AUTODESK UNIVERSITY

[CS21378]

Model-Based Bidding and Integrated Concurrent Engineering: A Dream Come True

Learning Objectives

- Learn the benefits of applying ICE to your infrastructure projects
- See how modeling results in amazing EPC design-build project optimizations
- See how InfraWorks 360 models are capitalized on for the bidding process
- Learn visualization and labeling tips and tricks for your InfraWorks 360 model presentations

Contact information

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Description

Sweco and Veidekke joined for calculation on an EPC contract, for a road-project in Norway.

The need for closer collaborations between consultant and contractor is enforced by market changes on the infrastructure side in the Nordics. Fewer and bigger clients, with demands of cost and time reductions, and even more contractors, competing on these contracts, along with cost effective providers from outside the Nordics. The current market situation calls for a change in work methodology. Contractors is now required to work closely with the consultant, creating a need for aligning philosophy and forming a coordinated scope. To accommodate these demands on cost reduction, higher quality and timesavings, smart technology use needs to be applied.

Better Together

The contractual arrangements made it necessary for contractors to ally with consultants, to not only build, but also plan and design. Veidekke went through a process to find a consultant to team up with in this project. Sweco's VDC-mindset, and philosophy on the use of Integrated Concurrent Engineering and LEAN-methods, made Sweco the preferred partner.

This presentation tries to explain how we did it. How, putting together the knowledge in one room, that normally does not interact in these early stages of a project, and that normally has a completely different agenda when meeting, created positive synergies. Using appropriate tools, creating aligned objective and a common understanding of what we were trying to achieve. What was the pitfalls? How did we overcome by using software in a smart way? Design decisions resulted from review and analysis of the InfraWorks 360 model.

In a few weeks, Sweco and Veidekke:

- Created a base model that could generate smart decisions
- Optimized the road-design, construction and maintenance, trough ICE-meetings
- Created the required documents for the bidding and tender process
- Calculated the EPC-costs

The Project	The Model
Highway of 7 km included an pedestrian walkway, in the southern parts of Norway. • Reconstructing and upgrading an existing road • New road with and pedestrian walkway • New tunnel EPC contract • Engineering, Procurement and Construction included.	Approximately two days spent on collecting data on existing condition and creation of base-model as presented, prior to the first ICE-session. • Base model in Infraworks 360 • Base model in AutoCAD Civil 3D • Preliminary road design in Infraworks 360 • Detailed road design in AutoCAD Civil 3D and Novapoint

Your AU Expert(s)

Terje is a specialist on the BIM Team in Sweco, Norway. He serves as a Building Information Modeling / virtual design and construction (BIM/VDC) strategist, manager, and coordinator, and is responsible for the implementation of new technology and processes on his team. He has worked for many years developing and enhancing the BIM experience for users across many disciplines. Before joining Sweco, Glad worked for Focus Software, where he implemented Autodesk, Inc., and other BIM solutions at the enterprise level. He was trained as a civil engineer and land surveyor, and gained essential construction experience working on construction sites during and after his education. Being raised at the very far reaches of Norway, Glad is an expert skier, and now living in Oslo, in the sunnier months he enjoys sailing the Sweco race boat long into the evenings after work.

Sofia is working as a BIM coordinator at Sweco Norway's BIM Team. Prior to this, she has been a part-time employee as both road-engineer and BIM coordinator within Sweco, while completing a degree in civil engineering. Sofia wrote a very exciting thesis together with Sweco, on the implementation and customization of digital collaboration methods in the design of infrastructure projects, with special focus on ICE methodology. (Integrated Concurrent Engineering)
Sofia is currently working in/on multiple large assignments in Sweco, like the Bergen Light Rail project. She has contributed with her expertise in ICE and other execution methods, and has been an important part of the BIM and ICT management in the project.
She is also involved in several projects as a BIM coordinator, and has been lifted BIM in Sweco to new heights through the implementation of new innovative processes and associated technology.

Christian was Veidekkes Project Manager for the bidding process. He works as ICT-manager in Veidekke and has been a key person when Veidekke implemented VDC into its organization. Christian have great skills on the field of technology and methodology, he also have extensive experience and competence on the construction field, and this makes Christian an expert in project planning and execution. When not building the world or creating amazing project plans, Christian prefers to enjoy life together with his wife and their kid. When things gets too hot at home, Christian cools himself down with a trip with his fatbike in the deep forests of Norway.

Learn the benefits of applying ICE to your infrastructure projects

> **"Integrated Concurrent Engineering (ICE) is a social method, helped by technology, to create and evaluate multi-discipline, multi-stakeholder VDC models extremely rapidly"**
>
> John Kunz, Center for Integrated Facility Engineering, Stanford

One key motivation for Veidekke choosing Sweco as partner was Sweco's experience in Concurrent Engineering. There was no doubt that ICE-methodology were going to be used in this project. So, for the first work-session, the outline for the bidding process were set. Need for breakout sessions were mapped, parallel activities identified, and the team composed with necessary knowledge. Through the ICE-workshops, experts in fields important to the process prepared in advanced on the challenges of the project, and where brought in to give a quick brief on their field of expertise, and stayed present in the workshop for any questions regarding their area of knowledge until it was embedded in the project's core group.

In the extended project-group, experts on asphalt technology, land-use planning and zoning, geologist and operation and maintenance workers where included. Having construction workers present during our first ICE-session gave a great diversity to the table.

Key benefits

By collocating the bidding-organization, and working towards a common scope, we created a joint understanding of critical areas and themes; we could split the project-group, work in effective breakout sessions, minimizing the waste of time.

The design then based on the Contractors extended knowledge about the actual building process; the equipment, safety for workers and end-users and an efficient and environmentally friendly operation of the road after the construction phase.

We managed, by using in-house expertise from both Consultant and Contractor, to achieve a high understanding of all disciplines involved in the project.

The result; The model, were used without any rework, directly for the extractions of volumes for calculation of the project, and was an invaluable tool for planning both project execution and maintenance

Output after the ICE sessions

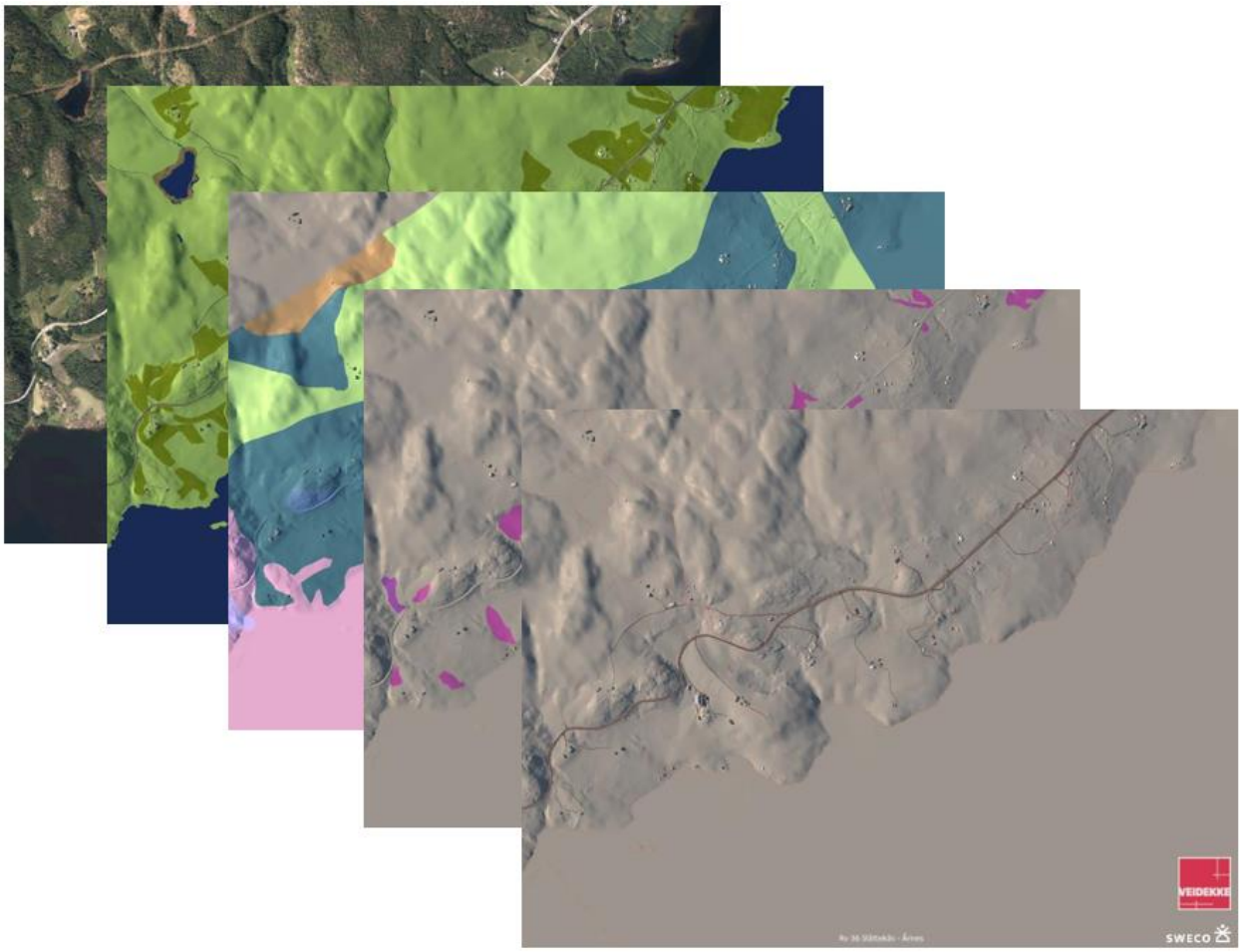
One of the greatest benefits of working with ICE-meetings is that it gives some great results either can be used directly, or as a underlay for further optimization and detailing.

This is a list of some of the outputs from the ICE sessions:

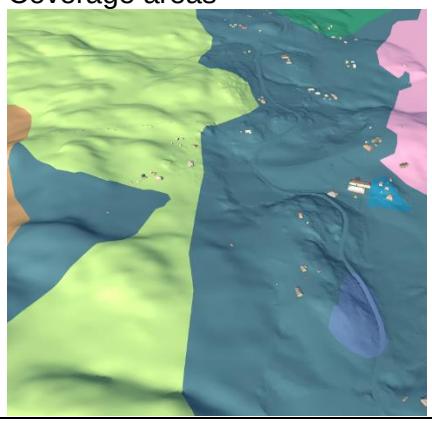
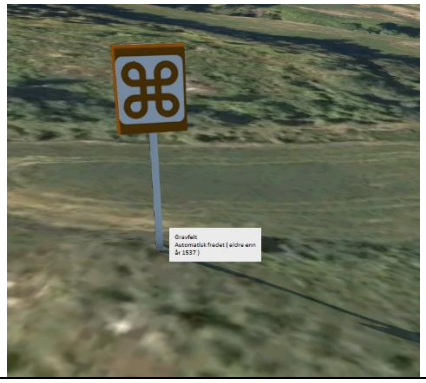
- Infraworks and Civil 3D base models
- Road-model in Infraworks and Novapoint, ready for Quantity Takeoff
- Rock TIN surface
- Visualizations for use in our quality description
- 4D simulation videos and images
- Phase plans
    - Visualizations
    - Underlay for phase drawing production
- Collaboration model in Infraworks
    - Was used for further planning of the project execution and as underlay for our Project Quality Description

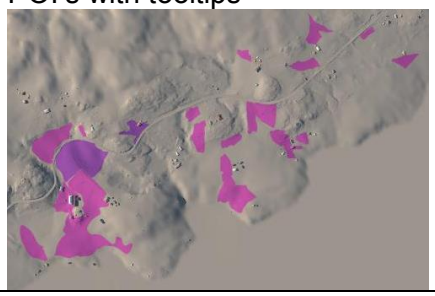
Learn visualization and labeling tips and tricks for your InfraWorks 360 model presentations

Infraworks 360 is a great tool to assemble and visualize data from different sources, one of the key elements is that InfraWorks 360 efficient allows you to use metadata attached to the imported objects. Tooltips and labeling is a great way to use the data, and to easily and effectively present large amount of information to the project team.



Beside of normal geo-data (laser-scanned existing terrain surface, aerial photo, ex. road, buildings, property lines, power and transmission lines, storm-water, pipelines and electro) we also used open datasets from several different sources – see table on next page for some of the data-sets and sources that we used in this project

Information/dataset	Source/format	Result
Area information about terrain erosion	The Norwegian Water Resources and Energy Directorate	Coverage areas 
Flood information	The Norwegian Water Resources and Energy Directorate	Coverage areas 
Cultural heritage	Directorate for Cultural Heritage	POI's with tooltips and coverage areas 
Water borehole data	Geological Survey of Norway	POI's with tooltips 

Information/dataset	Source/format	Result
Traffic information	Norwegian Road Authority	POI's with tooltips 
Protected species	Norwegian Biodiversity Information Centre	POI's with tooltips 
Landslides and avalanches	Geological Survey of Norway Norwegian Road Authority	POI's with tooltips 
Road object metadata	Norwegian Road Authority	POI's with tooltips
Weather information	Norwegian Meteorological Institute	POI's with tooltips
Access to maps and street view	Google	POI's with tooltips 

See how modeling results in amazing EPC design-build project optimizations & how InfraWorks 360 models are capitalized on for the bidding process

Through the ICE workshops, the project-group identified elements to optimize, and created a strategy for how to solve the different elements, based on the expertise and strengths in the group. Through design reviews, requirements and limitations where undergone, and the model was packed with information that was used by the project team to do the correct decisions.

Vertical Geometry

The first optimization task was the vertical geometry of the road. This is critical to achieve a better mass balance in the project. The optimization of the vertical geometry started by a review of the proposed the design in Infraworks 360. Then the detailed design of the vertical geometry was done In AutoCAD Civil 3D and Novapoint. By connection AutoCAD Civil 3D and Novapoint, the project team where able to transfer information between Novapoint and Infraworks 360. The main reason by using Novapoint instead of only Civil 3D, was that the project team did not have the proper resources to be able to use Civil 3D alone.

Mass Balance and Rock Surface

Due to the focus on mass balance, a rock surface was triangulated early in the process, using existing site investigations, in a breakout session between the BIM coordinator and the geologist. In Civil 3D, the existing TIN surfaces from a LiDAR scan was imported, then we imported both drilled rock holes as COGO points, where the point Z-value equals the rock depth, then we could use COGO points to manually place estimated rock depths. The COGO points where used to create a TIN surfaces representing the rock depth along the new road. Then we used a TIN Volume Surface to combine the Existing Surface and the borehole rock depth surface.

The resulting surface was imported to Infraworks and Novapoint, for further optimizations on roadgeometry, to ensure a reasonable mass balance, tunnel entrance placing and rock cuts.

4D, site and Phase Planning

The project is to be built along an existing road, that means that we had to handle both traffic on the existing road, the pedestrians along the existing walkway and the kids that uses the school bus. By using the Infraworks 360 model together with Navisworks, we could start planning the execution of the construction work, solve separate critical construction elements by using 4D, existing traffic management and finally create the phase-plans which is required by the Norwegian Road Authority

Dreamline Optimization

Since we had a quite positive mass balance (to much rock) we had to figure out how to handle the excess rock. Instead of moving the rock to landfill-areas, we decided to try to use it in a clever way. We then came up with the Dreamline-method:

- Identify areas where we double the width of the road, and increase the fill slopes from 1:2 to 1:4

This gives us the following benefits:

- By doubling the width of the road, we can have safe and normal traffic on one side, and a safe and effective construction site on the other side.
- By increasing the fill slopes to 1:4, we don't need to build railing along the road.
- We reduce the amount of excessive masses and reduce the need of transporting the excessive rock masses to landfills, means that we reduce the CO2 footprint in the project.
- When the project is finished, we will have a full width road, and a full width walkway.
  This makes the area attractive for training and cycling, and adds value to the local community

Prize Calculation, Drawing & documentation production

After the project optimization in the ICE meetings, we had a complete model in Infraworks 360. The model was used to produce the required drawings that we had to deliver with our bid, The 2D drawings was mainly created in Civil 3D by using the InfraWorks-connection and by exchanging data with IMX-files. Some drawings was also produced in Novapoint.
For calculation of volumes, Civil 3D and Powel Gemin was used.