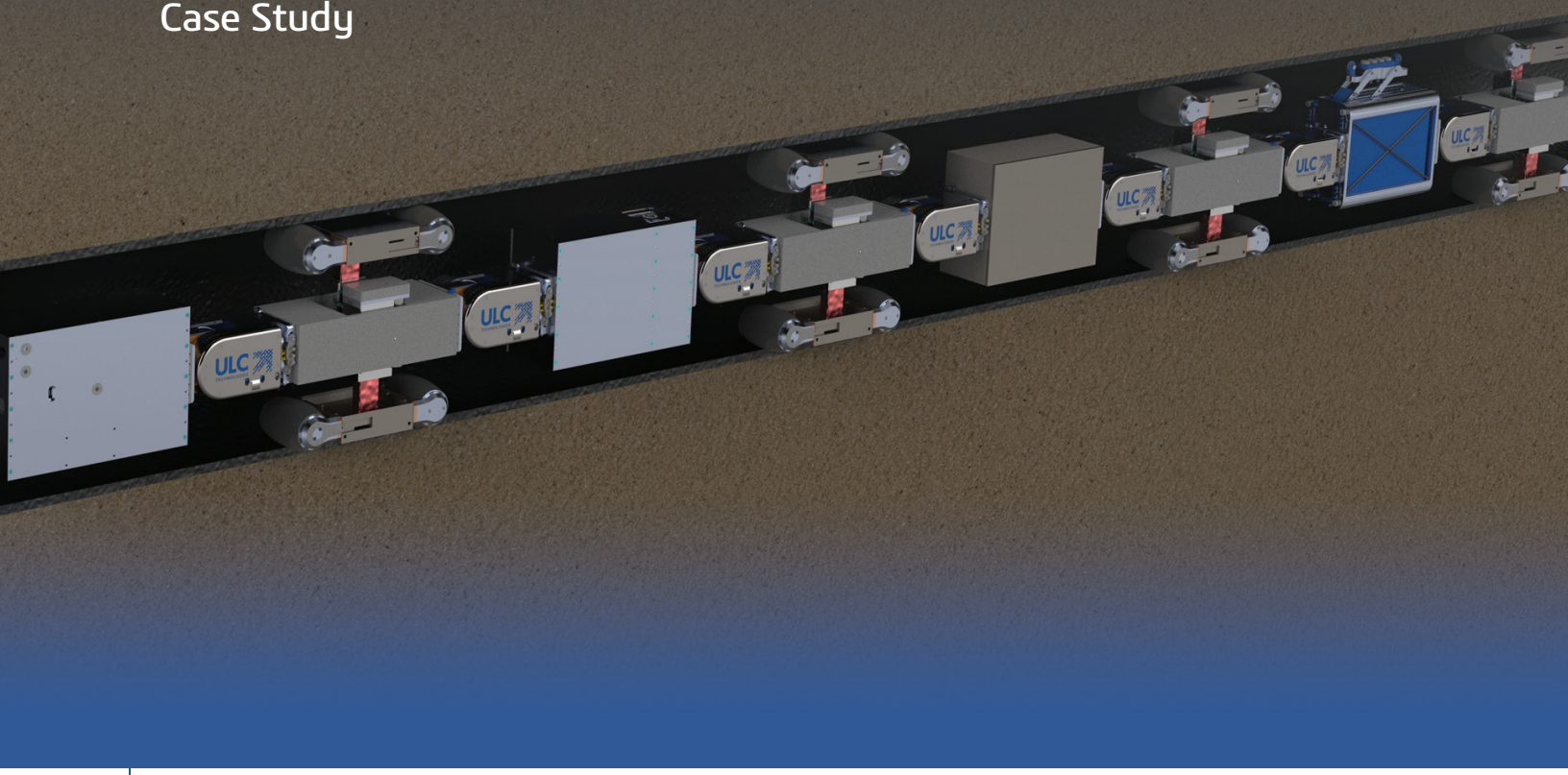
ULC TECHNOLOGIES

INNOVATING ROBOTS THAT INSPECT AND REPAIR PIPELINES FROM INSIDE WITH SOLIDWORKS SOLUTIONS

Case Study



With SOLIDWORKS design, structural simulation, motion simulation, flow simulation, product data management (PDM), and rendering solutions, ULC Technologies has innovated a modular, segmented, in-line robot for natural gas pipelines that is the first robot capable of traveling long distances within a pipeline, finding leaks as small as a pinhole, and repairing them from inside the pipe.

Challenge:

Develop innovative robotic solutions to perform critical tasks in difficult-to-reach areas and environments, such as inspecting and repairing pipelines from the inside, efficiently and cost-effectively to support the company's robots-as-a-service business model.

Solution:

Add SOLIDWORKS Flow Simulation for computational fluid dynamics (CFD) analysis to the company's SOLIDWORKS design, structural simulation, motion simulation, product data management (PDM), and rendering software solutions.

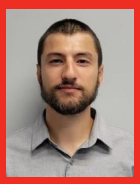
Results:

- Developed breakthrough robot for inspecting and repairing pipelines
- Cut months of time from development cycle
- Eliminated hundreds of hours in prototyping time and related costs
- Created pipe farm in SOLIDWORKS for simulated testing

Founded in 2001, ULC Technologies develops and deploys robotic systems, unmanned aerial systems, machine learning applications, and inspection technology for use in the energy, utility, and industrial sectors through its ULC Robotics division. The company's customers include gas and electric utilities, developers and owners of offshore wind and renewable power installations, and industrial companies. Headquartered on Long Island, New York, and with a significant presence in the United Kingdom, ULC helps utility and energy industry companies confront the increasing need to repair and maintain their pipelines and infrastructure through the development and commercialization of innovative robotic solutions and inspection services. ULC's technologies help companies cause less disruption to the public, reduce greenhouse gas emissions, and minimize costs.

The robots that ULC develops support the company's robotics-as-a-service business model, under which the company develops robots, which are then utilized to perform specific services for its customers for set fees. ULC's latest advancement in robotics technology is designed to travel inside a live pipeline for at least 1 km (1,000 meters) in either direction from its sealed launch point, and navigate through valves and miter joints, around bends, and past obstructions, as well as make 90-degree turns. The technology—referred to as the modular in-line robot—was developed under contract with the U.S. Department of Energy (DOE) for inspecting and repairing pipelines that carry gases, such as natural gas and hydrogen.

ULC has used SOLIDWORKS® design, structural simulation, motion simulation, product data management (PDM), and rendering software solutions to create its robots. It needed additional capabilities to develop a robot that travels long distances and around obstacles while inside a pipe full of pressurized gas, according to Mechanical Engineer Nicholas Efthimiades. "The environment through which the robot has to travel is extremely hostile," Efthimiades explains. "A natural gas pipeline, our primary market, is pressurized at up to 1,000 PSIG and has a gas density of 45 kg/m^3, about 30 times that of standard air. Natural gas is also combustible and corrosive to many materials, and the pipe itself has sharp edges and irregular surfaces that must be accounted for. Because of the difficulty inherent to traveling through such a harsh environment and past a variety of obstacles, we were faced with building a pipe farm for physical testing, buying or renting time at a wind tunnel, or using simulation tools to test and prototype the robot virtually.



"Using SOLIDWORKS Flow Simulation and SOLIDWORKS motion analysis capabilities to simulate robot travel within the pipe—as well as coupled structural/flow simulations—saved us hundreds of hours in prototyping time as well as the potentially exorbitant costs associated with several rounds of physical prototyping."

— Nicholas Efthimiades , Mechanical Engineer

"Fortunately, we had a faster, more cost-effective solution readily available to us in SOLIDWORKS Flow Simulation integrated with SOLIDWORKS," Efthimiades adds. "We acquired SOLIDWORKS Flow Simulation so that we could build a virtual pipe farm comprised of all of the different types of obstacles that our robot faces, simulate the difficult environment and robot travel inside the pipe, and observe the robot's motion and performance under these conditions."

SNAKELIKE, SEGMENTED, MODULAR ROBOT

Using SOLIDWORKS design, PDM, structural simulation, motion simulation, flow simulation, and rendering tools, ULC was able to cut months from the development cycle for the first robot capable of traveling long distances within a pipeline, finding leaks as small as a pinhole, and repairing leaks from inside the pipe. Deploying a robot to locate and fix pipeline leaks minimizes environmental impacts and is much less costly—by an order of magnitude—than excavating the

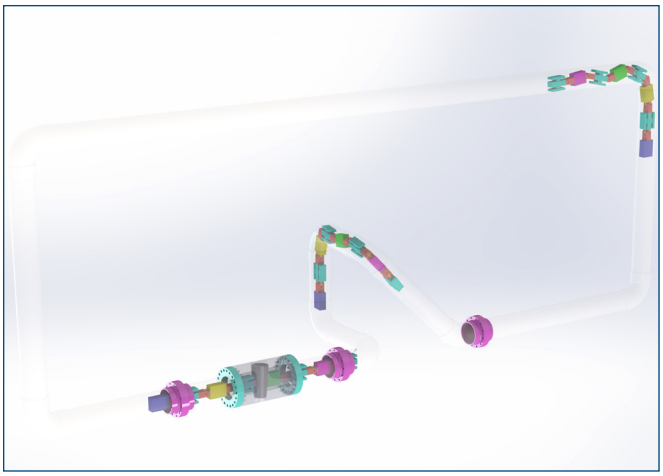
pipeline and repairing leaks manually. The cost savings and ease of use promote more frequent preventative maintenance. It also means we can find and repair leaks in places where normal excavation is impossible—think under layers of city infrastructure or beneath a river crossing.

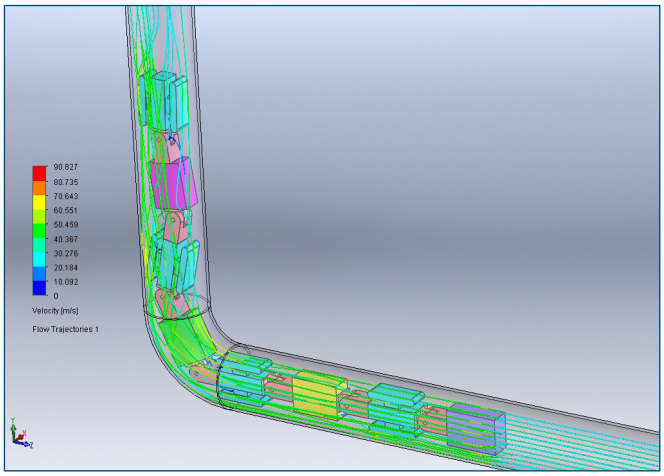
"The in-line pipeline robot looks like a snake because it is a series of eight or more modular segments with joints in between them," Efthimiades says. "Although the robot cross-section is smaller than a sheet of paper [8.5x11 inches], it must also have the ability to shrink and expand from 7.5 inches up to 20 inches tall as it travels on motorized wheels along the inside walls of the pipe without creating significant blockages to the flow of high-pressure, high-velocity gas. Having access to all of the integrated SOLIDWORKS tools that we have helped us collaborate and iterate more efficiently, cutting months from the development cycle."

SIMULATED TESTING SAVES TIME AND MONEY

Instead of building an expensive mock pipe farm to incorporate all of the possible obstacles and turns within a pipeline that the robot has to be able to traverse, or renting time in a wind tunnel, ULC built its own virtual pipe farm in SOLIDWORKS. The company then used Motion Analysis, available with SOLIDWORKS Premium or SOLIDWORKS Simulation Standard, Professional, and Premium, and SOLIDWORKS Flow Simulation for computational fluid dynamics (CFD) analysis to simulate the motion and performance of the robot inside a pressurized pipe. ULC then tested the robot's performance in the most difficult segments of pipe to transit with a single, final round of physical testing in a "pipe playground" set up by ULC in concert with pipeline manufacturers.

"Using SOLIDWORKS Flow Simulation and SOLIDWORKS motion analysis capabilities to simulate robot travel within the pipe—as well as coupled structural/flow simulations—saved us hundreds of hours in prototyping time as well as the potentially exorbitant costs associated with several rounds of physical prototyping," Efthimiades stresses. "It helped us to dial in the robot's holding force and the torque on its wheels—while reducing weight—by determining the drag forces and other disturbances on the robot. We were able to increase strength where it was required but reduce our material and weight in less critical areas and mechanisms, optimizing the design."





"We often included renderings created in SOLIDWORKS Visualize to better illustrate design concepts. From CAD to PDM to simulation and rendering applications, SOLIDWORKS provides the integrated tools that we needed to support collaboration and drive innovation on this project."

— Nicholas Efthimiades , Mechanical Engineer

PROFESSIONAL REPORTS AND RENDERED IMAGES

In addition to supporting development of the in-line pipeline robot at ULC, SOLIDWORKS solutions facilitated communication with DOE personnel through the generation of analysis reports and rendered images of design concepts. "We were required to file written reports and provide monthly status updates to the DOE, and the report generation capabilities of SOLIDWORKS simulation solutions automated the process of producing professional quality reports," Efthimiades notes.

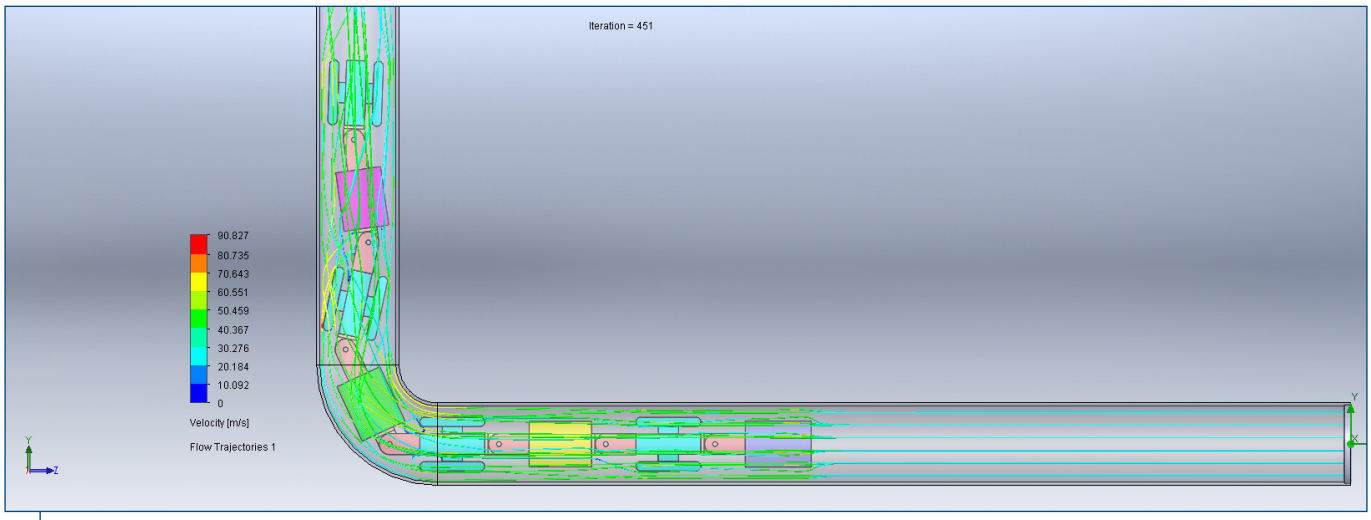
"We often included renderings created in SOLIDWORKS Visualize to better illustrate design concepts," Efthimiades adds. "From CAD and PDM to simulation and rendering applications, SOLIDWORKS provides the integrated tools that we needed to support collaboration and drive innovation on this project."

Focus on ULC Technologies
VAR: CADimensions, Inc., Middletown, CT, USA

Headquarters: 88 Arkay Drive
Hauppauge, NY 11788
USA

Phone: +1 631 667 9200

For more information
www.ulctechnologies.com



Using SOLIDWORKS design and simulation tools, ULC Technologies built a virtual pipe farm for simulation testing to ensure that the in-line robot can travel around bends and through obstacles like valves, cutting months of time from the development effort as well as hundreds of hours in prototyping time and related costs in the process.

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France

Asia-Pacific
Dassault Systèmes K.K.
ThinkPark Tower
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Japan