Gridgen
Reliable CFD Meshing

Endangered Fish Benefit from CFD

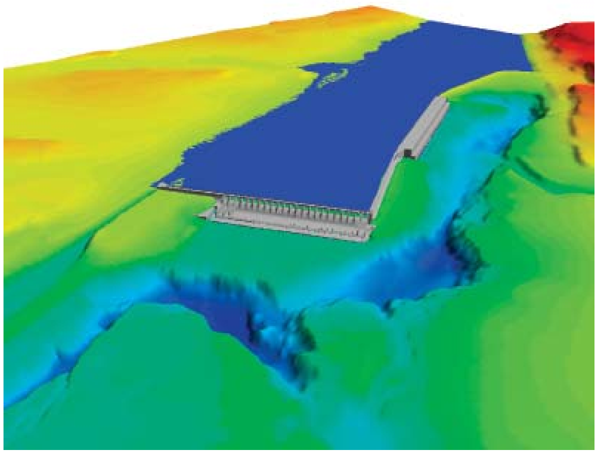

Figure 1. Bathymetry of the Dalles tailrace. The gray structures are the spillway in the center and the powerhouse in the upper right.

Environmental applications of computational fluid dynamics (CFD) have become more common in recent years with the increased availability and ease of use of commercial grid generation software and CFD solvers. At Pacific Northwest National Laboratory, we have been supporting studies by the US Army Corps of Engineers, Portland District by creating and applying Reynolds-Averaged Navier Stokes (RANS) CFD models to the Columbia River and portions of the dam structures at several hydroelectric projects, including the tailrace of The Dalles Dam.

Numerical models in The Dalles tailrace are being used to support efforts to reduce fish mortality associated with fish passaging of the hydroelectric project. At The Dalles, several locations have been proposed for a high flow outfall that would move fish around the dam rather than through the turbines or over the spillway. The bathymetry downstream of the project is quite complex (Figure 1), and includes several islands and a shelf at about 68 ft. elevation adjacent to deeply carved depressions (below –200 ft. elevation). Data sets for the computational domain included point measurements and contours of bathymetric data, shorelines extracted from orthophotos, and hard copies of drawings of the draft tubes and spillway structures. Three stereolithography (STL) files were created from these data (river, powerhouse draft tubes, and spillway stilling basin) and used as the underlying geometry for creating a 3D hybrid (tetrahedral and hexahedral) mesh for use with STAR-CD. In this case, these STLs were also needed for use with another CFD solver, so the STL files provided a common format from which to develop the computational meshes for both models. We were pleased to beta test Version 14 because of the new feature that allows us to use and project to STL's.

The numerical model was a steady-state, rigid lid model, hence the computational mesh needed to have the option of removing or adjusting the top layers for flow scenarios with higher or lower tailwater elevations. This meshing approach increases the suite of flow scenarios for which the mesh can be used without the need to generate and validate a new computational mesh. Flow results (Figure 2) are validated to field-measured data, reduced-scale physical model data, and results from another CFD flow solver. In the future, free-surface simulation results from the high flow outfalls will be used to provide inflow conditions to the STAR-CD model. These results will be used to support high flow outfall location decisions.

Gridgen Version 14's ability to project to STLs made it possible for us to create complex 3D hybrid meshes of the river and engineered structures. The use of the STLs in Gridgen Version 14 also allowed us to use a common set of geometric and bathymetric base data for multiple CFD solvers with different geometry requirements.

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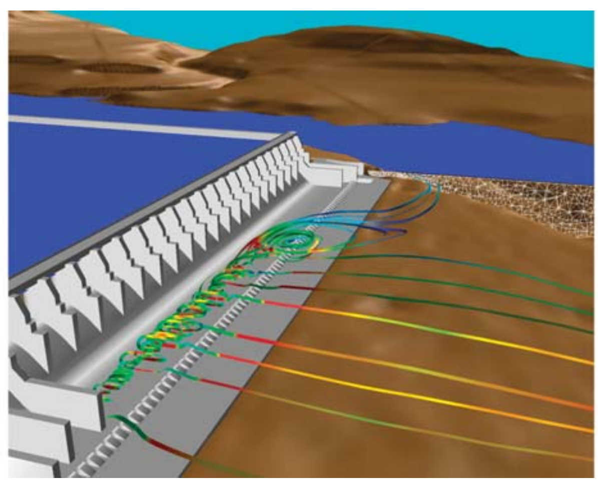

Figure 2. Example of particle tracks of neutrally buoyant particle in the spillway stilling basin.

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App Sheet—Endangered Fish
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