Use of 3D visualization in early phase planning of hydropower projects

G.A. Hansen
Multiconsult, Norway
goran.andre.hansen@multiconsult.no

ABSTRACT:

In Norway many of the large rock-fill dams needs to be rehabilitated. This is mostly due to more stringent demands in the new dams safety regulations and larger calculated floods. In a reassessment and in planning the rehabilitation work of a dam it is important to get a good overview of the area. This paper introduces 3D-visualisation models as a tool to enhance the use of basic data and to help communicate the planned work to all parties involved in the project. We will use Kallvassdammen, a dam project from northern Norway as an example and explain the advantages we see using these models.

For this particularly project it was decided to do a LIDAR Scan of the area together with a Multibeam Echosounder Recording to map the area both over and under water. The product of the site survey was processed in AutoCAD Civil 3D, a design and documentation program used to make terrain models, do terrain work in 3D and make overview, plan and section drawings in 2D. AutoCAD Civil 3D is based on the same visual engine as AutoCAD with a black background showing triangulated models, contour lines and lines in different colours.

Infraworks is a software designed to combine and connect data from different sources. The program uses the terrain model established in AutoCAD Civil 3D in combination with an aerial image to display a model in the context of the real world, not the CAD world. This enables the user to obtain a whole new overview and understanding of the project area with minimum of effort and cost. The great thing about 3D-visualization is that it is a universal language. When you are using 3D-models to show your design in a real world context, everybody can see and understand what you are going to build and how it is going to look like.

A successful project depends on good communication flow through all project phases. Proper use of 3D visualization models ease this process and are a powerful tool to reach a common understanding of the project.

Keywords: 3D visualization models, Communication
INTRODUCTION:

In Norway many of the large rock-fill dams needs to be rehabilitated. This is mostly due to more stringent demands in the new dams safety regulations and larger calculated floods. In a reassessment and in planning the rehabilitation work of a dam it is important to get a good overview of the area. Methods commonly used are field investigations and study of photos, aerial images and highly detailed contour maps. It is also important to keep a good overview of the planned work throughout the project. This paper introduces 3D-visualisation models as a tool to enhance the use of basic data and to help communicate the planned work to all parts involved in the project.

The development within computer software's for the engineering industry has been remarkable in recent years. Since turn of the century we have had good 3D-modelling programs, but the realism now put into the software’s later years has changed the way we work. The program we are going to talk about is a visualisation program called Infraworks that allows us to easily make more realistic visual models using the same basic data used in traditional projects. We will use a dam project from northern Norway as an example and explain the advantages we see using these models.

ABOUT KALLVASSDAMMEN:

Kallvassdammen is a 400 m long 49 m high rock-fill dam located in Nordland, Norway. Statkraft has been required by the Norwegian regulator of dams NVE to rehabilitate the dam in accordance with new Dam Safety regulations of 2010. Multiconsult was engaged by Statkraft in 2012 to evaluate the state of the dam and propose measures to meet the new demands.

Figure 1: Photo of Kallvassdammen
**LIDAR SCAN AND MULTIBEAM ECHOSOUNDER RECORDING:**

The large rock-fill dams in Norway are often located in remote areas where the map quality is low. A result of this is a need for new surveying of the project area. A method for doing this is LIDAR scanning. LIDAR is a technology used to make high-resolution maps generated by airborne and stationary LIDAR devices that uses light in the form of a pulsed laser to measure ranges to the Earth (NOAA).

![Figure 2: Illustration of airborne LIDAR scanning](image)

For this particularly project it was decided to do a LIDAR Scan of the area together with a Multibeam Echosounder Recording to map the area both over and under water. The level of detail for the scanning was 20 points per m² on the Lidar Scan and a topographic map with contour interval 0.2 meter from the Echosounder recording. This data combined generates high-resolution basic data for both sides of the dam. Together with the products from the LIDAR Scan the supplier provided a high detailed aerial image of the area.

**PROCESSING DATA IN AUTOCAD CIVIL 3D:**

The product of a site survey (LIDAR Scan and Multibeam Echosounder recording) is usually a point cloud, TIN model (Triangulated Irregular Network, which is a triangulated terrain model) and a high-resolution digital elevation map. This data is processed in AutoCAD Civil 3D.

AutoCAD Civil 3D is a design and documentation program used to make terrain models, do terrain work in 3D and make overview, plan and section drawings in 2D. AutoCAD Civil 3D is based on the same visual engine as AutoCAD with a black background showing triangulated models, contour lines and lines in different colours.
Although AutoCAD Civil 3D is a great program for design and documentation it does not give the user a visual experience of how things really look like. Because of this, doing a field investigation and taking good photos of the site is of high importance before starting reassessing the dam and eventually planning the rehabilitation work.

COMMUNICATION WITH 3D-VISUALIZATION USING INFRAWORKS:

The great thing about 3D-visualization is that it is a universal language. When you are using 3D-models to show your design in a real world context, everybody can see and understand what you are going to build and how it is going to look like.
Infraworks is a software designed to combine and connect data from different sources. The program uses the terrain model established in AutoCAD Civil 3D in combination with an aerial image to display a model in the context of the real world, not the CAD world. This gives the user a whole new overview and understanding of the project area, without being time consuming to establish for us as consulting engineers or expensive for our clients. Site works such as new roads, tunnels, spoil heaps, concrete structures and other planned work can easily be loaded into the model as the project leaps forward.

**THE USE OF INFRAWORKS IN THE KALVASSDAMMEN PROJECT:**

From the survey data we established a terrain model in AutoCAD Civil 3D combining survey data from over and under water. To get a understanding of the area surrounding the dam we also downloaded a free terrain model from Kartverket.no where you can download terrain models with accuracy from ± 2-3 to ± 4-6 meter depending on the accuracy on the basic data. Combining these terrain models with an aerial image in Infraworks we got a model with large extent and with high level of detail for the important area near the dam, displaying the terrain and dam in a very realistic way.
With the high level of detail on the model, in this case 20 cm contour intervals, it is possible to evaluate the condition of the upstream side of the dam and see if there has been any instability, settlements or other damage in the upstream submerged face.

After the reassessment it was decided that considerable work on the dam is needed to meet the demands in accordance with the new Dam Safety regulations. This led to a decision to open an old quarry on the reservoir bed for extraction of rock to reinforce the dam. Different proposed designs on changes to the quarry were illustrated in Infraworks to show the client how the extraction of rock would affect the landscape at different water levels.
The model has been used in every meeting with the client as a basis for discussion. Terrain works, concrete works, property boundaries and all other useful information for the project has been loaded into the model using it as a communication basis for the project.

**SHARING OF DESIGN:**

Another advantage using 3D-visualization models is the possibility to share the model through an internet browser or Ipad. In the Internet browser you can orbit and pan in the model comment on the design without the need for installing any software. In addition to the features provided by the Internet browser the Ipad features augmented reality. Augmented reality allows you to place life-size 3D models in the context of the real world, using the Ipad’s GPS and accelerometer to place you inside the model.

![Figure 7: Picture of the client viewing the model on-site](image)

**CONCLUSION:**

A successful project is dependent on good communication flow through all project phases. Proper use of 3D-visualization models ease this process and are a powerful tool to reach a common understanding in the project. 3D-visualization programs as Infraworks makes it easy to establish realistic models using the existing models generated in other building information modelling software to make traditional 2D drawings. 3D-visualization models can in addition to being great visual models, be good compilation models for infrastructure projects. They are easy to use and a great supplement to better the project workflow without being time consuming or expensive for our clients.
REFERENCES: