction. One of their key characteristics is innovation in research and technology to develop new solutions - including topics such as renewable energies, urbanization, mobility, and infrastructure.

The Max Bögl Group has already been involved in magnetic train technology for over 20 years. The development of the TSB, the Transport System Bögl, began in 2010. It is a future-oriented local transport system. Based on magnetic levitation, this system is quiet and flexible while also saving space and lowering emissions.

The main emphasis of this system lies on providing a sustainable solution of a transport system for densely populated areas.



FIGURE 1: TRANSPORT SYSTEM BÖGL

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Early Design Visualizations

The first step was to look on a solution that allows to create early design visualizations of the TSB Track Design in Context of the Existing Environment in a quick way.

Especially for the bidding phase it is important to be able to quickly generate a model containing the existing environment, to be able to show where a new TSB track will be planned.

As one of the key TSB elements is the lightweight track, the visualization needs to include a realistic looking model of this structure.

The TSB Track can be elevated, at-grade or underground.

InfraWorks Civil Structure workflow

To generate this visualization model, we make use of the InfraWorks Civil Structure Design.



FIGURE 2: INFRAWORKS CIVIL STRUCTURE DESIGN

The InfraWorks Civil Structure Design comprises the design of the structure in InfraWorks (i.e. a bridge), the road design from a Civil 3D model and highly customizable parametric components generated in Inventor. In this case we concentrated on these three parts (InfraWorks, Civil 3D, Inventor) of the Civil Structure Design workflow.

Autodesk InfraWorks is a visual 3D design and communication platform that allows to create models with large extents to show the track design in context of the existing environment.

The quickest way to start with InfraWorks for creating an existing condition model is to make use of the built-in Model Builder. You simply define a boundary of your area of interest and will get a model containing terrain data, ground images, buildings, roads, rails, water network. The data used in this model is publicly shared data. The accuracy of the data is good enough for a start, and then it's up to you to add or replace data with data of higher accuracy.

For the track design, you can start with designing the track directly in InfraWorks. This step is good for early design, as the track can be placed quickly in the right location. This information can be used in Autodesk Civil 3D, to continue detailing the design of the track. InfraWorks and

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Civil 3D have a close collaboration. When importing the Civil 3D track design model (in this case it is the Civil 3D alignment and profile) into InfraWorks, this is directly generated as the designed track and if design updates are done to the Civil 3D model, they can be automatically applied in InfraWorks.

After the creation of the TSB track routing, the next part is to design the actual TSB structures. Here we make use of the InfraWorks Bridge Design capabilities.

The InfraWorks Bridge is based on parametric model components, which can be highly customized using Autodesk Inventor. InfraWorks already contains a library of ready to use parametric models, but in this case, as it was important to exactly generate a model that reflects the TSB track design, we generated custom parametric models, for example for the piers and for the girders (girders in this case reflect the TSB driveway).

The key part of the girder component for the elevated track is to show that it's not a continuous concrete slab. Including the voids in the parametric girder models were key to visualize the lightweight track. In using the InfraWorks analysis tools for different day, sun and sky settings, the model helps to demonstrate and visualize different shadowing conditions caused by the newly designed track.

The benefit of this workflow is that once the parametric components have been defined, it is mostly just a case of applying them to the relevant track section. This allows to generate the TSB track in a quick way, especially as the majority of the TSB track components are standardized.



FIGURE 3: REAL WORLD PICTURES VS INFRAWORKS MODEL PICTURES

Enhanced visualization with animations

The next step was then to enhance the visualization of the already created InfraWorks models by adding animated parts to it.

Max Bögl developed the TSB Cargo, which is based on the same maglev technology. The TSB Cargo is developed as a sustainable, low-emission system for moving containers.

The basic underlying technology and TSB track structure is the same as for the TSB Passenger system.

To better explain how this driverless transportation system works in action, parts of the solution needed to be animated.



FIGURE 4: TSB CARGO

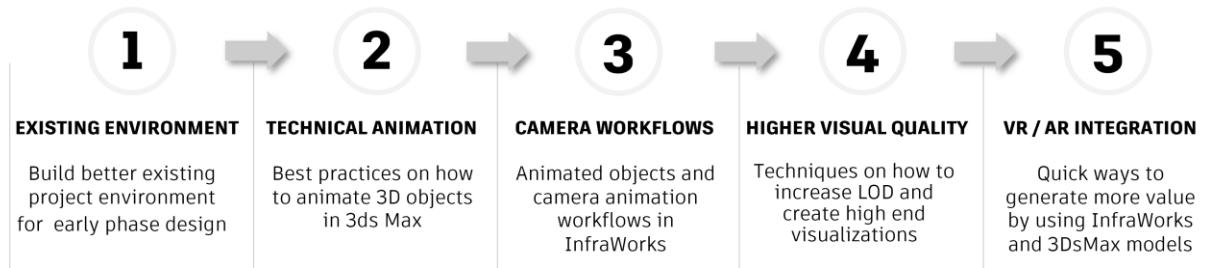
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Different Levels of Visualization



FIGURE 5: DIFFERENT LEVELS OF VISUALIZATION

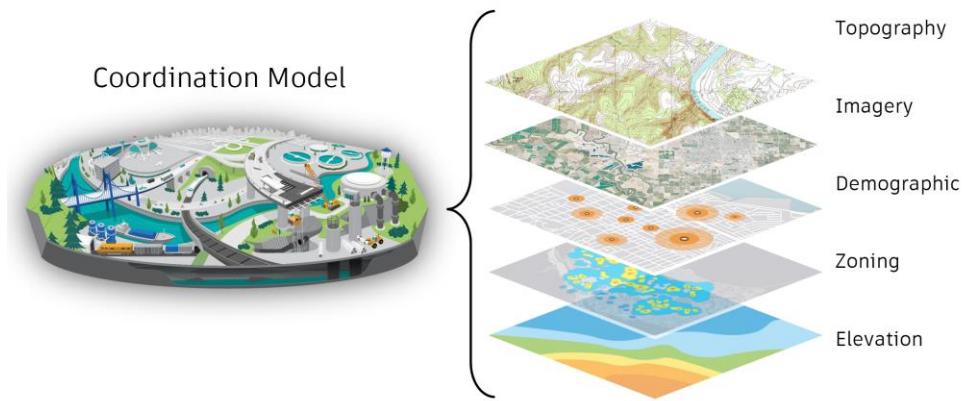
The proposed workflow we defined allows the project team to use design data from the early stage and reuse it in following project stages, to generate higher quality visualizations, movies or maybe start creating interactive VR, AR solutions.



The diagram above names the main steps of the workflow we proposed:

- Existing environment
 - *How to improve the quality of the Existing Condition Model?*
- Technical animation
 - *How to animate technical parts using 3ds Max?*
- Camera Workflows
 - *How to best incorporate animations into the InfraWorks model and create camera animation workflows?*
- Higher Visual Quality
 - *How to increase the Level of Detail and create a higher visual quality using 3ds Max?*
- VR / AR integration
 - *How to generate more value by using InfraWorks and 3ds Max models for a VR/AR solution?*

Improve quality of the Existing condition model



Key for improving the quality of the existing condition model is the availability of data. And this often means that some data needs to be purchased to get the desired result. But before knowing this, the question needs to be answered: What level of detail do we need in our final result? And for which area do we need a higher LOD?

Especially for Infrastructure models, good terrain models are key, to allow realistic looking visualizations. If the model spreads over a long distance, it might be worth thinking about the need of generating the whole model or only the main area of interest with a higher LOD. This can influence the costs for purchasing data and the model handling.

The more detail data is available, the better. Still, most important is to know what needs to be generated as the final result, and where the emphasize for the presentation needs to be set.

In addition to the existing condition data, it is also important to think about how to model the project design data. Long tracks for example need to be split into manageable sections; for adding additional structures, or any other details it needs to be checked if they are available in the right format, file type, location, data structure, etc.

These are all considerations that should happen at the beginning when starting to generate the visualization model.

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Creation of animations

The animations are created in Autodesk 3ds Max.

For the visualization of the TSB Cargo system, it is important to show how the vehicle drives along the track and how the containers are lifted from and put on to the TSB vehicle.

Track animation

To generate the animation of the TSB cargo driving along the track, we used the track geometry (the alignment) from Civil 3D as well as the 3D model of the InfraWorks TSB Track (.fbx). The Civil 3D alignment provides the path and the right location, the 3D model of the TSB track (the .fbx model) serves as additional information to better review the result of the generated animation.

For a general track animation overview, the Civil View Add-in of 3ds Max provides a quick way to automatically animate several vehicles along a given path.

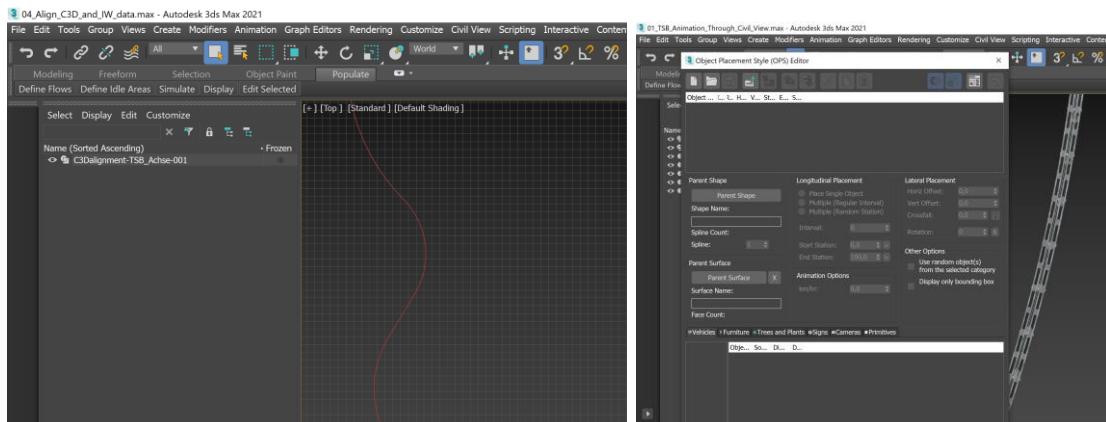


FIGURE 6: USING CIVIL VIEW TO ANIMATE VEHICLES ALONG THE TRACK

To better control the movements, for example increase or decrease the speed, stop at a station, etc., it's recommended to manually create the animations. This requires more steps but is much more flexible.

Moving part animation

For the animation of parts to simulate mechanical movements the input model needs to have the required level of detail. This must be checked before starting with the actual animation, as well as general good practice modelling tasks like combine (compound) 3D elements to optimize the performance, create a model hierarchy and work with layers for a better structure of the model and allow to have parent-child relationships when moving parts, understand the Point of Origin / Axis / Pivot point, especially when combining different movements, etc.

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The basic steps to generate the animation can be outlined as following:

- Linking Objects:
 - Link all objects that should “move” together in the same way.
- Create Helpers:
 - Instead of defining the animation path for the actual model objects, make use of so-called helpers, which are simple geometries.
- Animation Constraints:
 - Create the constraint an animation should follow, for example a linear path.
- Create Attributes:
 - Attributes assigned to an animation path, allow easier control how the object should move.
- Animation:
 - Definition of actual animation, where to start, the speed, where to stop, etc.

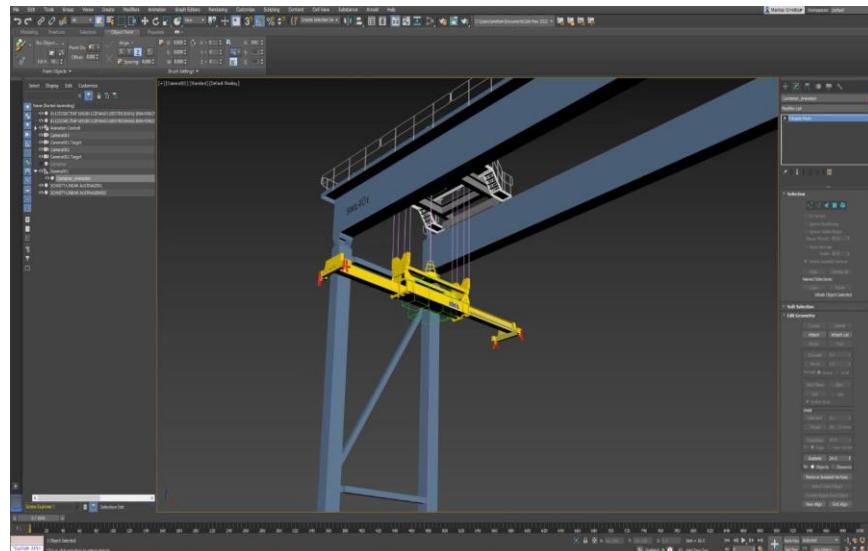


FIGURE 7: ANIMATED PARTS IN 3DS MAX

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Animated objects and camera animation workflows in InfraWorks

The 3ds Max animations will now be added to the InfraWorks model, for this they are exported as Collada (.dae) files. The animated mechanical parts will be placed manually to the right location, the track animation will automatically be placed to the right location when importing into the InfraWorks Model, as we generated the path in 3ds Max based on the georeferenced track alignment.

The next step is to generate the actual movies, this is done in InfraWorks using the story board creator, that allows to control the camera position, angle, etc.

Using all these techniques the Max Bögl TSB Team generated these convincing visualizations within a short time, showing the TSB in action.



FIGURE 8: TSB SYSTEM VISUALIZATIONS

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Higher Visual Quality and VR/AR

Stepping into the next levels, the generated models can then be used to enhance the visual quality and to use them for generating Virtual (VR) or Augmented Reality (AR) solutions.



FIGURE 9: HIGHER VISUAL QUALITY

Higher Visual Quality

Enhancing the already created visual models with additional effects, or additional environmental objects (i.e. trees) can already make a big difference regarding the quality in the coordination environment. 3ds Max can be used to add these enhancements, adding more realistic looking textures or materials, create a more realistic environment light, animate object, create special effects, add quality working with transparencies, illumination, etc.

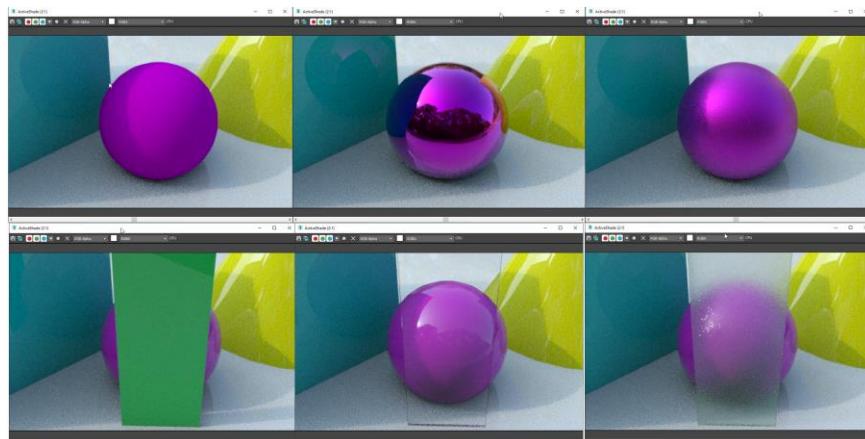


FIGURE 10: INCREASE VISUAL QUALITY USING 3DS MAX

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VR / AR Solution

The following high-level workflow shows how the InfraWorks and 3ds Max 3D models can be reused to generate a Virtual or Augmented Reality solution.

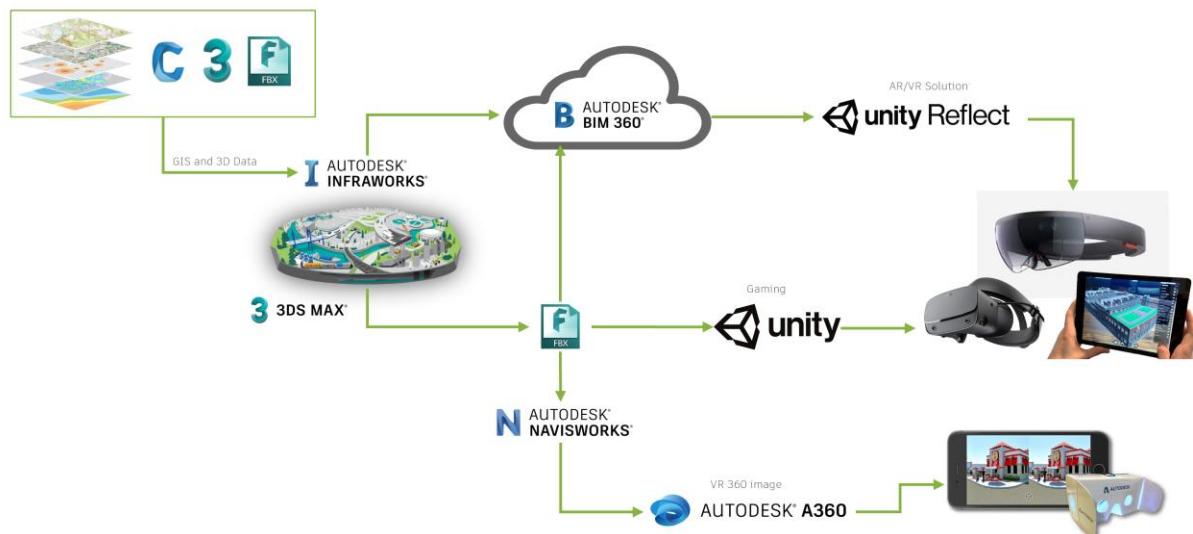


FIGURE 11: WORKFLOW INCLUDING VR/AR INTEGRATION

There are different options, depending on what the desired goal is.

First option: through the integration of Unity Reflect, a real time design review and coordination solution that connects all project members on one immersive, collaborative, real time VR/AR platform. This system allows users to link the generated 3D InfraWorks model to Unity Reflect directly from a BIM 360 environment. By using the model from BIM 360 within Unity Reflect, construction teams can use these data-rich workflows to incorporate most up-to-date information.



In this collaborative environment you can fly or walk through, you can share your view with others you can communicate in the same model space with other team members. You can link your model to the environment you are surrounded. In the example shown during the presentation, the model has been linked to a tabletop, picked the right scale, what allows us to place the InfraWorks model on the table. This is the simplest way to create an AR solution.

Second option shows the way the data from our 3D model can be used in the 3ds Max to the Unity Pipeline.

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Third option describes how we can generate a 360° panorama image, that can be viewed in a web browser, or with VR Glasses. The model is sent to Navisworks to create a 360° Panorama Image.

These are just some possible options, of course there are other possibilities to continue generating VR/AR solutions.

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Summary

The described possibilities to generate Different Levels of Visualization using the same model components allow to generate the right result for the desired output.

In this case we started from the early design visualization for the Existing Condition Model and the track design by creating an InfraWorks model.

The next level was then to include animated parts to the InfraWorks model to better communicate the system in action.

Followed by enhancing the visual quality by adding more details and make use of different effects and giving an outlook on how to Generate VR / AR solutions to provide interactive solutions based on the models created before.

Benefits you can gain by creating visualizations with animations and higher quality:

- Minimize the time needed to explain a solution.
- Reduce the potential misinterpretation when communicating a design.
- Make use of animations to explain technical details of moving parts.
- Attract a bigger audience when sharing more appealing visualizations on social media.

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Additional References

This is a small selection of some previous AU classes, covering related topics:

[Bridge Design Workflow: Best Practices for Data Exchange](#)

In this session, we will teach you the best practices for exchanging data between Civil 3D software, InfraWorks software, Inventor software, and Revit software. We will get into the differences of the software interactions when using FBX or IMX or Autodesk; the differences between creating Inventor Parts (single body versus multibody) versus Assemblies (with skeleton modeling and iLogic) and their advantages and disadvantages; and how this translates to Revit for detailing and what you need to watch out for in Revit.

[InfraWorks Bridges the Gap for Structural Modeling](#)

This class will cover the workflow for using InfraWorks software, with Inventor software and Revit software, for bridge modeling. It will cover what you can do with the software today, as well as what will be available in the near future. We will use a data set from a pilot project that uses this workflow. We'll discuss the steps your company can take to move out of a 2D world, and the lessons learned from the pilot project, and we'll show how the project team can work together with an integrated model to manage change. Lastly, we'll discuss the key differences between using this workflow and using Dynamo for Revit software to model bridges.

[Modeling an Elevated Guideway with InfraWorks, Civil 3D, Inventor, and Revit](#)

In this class, we'll cover how different steps of modeling the guideway are carried out within Autodesk software. We'll start with demonstrating how to generate the guideway's alignment and then import into InfraWorks software to define the course of the guideway. Next, we'll present how to generate various sections of the guideway in Inventor software and then import to InfraWorks to build up the model. Finally, we'll show how the guideway model is exported to Revit software to be enhanced with appurtenances that are natively modeled in Revit. The overarching goal of this class is to demonstrate how this workflow empowers the software to interact and supplement each other to ultimately produce a guideway model that is parametric and dynamic. Furthermore, you could readily use the model for developing construction documents, as well as delivering multiple BIM (Building Information Modeling) uses, such as 4D scheduling, and 5D estimating

[Civil 3D to 3ds Max Using Civil View for Compelling Civil Construction Sequences](#)

Importing corridors and roadways from Civil 3D software into 3ds Max software is just the start to making your roadways pop for presentation graphics. Using the components built into Civil View, you can transform a basic corridor model into a realistic-looking intersection or highway that will make your renderings stand out. The course will review Object Placement and Road Marking Style Editors built into 3ds Max Civil View, and the best practices for applying the elements to corridors imported from Civil 3D. This course will show how Skanska uses Civil View in their construction sequences to help their graphics stand above the rest to the owner.

[Create Custom Components in 3ds Max Civil View for Civil Construction Sequences](#)

3ds Max Civil View software already has a large selection of library objects to place into your civil infrastructure model. However, Civil View is scarce on objects used for civil construction sequences, such as construction barrels or barriers that are used to display to the owner how you're going to maintain a safe construction zone on an active highway. Adding that object to the library can be difficult if you do not follow the required steps. Throughout the class, the instructor will show you how to set up and configure your models to be used by the Object Placement Style editor, whether it is adding a new light pole, construction barrel, or car to the Civil View library. Adding your own custom elements to the object placement library will make your process more efficient and streamlined as you create construction sequences to be used during the proposal and preconstruction phase of a civil construction project.

[Streamlining communication in AEC with Unity Reflect](#)

In the past, the architecture, engineering, and construction (AEC) industry relied heavily on in-person interaction, physical models, and 2D visuals. Communicating design intent in this way —especially with COVID-19 impacting the future of work—has posed challenges for design reviews and coordination meetings to provide the right context for all stakeholders. Using real-time BIM enables companies to create immersive, interactive experiences for virtual reality (VR) and augmented reality (AR). Companies can conduct design reviews between designers, owners, and construction trades irrespective of geographic location and iterate across teams before the concrete is poured. This session will explain how Unity Reflect enables immersive design review and coordination to empower better collaboration and faster decision making, bridging the gap between designers and decision makers

[Advanced Data Flows And Visualization Through InfraWorks](#)

In this class, we will cover how to accelerate the transition to connected BIM (Building Information Modeling) for infrastructure with improved efficiency and project approvals through an end-to-end design approach using InfraWorks software as the aggregator and design data visualizer. We will walk through one of our road projects and demonstrate the data collection solution we're using in our data flow solution. Our techniques and workflow include high-end existing modeling conditions, road design representations in InfraWorks combined with built-in road and bridge design tools, ArcGIS Data collection and presentation in InfraWorks, Ramboll Risk Management data representation in InfraWorks, BIM 360 as collaboration tool for InfraWorks, InfraWorks data flow for 3ds Max software or Forge in the future, advanced visualization—virtual reality (VR), augmented reality (AR)—and more. We will expose attendees to leading practices using InfraWorks for data visualization and aggregation, and they will get inspired about