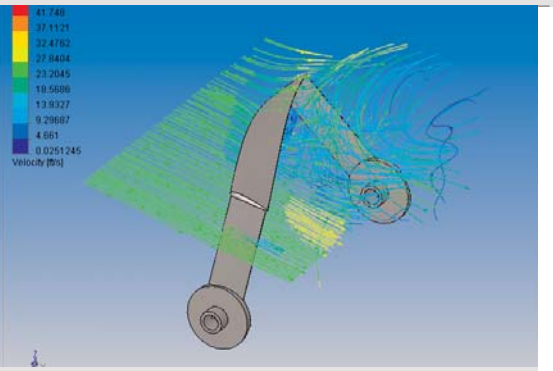
Sigma Design Company

ANALYSIS SOFTWARE HELPS PUT NEW TWIST ON ELECTRIC TURBINE DESIGN



A feature in the latest COSMOSFloWorks includes a rotating frame of reference to simulate blade rotation. Results include forces generated by flow on the blades, and rotor torque. Analysis predictions closely matched experimental results.

→ "We created a single SolidWorks model and added appropriate boundary conditions to determine the hydrodynamic forces and distributed them across the blades to simulate the effect of tons of water flowing against them," said Jerry Lynch, president of Sigma Design Company. "Because the software is tightly integrated between design and analysis, our engineers can use the same 3D SolidWorks model for fluid dynamics and finite element analysis, as well as for detailed construction drawings. We achieved and passed on to our client substantial savings in record time."

Tides, currents, and other free-flowing waters are an unlimited albeit difficult-to-extract, source of clean electricity. San Antonio-based engineering company GCK Technology has developed a unique turbine that captures the energy these alternative sources offer and is almost free to operate. The Gorlov helical turbine has a completely different shape from a conventional turbine and always rotates in the same direction regardless of how the current runs.

The Gorlov helical turbine's radical new design demanded intense testing to determine the bearing and blade support loads to ensure the turbine could withstand the water's forces. The most common testing approach would have been to hire research consultants to perform the tests using high-end analysis software. However, the cost of licensing the software and paying for highly trained analysts to perform the calculations make this approach very expensive because in the end the customer still needs a design that can be manufactured, and research analysts do not provide these services. To reduce their time to market and better manage the project, GCK hired Sigma Design Company, a New Jersey-based design/engineering firm. Sigma performed computational fluid dynamics (CFD) and finite element analysis (FEA) on the helical turbine design, took the analysis results and developed a design package that was manufacturing friendly. Performing the tests with COSMOSFloWorks™ CFD software and COSMOSWorks™ FEA software, both from SolidWorks Corporation, helped reduce the turbine's overall design cycle costs by 50 percent. COSMOSFloWorks and COSMOSWorks are tightly integrated with SolidWorks® 3D mechanical design software, which Sigma used to render GCK's designs as 3D solid models.

A unique turbine design with big testing needs

Hydropower is a clean energy source, but it requires huge, expensive dams that flood vast areas, displacing people and disrupting the environment. The Gorlov helical turbine taps alternative sources of water power without the widespread environmental harm of large dams. Alexander Gorlov's design consists of blades twisted into the shape of a helix, the shape of a DNA molecule. The turbine's blades rotate at twice the velocity of the water current flow, and capture's more of the water's energy than a conventional turbine. An open-river system of helical turbines should generate electricity for just $400 to $600 per kilowatt, far less than the cost of constructing other power-generation systems. The helical turbine also has virtually zero operating costs.

After Gorlov developed the helical design concept, GCK engineers needed to take laboratory and prototype data and turn it into a real working machine. They wanted to determine loads on the blades, shaft and bearings so they could optimize the design, reduce manufacturing costs, and ensure reliable operation. Before the advent of analysis software, engineers would have had to build a prototype and instrument the turbine with strain gauges and encoders. This would have taken too long, determined stress at only a few discrete points, and could not provide any information on flow for

SolidWorks

- Integrated CFD Reduces Cost of Analyzing Water Turbine by 50%.
- Optimised the design.
- Reduced manufacturing costs.
- Ensured reliable operation.

"This project let us optimize the turbine's structural design at only about half the cost of using traditional high-end software," Lynch said. "Our client was impressed by COSMOSFloWorks' accuracy, as well as its ability to provide more information than experiments yield. The combination of COSMOSFloWorks and COSMOSWorks provided a complete analysis solution that addressed all of the critical issues raised during the design process, particularly hydrodynamics forces and structural integrity. Our client talked to several other CFD/FEA consultants using high-end analysis tools, but gave Sigma Design the job because we could do the analysis faster, plus provide a manufacturing review for half the price and give them results that were just as accurate."

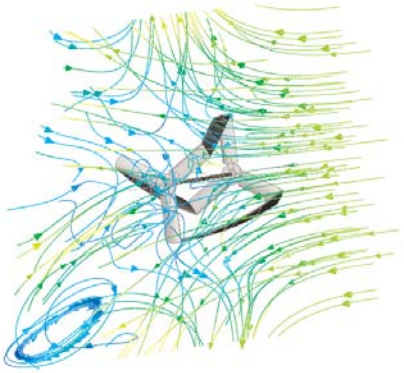
improving the design or for developing future designs of varying sizes.

FEA software simulates loads on a structure and determines stresses and deflections without the time and expense of building and instrumenting the turbine. High-end, research-focused FEA/CFD software might cost $30,000 per user and is so complicated only an analyst with an advanced degree and specialized training can use it well. Typically, engineers use standalone programs, construct separate models for each component, and manually transfer them from CFD to FEA. That drives up costs.

Sigma Design's approach of using analysis software that's tightly integrated with design software eliminates re-creating and manually transferring models. Sigma's COSMOS analysis software provides all the critical analyses the company needs, and can be used by design engineers with nominal training.

Since the turbine was originally designed by hand, Sigma engineers began by using SolidWorks to model its geometry. They took dimensions off measured sections of the blades and extruded them to create the basic 3D geometry in SolidWorks. After verifying the geometry with GCK, the Sigma engineers accessed the geometry from COSMOSFloWorks, fluid flow analysis software, which provides fluid velocity and pressure values throughout the solution domain for systems with complex geometries.

Sigma engineers used the COSMOSFloWorks project wizard to define the flow analysis on the solid model. The next step was defining the boundary conditions of the model, which were based on water flowing through the turbine at a speed of five knots. They defined a velocity at the flow inlet, which the software converted to a mass flow, as well as a pressure boundary at the downstream end of the model. They instructed the software to automatically mesh the fluid volume, the empty space within the solid model. When the CFD analysis was finished, Sigma applied the CFD resultant forces to the turbine structure and ran the FEA. This FEA analysis documented stress levels throughout the structure, showing that they were too high in some places and low enough in others that designers could reduce the mass. The analysis also enabled engineers to recommend changes to the structure to reduce weight and stress.



The water turbine uses helically shaped blades rotating at twice the velocity of the flow, and spinning the same direction regardless of flow direction. The turbine captures 35% of the water's energy, compared to 20% for conventional turbines. Anticipated costs for an open-river hydropower system should be $400 to $600/kW, lower than other systems. GCK Technology, San Antonio, is further developing the turbine.

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