CLEAN INNOVATION IN FOCUS

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THIS ISSUE FEATURING

Hifi Engineering Inc.


Company Vitals
Incorporated: 2007
President: John Hull
Products/Services: Detecting low volume gas leaks
Market Niche: Oil and gas
Geographic Market: Canada and USA
Current Number of Employees: 12

Turning a science project into a commercial venture.

It has been over eleven years since John Hull first mused whether fiber optic sensors could be used in the oil and gas sector. An electrical engineer by education, John was working at Schlumberger as a wireline logging engineer. Part of his job was to test for casing failures and surface casing vent flows on abandoned wells. A gas leak from an abandoned well can contribute to greenhouse gas emissions, result in non-compliance with government regulations, and can cost oil and gas companies hundreds of thousands of dollars to detect.

John Hull, President of Hifi Engineering Inc.

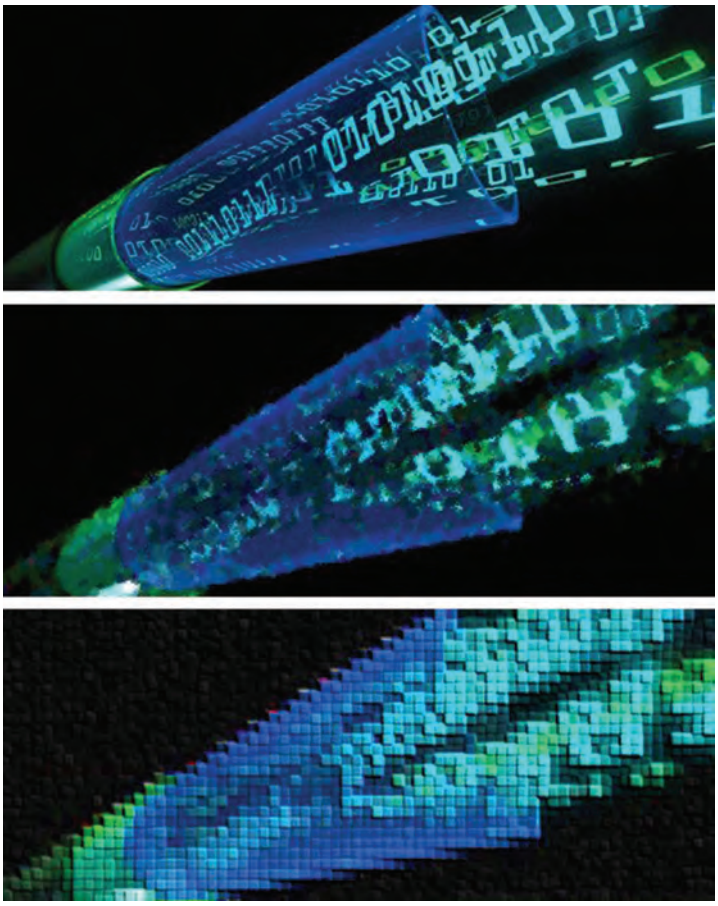
| 2005 |

In 2005, he learned about fiber optic sensing, an emerging technology that could be used as an acoustic sensor. He wondered if it could be developed into a tool to be used in the oil and gas sector specifically to detect and locate low volume gas leaks in abandoned wells.

> **"John wondered if fibre optic sensing could be used to detect and locate gas leaks in abandoned wells."**

The prospect of developing a new product within a large company felt as though it would be slow and cumbersome. In large companies, at that time, the majority of research was focused on exploration and not on maintenance or trouble shooting. He felt that he would be better served to develop the technology on his own. He was young and naive; if he knew how much time and capital was required, to get to a commercially viable product, he might have reconsidered.

John knew very little about fiber optics but he did know a lot about oil and gas. John's father, Bill Hull, a successful entrepreneur himself, was a strong supporter of John right from the very beginning. With some seed capital from his father, John started to work out of his garage in the evenings and on weekends. He studied fiber optics and developed a **prototype** of sorts. It was made out of plumbing parts and held together with duct tape.



Marrying fiber optics with a high fidelity sensor resulted in clean, crisp, clear data.

| 2006 |

In 2006, John went to California to talk with the "fiber optic experts" in the field. He had difficulty finding an audience but eventually met with Jeff Bush and Allen Cekorich, pioneers in using fiber optics as acoustic sensors. They worked at Optiphase, now a Halliburton company. They felt John's idea showed promise and Jeff agreed to come to Canada for two days to test John's prototype for a $25,000 fee. Together they did some experiments which provided enough of a **'proof of concept'** that John felt the **technology was worth pursuing,** though it later turned out that it had worked for all the wrong reasons. In 2007, John originally incorporated the company as EnviroSonix (Enviro).

A fiber optic sensor is a sensor that uses optical fiber either as the sensing element itself (intrinsic sensors) or as a means of relaying signals from a remote sensor (extrinsic sensors). The first version of John's product was called the **Micro LeakSonar™**, an external fiber optic acoustic sensor technology developed for acoustic well logging and profiling. This device allows gas producers to monitor, identify and locate noise events associated with fluid flow, migration and casing integrity. John would spend the next two years developing the technology further.

| 2008 |

Unlike other fiber acoustic sensors John decided to marry fiber optics with a high fidelity sensor. The result is a sensor that is **tenfold more sensitive than any other sensor in the market**. Using high fidelity acoustics produces clean, crisp, clear data. This is important in detecting events like gas leaks, something John's competitors cannot do reliably. John changed the company name in 2008 to Hifi Engineering Inc. (Hifi) to reflect this competitive advantage. Hifi stands for 'high fidelity'.

> **"Hifi stands for 'high fidelity'. Using high fidelity acoustics produces clean, crisp, clear data."**

John was still a one-man show doing everything from learning to run a company and the bookkeeping, to learning how to splice fiber optic cable. Cash reserves were running thin, if not non-existent, and he was surviving on the generosity of family and friends.

| 2009 |

John reached out to outside organizations for help. He participated in several of CETAC-WEST's workshops. At one of the workshops participants were asked to prepare mock investment pitches to be presented to Paul Godman, then Fund Manager of the Cenovus Energy Environmental Innovation Fund. Little did John know, but Paul liked what he heard and the mock pitch turned into a real investment. In 2009, after a year of due diligence, Cenovus invested just over $1 million acquiring 20% of the company. That investment saved the company.

The Micro LeakSonar™ is an external fiber optic sensor system where an acoustical tool at the end of a fiber optic cable is sent down a well hole to detect and locate casing failures and surface casing vent flows. The Micro LeakSonar™ records noise files for playback to aid in interpretation. As the sound files are recorded optically there is no electronic degrading of the sound quality. With the Cenovus investment, Hifi had a working prototype that could be tested in the field.

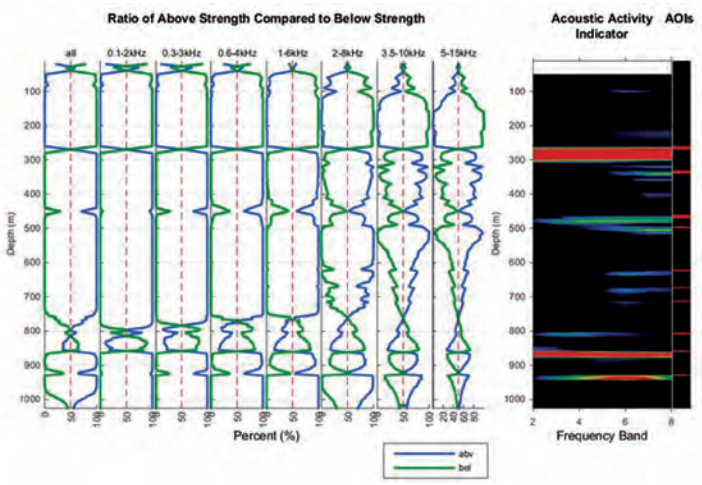
> **“Husky Energy was an early adopter and championed the product.”**

In 2008, John built a relationship with Husky Energy, an early adopter of the technology. Despite marginal results early on, they allowed John to continue to use his equipment on their wells. This allowed Hifi to make mistakes and learn along the way. It took months and months to give Husky a product that worked reliably and made sense. Husky Energy proved to be a good operational partner and still uses the technology today.

In 2008 Hifi received its first National Research Council - Industrial Research Assistance Program (NRC-IRAP) grant and has continued to receive NRC-IRAP assistance through to today. NRC-IRAP has stepped in when John needed help either with advice, research dollars or money to hire key people. Ehsan Jalillian, Hifi’s first NRC-IRAP rep, was instrumental in helping Hifi to get the data analyzed and visualized so the clients would understand it.

| 2010 |

In 2010 through another NRC-IRAP grant, they hired software engineers. The company was “nearly broke” and still did not have a commercially viable product. The software engineers developed an algorithm to interpret the noise data to pinpoint and locate acoustic events such as migrating gas. The software makes the analysis user friendly - it is easier to do and provides for more consistent results. This was an integral step in the evolution of the technology as it gave Hifi a complete package and the business was now scalable. It would not have to rely on a person to interpret the results and customers understood them. An angel investor introduced to Hifi by NRC-IRAP, Derek Logan, invested and started to help at that time as well.



The data can be used to locate noise events associated with fluid flow, migration and casing integrity.

| 2011 |

The first **commercially viable** version of the Micro LeakSonar™ was introduced in January of 2011. By now Hifi had been used in 25 to 40 wells. Today’s version, the Hifi Micro Tool, which is the 3rd generation, is used for diagnostics, a one-time-use to gather the high-fidelity measurements that require extreme precision and pinpoint accuracy (such as detecting downhole low-rate leaks).

| 2013 |

The **business model** was never to become a service company. John wanted to licence the technology to service companies. The first licensee was Voltage Wire Line, which signed a two year contract in 2009. The large players such as Halliburton and Schlumberger started to tire-kick the technology as early as 2009. It proved difficult to get their full attention. That is until 2013, when the Micro LeakSonar™ became the tool of choice for ConocoPhillips. The industry giants started to take notice. Hifi had been used in over 200 wells and was cash flow positive

from operations. The company was a winner of a prestigious **ASTech Award** presented by the Alberta Science and Technology Leadership Foundation that same year, 2013.

| 2014 |

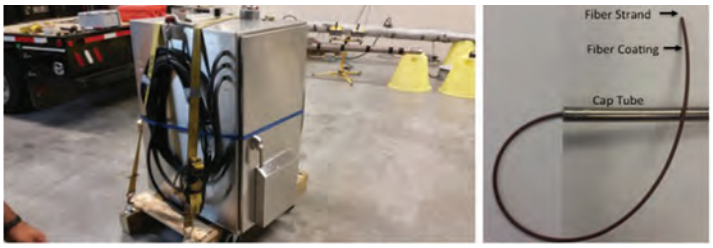
By the end of 2014 Hifi had secured eight monthly licensees including Schlumberger and Halliburton, and the technology had been used in over 700 wells. John's science project is now a commercially accepted technology and is quickly becoming the industry standard for detecting low level leaks in abandoned wells.

> **"Now as a commercially-accepted technology, it is quickly becoming the industry standard for detecting low-level leaks in abandoned wells."**

By 2012 the company had developed an entire suite of tools to detect low volume gas leaks. One of the products was the **Ventmeter**. Employed along a length of a well, it can determine or measure the entire length of the wellbore simultaneously and in real time. Data is sent back to Hifi through the internet. This was useful in horizontal production logging and wells requiring a permanent installation. This **became commercially viable** in 2014. John and his development partners determined that this technology can be applied to pipelines which, as John says, from a sensing perspective are "essentially a horizontal well."

Testing apparatus to verify continuous monitoring in real time.

Adapting the technology for continuous monitoring in real time for pipelines required a substantial capital investment. Mark Blackwell of Cenovus set up a meeting with Enbridge and negotiations started. John applied for a Sustainable Development Technology Canada (SDTC) grant from the Federal Government. On their second try, in 2012, they were awarded a $2 million grant which was leveraged with Enbridge, an industry partner, for a total of $6 million. The deal was closed in February, 2014. Cenovus has made several investments in Hifi over the years and invested again to ensure their equity position was not diluted. Hifi now had the funds needed to provide a proof of concept. They are now two thirds the way through the project.



Hifi Enclosure and Fiber Optic Cable

Pipelines are at risk from: third party malicious events; strains; hot spots or leaks due to corrosion or other causes; and seismic events. The system uses optical fiber distributed sensors to provide continuous, simultaneously distributed measurements for the detection, monitoring, and location of those events. Unlike the downhole business, Hifi needed a different business model to address the pipeline market. The original concept was to charge a one-time fee for installation of the technology, as John calls it, a "sugar fix," and then set themselves up as an alarm company would, by charging a monthly monitoring fee. They would then report to their customers if there was an event.

| Strategic Partner |

By luck, John was in a golf tournament and was partnered with a General Electric (GE) executive who put him in touch with head office, who put him in touch with the guys in the Nevada office. What Hifi was developing fit exactly with GE's grand vision of the future, an industrial internet. GE agreed to participate in some testing and put Hifi through the ringer. GE has invested heavily in a real time software platform for industrial applications called Predix. Essentially, with this platform companies can build custom solutions and entire businesses on top of GE's Predix system. They see pipelines as an example of changing the world through real time monitoring. In Canada, there are nearly 71,000 km of pipe moving approximately 1 billion barrels of oil per year. World-wide there are 2 million miles of pipe moving 40 billion barrels of oil per year. That is enough pipe to go around the world 80 times. 50% of the pipe is over 25 years old.

> **"In Canada there are nearly 71,000 kilometers of pipeline, with 50% of it more than 25 years old."**

Currently Hifi is finding it difficult to find an audience with Canadian pipeline companies. They feel their best bet is to go to the US first and allow their product to be offered as part of GE's product offering. It will become a GE branded product powered by Hifi. Hifi's technology represents a missing component of GE's service offering, detecting low volume leaks. GE will act as the front end, customer interface. Hifi will do the back end, monitoring the data and sending information of an event back through to GE's Predix. Hifi will also generate revenues through laying and installing the infrastructure. GE became a partner with Hifi, contributing in-kind investment into the development of the SDTC project. The first unit is going into the field at the beginning of 2016.

Two fiber sensor arrays deployed with the Ventometer.

Deployment in the field

| The Future |

Hifi is just now beginning to commercialize its new technology to continuously monitor pipelines in real time for low level leaks throughout North America. Deciding on key partnerships and strategic alliances will be critical to their success.

The generous and
timely support by the
National Research Council – Industrial Research Assistance Program and
Sustainable Development Technology Canada
has been a significant contribution
to the company's growth.

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