Icelandic Hydrogen

Customer Success Story

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AutoCAD® Electrical

We did this project in a very short time. We signed the last contracts in October 2007, and the project was opened on April 24 of the following year. That could never have been achieved without Inventor.

—Hallmar Halldors
Chief Executive
Icelandic Hydrogen

Autodesk®

Sailing on sustainable energy.

Autodesk® Inventor®-based Digital Prototyping helps Icelandic Hydrogen pioneer the world's first hydrogen-equipped commercial sea-going vessel.

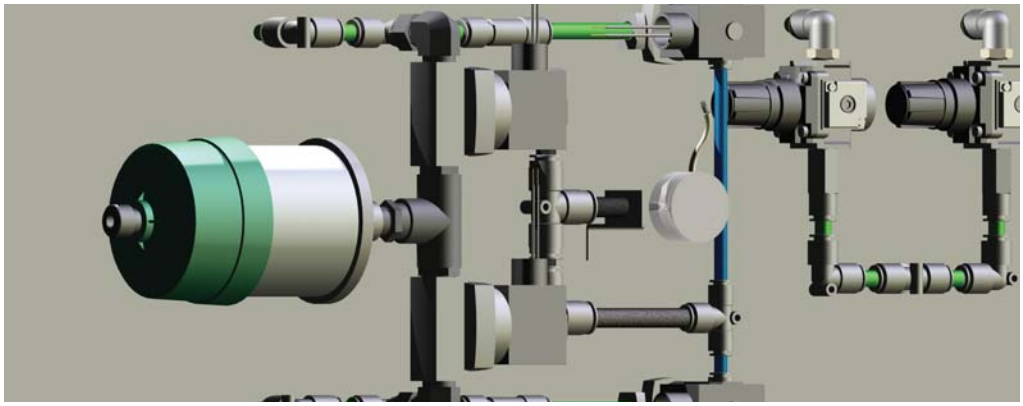

Image courtesy of Icelandic Hydrogen

Project Summary
Icelandic Hydrogen (IceH2), a pioneering manufacturer of hydrogen-based generators and renewable energy infrastructure solutions, uses the Autodesk® solution for Digital Prototyping to help develop innovative products that bring, as its slogan says, "H2—tomorrow's fuel, here today." For one project, IceH2 designed, manufactured, and helped install a hydrogen auxiliary power unit (APU) on board a whale-watching tour boat, making it the world's first hydrogen-equipped commercial sea-going vessel. Although the ship is propelled by a regular diesel engine, IceH2's APU provides hydrogen-based electricity to run the lights, navigation machinery, and other electrical equipment while cutting oil consumption, reducing engine noise, and producing only water vapor as a by-product.

To develop the APU, IceH2 relied upon Autodesk® Inventor® and AutoCAD® Electrical software products to help:

- Design, visualize, and simulate all components of the APU, including large assemblies, before manufacturing
- Integrate 2D and 3D mechanical and electrical software tools for concurrent design of sophisticated mechatronics systems
- Simulate the behavior of the APU under operating conditions, thereby helping to ensure the safety of the ship, crew, and passengers
- Rapidly complete this pioneering demonstration project in under seven months

The Challenge
Iceland, an island nation located off the southeast coast of Greenland in the North Atlantic Ocean, is a world leader in the research, development, and use of renewable energy technology. Thanks to plentiful rivers and waterfalls, as well as volcanic activity beneath its crust, all of Iceland's space heating and electrical production are hydrothermal or geothermal. Additionally, a national movement—involving government, academia, and industry—champions hydrogen energy as a means of reducing dependency on imported fossil fuels, such as oil and gasoline.

The potential benefits of replacing fossil fuels with hydrogen are particularly important to one of Iceland's leading industries, commercial fishing. Currently, the nation's fleet of more than 1,300 fishing vessels runs on imported oil and diesel fuel. A recent study showed, for every kilogram of fish processed, ships combusted 1.1 liters of fuel. If fishing vessels could be converted to hydrogen fuel, the economic savings and environmental benefits—including decreased greenhouse gas emissions—would be enormous.

"The ultimate goal is to catch the fish without using oil and to use our renewable energy sources here in Iceland, which we have in abundance," says Hallmar Halldors, chief executive of IceH2. As the first step, IceH2 collaborated in a research partnership with project manager Icelandic New Energy and Elding Whale Watching, a boat tour company located in Reykjavik, the capital city of Iceland. Elding offered its flagship whale-watching vessel, named the *Elding* (Icelandic for *"Lightning"*), as a test-case for using hydrogen energy on board a commercial marine vessel.

"The Elding project is part of the hydrogen research and demonstration work that has been done in Iceland in the last couple of years," says Halldors. "We became involved with them due to our long-time interest in using hydrogen on board ships." In 1998, as a student in Germany, Halldors conducted a feasibility study on hydrogen ships. He explains that military applications for hydrogen energy are advanced—the German navy has fuel cells on board its submarines—but taking the technology into the commercial sector is a new venture for private enterprise.

Icelandic Hydrogen used Autodesk Inventor to design and test all enclosures and every part of the storage systems.

The Solution

Icelandic Hydrogen developed a complete on-board hydrogen energy system for the vessel. Its hybrid system is comprised of a hydrogen storage tank linked by a supply line to the fuel cell and a 48-volt DC battery system, which transforms electrical energy into three-phase energy through a grid. Essentially, the fuel cell takes hydrogen from the storage system and converts it into useable electrical energy.

Critical in the ability to design this unique system and help ensure its safe operation was the company's use of 3D Digital Prototyping technology, which could help them design the system and test its operation. Icelandic Hydrogen used Autodesk Inventor software to design not only the hybrid system but also a 3D model of part of the ship to test how it would operate.

"At first, we used AutoCAD Electrical just to design a layout of the system, or the P&ID [piping and instrumentation diagram] drawings," says Halldors. "Then when we began to design the storage systems, we used Inventor a lot. We used it for all enclosures, every designed part—the components and all the tubing throughout the system from the storage tank to the fuel cell site. There were a couple of parts where it was critical, because this was quite a difficult project in terms of safety."

Hydrogen may be a clean, green fossil fuel alternative, but it must be treated with great respect. If hydrogen is mixed with air in a certain ratio, it can create an explosive gas, so a great deal of effort goes into preventing the hydrogen from mixing with air.

"We had to make sure the complete system was safe for the tourists on board. We were designing enclosures and had to be sure they would hold certain pressures to eliminate leakage in dangerous areas. For testing the pressures on many of these parts, we used Inventor's stress analysis tool," he adds, explaining that it simply couldn't have been done any other way within the time available.

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Autodesk Inventor provides a comprehensive set of tools for designing, producing, and validating complete 3D digital prototypes of virtually any product. It helps to visualize, simulate, and analyze how a design will look and how it will work under real-life conditions before a single part is ever built. Leveraging the Digital Prototyping capability of Inventor enabled Icelandic Hydrogen to fine-tune an accurate 3D model of the *Elding* before incurring any production costs and without compromising the safety of those involved in the project or on board the ship.

The Result

Following installation of the hydrogen APU, the *Elding* was first launched on April 24, 2008, and has run in continuous service ever since. The implications for the tourists are awesome, according to those who have been on the trips. When the crew members spot whales in the vicinity, they shut down the main engines to let people hear the mammals swim and blow water in silence—an experience that had been marred in the past by the rumble of the diesel auxiliary engine below.

"The next step is to include the propulsion so the complete trip will be on renewable energy," says Halldors. However, he is quick to point out that this is a research project, not a commercial project.

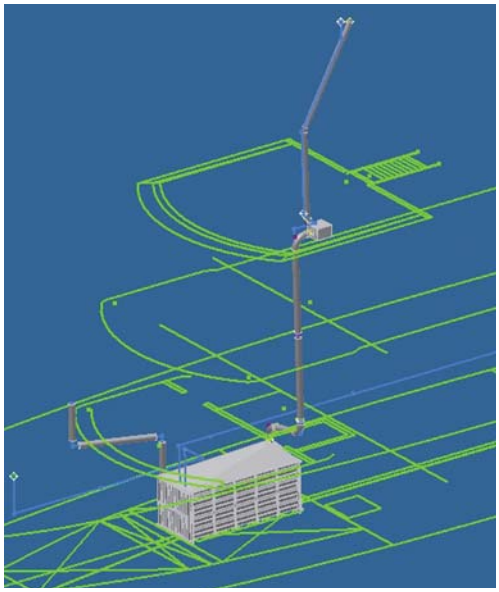

Image courtesy of Icelandic Hydrogen

"The purpose of the project is first of all to show that we can use hydrogen on board ships and then to get it certified," says Halldors. "We are passionate about using hydrogen on board fishing vessels in the coming years, but it's definitely a possibility now to use hydrogen for the propulsion of smaller fishing boats."

Looking ahead, Halldors adds, "It may be too early to say, but by replacing the current combustion engine with this hydrogen technology, there is no reason why we couldn't soon replace the entire fishing fleet."

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