

Technology Innovation of the Year, Fiber Optic Sensors for Oil & Gas North America, 2010

Frost & Sullivan's Global Research Platform

Frost & Sullivan is entering its 50th year in business with a global research organization of 1,800 analysts and consultants who monitor more than 300 industries and 250,000 companies. The Company's research philosophy originates with the CEO's 360-Degree Perspective,* which in turn serves as the foundation of its TEAM Research** methodology. This unique approach enables us to determine how best-in-class companies worldwide manage growth, innovation and leadership. Based on the findings of this Best Practices research, Frost & Sullivan is proud to present the 2010 North American Technology Innovation of the Year Award to US Sensor Systems Inc. for their development of fiber optic sensor technology for the oil and gas industry.

Significance of the Technology Innovation Award

Key Industry Challenges

New oil discoveries and current levels of oil production are unable keep pace with growing worldwide oil demand. To make up for this shortfall, companies need to improve oil productivity from existing fields. This, in turn, will require improvements in oil recovery techniques. Sensor technology also plays a critical role in this process by providing the needed support to achieve increased oil production. One such method, known as the 4D seismic technique, helps increase the percentage of oil extracted. For the 4D technique to be cost-effective, permanently installed seismic sensors are essential. Since legacy sensor systems, based on magnet or coil geophones that are used for 4D seismic sensing, are not designed for permanent installations, the cost and reliability of those systems are not suitable for critical applications such as those used in the oil and gas sector. As a result, the possibility of errors is increased. When it comes to using conventional sensors, electronics are required to convert the relatively weak output into a usable form that can be transmitted over long distances. It is important that these electronics be placed in close proximity to the sensor in order to limit unnecessary noise prior to amplification and digitization of the signal. Therefore, replacement sensors with enhanced features are required to achieve improved oil recovery efficiencies and thus address growing oil demand.

Before an industry will adopt an all-new technology, several factors need to be considered such as cost, noise floor, safety, operating bandwidth, etc. It is also important that the technology be reliable and a comparatively less expensive solution so that the costs associated with permanently installed sensors makes economic sense as compared to temporary (retrievable) systems. These sensors also need to possess a low noise floor, which is an essential aspect in order to detect the quietest seismic signals.

In 4D reservoir monitoring, the sensor's ability to operate over a wider bandwidth provides a picture with higher resolution thus giving better clarity of reservoir properties. The system's safety and reliability are also critical in achieving widespread adoption. When it

comes to geophones, coupling the geophone with a suite of electronics, which must be miniaturized, poses a huge challenge. In addition to ensuring the system's safety, the use of electrical power downhole must be congruent with OSHA regulations. However, fiber optic sensors would easily meet these needs as they would not require said electronics, thereby improving reliability while also providing immunity to electromagnetic and radio frequency interference.

Impact of Technology Innovation Award on Key Stakeholders

The Technology Innovation Award is a prestigious recognition of US Sensor Systems Inc.'s accomplishments in the Fiber Optic Sensor domain. An unbiased, 3rd party recognition can provide a profound impact in enhancing the brand value and thereby accelerating US Sensor Systems' growth. As captured in Chart 1 below, by researching, ranking, and recognizing those who deliver excellence and best practices in their respective endeavors, Frost & Sullivan hopes to inspire, influence, and impact three specific constituencies:

- **Investors**

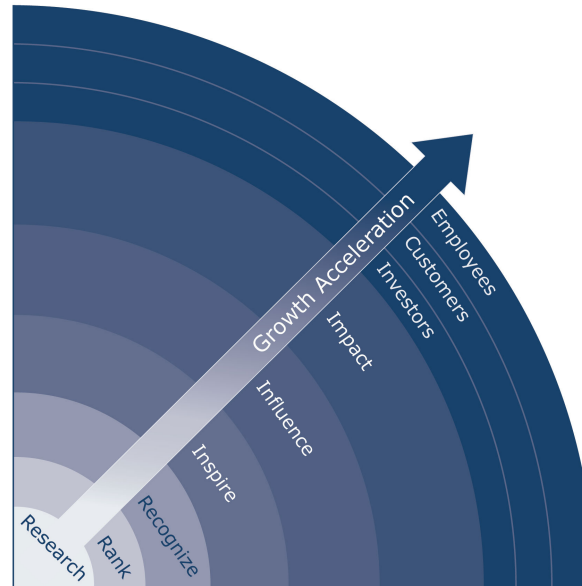
Investors and shareholders always welcome unbiased and impartial third party recognition. Similarly, prospective investors and shareholders are drawn to companies with a well-established reputation for excellence. Unbiased validation is the best and most credible way to showcase an organization worthy of investment.

- **Customers**

3rd party industry recognition has been proven to be the most effective way to assure customers that they are partnering with an organization that is leading in its field.

- **Employees**

This Award represents the creativity and dedication of US Sensor Systems' executive team and employees. Such public recognition can boost morale and inspire your team to continue its best-in-class pursuit of a strong competitive position for US Sensor Systems Inc.

Chart 1: Best Practices Leverage for Growth Acceleration**Key Benchmarking Criteria for Technology Innovation Award**

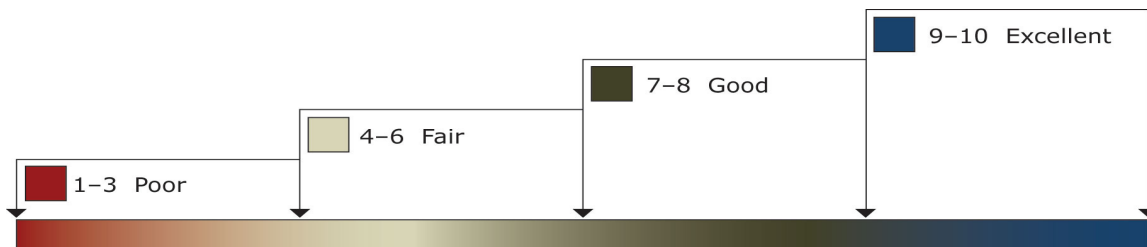
For the Technology Innovation Award, the following criteria were used to benchmark US Sensor Systems Inc's performance against key competitors:

- **Uniqueness of the Technology**
- **Impact on New Products/Applications**
- **Impact on Functionality**
- **Impact on Customer Value**
- **Relevance of the Innovation to the Industry**

Decision Support Matrix and Measurement Criteria

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Matrix (DSM). The DSM is an analytical tool that compares companies’ performance relative to each other with an integration of quantitative and qualitative metrics. The DSM features criteria unique to each award category and ranks importance by assigning weights to each criterion. The relative weighting reflects current market conditions and illustrates the associated importance of each criterion according to Frost & Sullivan. Fundamentally, each DSM is distinct for each market and award category. The DSM allows our research and consulting teams to objectively analyze each company's performance on each criterion relative to its top competitors and assign performance ratings on that basis. The DSM follows a 10-point scale that allows for nuances in performance evaluation; ratings guidelines are shown in Chart 2.

Chart 2: Performance-based Ratings for Decision Support Matrix



This exercise encompasses all criteria, leading to a weighted average ranking of each company. Researchers can then easily identify the company with the highest ranking. As a final step, the research team confirms the veracity of the model by ensuring that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

Chart 3: Frost & Sullivan’s 10 Step Process for Identifying Award-Recipients



Best Practice Award Analysis for US Sensor Systems Inc.

The Decision Support Matrix, shown in Chart 4, illustrates the relative importance of each criterion for the Technology Innovation Award and the ratings for each company under evaluation. To remain unbiased while also protecting the interests of the other organizations reviewed, we have chosen to refer to the other key players as Competitor 1 and Competitor 2.

Chart 4: Decision Support Matrix for Technology Innovation Award

<i>Measurement of 1-10 (1 = lowest; 10 = highest)</i>	Award Criteria					
	Uniqueness of the Technology	Impact on New Products/Applications	Impact on Functionality	Impact on Customer Value	Relevance of the Innovation to the Industry	Weighted Rating
Relative Weight (%)	20%	20%	20%	20%	20%	100%
US Sensor Systems Inc.	9	9	9	8.5	8.5	8.8
Competitor 1	7	7	7	7	7	7
Competitor 2	7	6.5	6.5	6.5	6.5	6.6

Criterion 1: Uniqueness of the Technology

The oil industry needs new and innovative technologies to improve oil recovery in order to meet the globally growing demand for oil. Since markets that traditionally utilize technologies based on fiber optic sensors are conservative, gaining recognition and achieving widespread adoption takes a much longer time. New technologies need to exhibit unique features when compared to existing solutions so that they may achieve successful penetration.

The system from US Sensor Systems Inc. is based on proprietary technology, referred to as 'fiber optic acoustic sensing technology', and it consists of two key integrated building blocks. The first element consists of a fiber optic sensor used to detect events by observing the changes to a reflected light signal. The second element is comprised of a remote electronics module (called an interrogator) to convert the reflected optical signals into digital electronic data to be provided to the end user for further analysis. The reflection and transmission of particular wavelengths of light are achieved using fiber Bragg grating (FBG). Although FBGs measure the value of strain, temperature, etc. in only one point and they require several gratings to measure numerous points, they provide improved spatial resolution, which in turn improves the clarity of the image and accuracy of the measured data when compared to the distributed sensors based on Raman, Rayleigh, or Brillouin scattering techniques.

The seismic monitoring system used by competitor 1 consists of sensors that use a fiber and a proof mass. These sensors decrease the uncertainty about the availability of the product under detection by providing consistent reference points in the subsurface. They also eliminate repeatability errors that might arise from redeployment of temporary sensors. However, these are achieved at a cost of highly complex circuitry, which poses a significant challenge to the end user with respect to installation and maintenance. The system from competitor 2 is a passive in-sea system with absence of in-sea electronics. Although this feature offers a more cost-effective alternative to other electrical systems and ensures safer operation, the detection capability is comparatively restricted.

When it comes to systems that are based on legacy magnet/coil geophones, they are not designed for permanent installations and hence serve only the purpose of short-term temporary installations. In addition, these geophones have an operating bandwidth of 80 Hz whereas 4D reservoir monitoring has the ability to operate with a higher operating bandwidth and hence provide better resolution. US Sensor Systems' geophone system currently has an operating bandwidth of 350 Hz.

US Sensor Systems' technology is expected to replace Micro-Electro-Mechanical Systems (MEMS). The main reason for this is that the noise floor for MEMS is 10 to 15 times higher than the standard magnet/coil geophone but still costs more. They also require electronics and electrical power downhole, which in turn necessitates adherence of OSHA guidelines.

Criterion 2: Impact on New Products/Applications

The fiber optic sensing cable is a high sensitivity, fiber optic assembly enabling the detection of very low sound, vibration, or strain levels. The fiber optic sensing cables utilized by US Sensor Systems employ Fiber Bragg Gratings (FBGs) embedded into the core of the fiber, which has the ability to provide images with better clarity. This sensor fiber is packaged into rugged cables designed for a variety of operating environments be it downhole in an oil well, on the ocean floor, or buried around the perimeter of a secure facility. This makes the system suitable for use even under harsh environmental conditions.

The interrogator is where all of the electronics for the system resides, typically housed in a standard electronics cabinet at the user interface end of the system. The interrogator is designed to provide a high fidelity digital reproduction of the detected events with high linearity and dynamic range, with stable signal scaling and low distortion. These factors ensure the delivery of details about the product availability with improved accuracy and thus ease the process of further analysis.

Criterion 3: Impact on Functionality

Since the optical fiber is the sensor, no electronics are required in the sensor cable. A single sensor cable can be up to 25 km long and include hundreds of discrete sensors. The system does not require couplers or splices, which are generally employed to facilitate the utility of the system for long distance measurements. This in turn reduces the system's complexity. It has the highest sensitivity, which enhances the detection capabilities of the system. In addition, it has the lowest system noise floor, which enables the detection of very low level seismic signals.

Criterion 4: Impact on Customer Value

US Sensor Systems' fiber optic acoustic sensing technology is similar to that currently employed by the US Navy on its newest class of submarines. The key difference between US Sensor Systems' all fiber optic geophone and others that are currently available are the sensitivity and the cost. The product based on the company's technology is currently undergoing full-scale field testing and beta testing with oil companies and oilfield service companies. The company conducted a side-by-side (surface seismic) test against a standard geophone, which provided excellent results. In addition to this, they also tested their geophone at the Department of Energy's Lawrence Berkeley Laboratory against their "Gold Standard" seismic geophone, which provided positive results around this product. The company is also utilizing an investment from Acorn Energy, Inc.'s to conduct field trials in order to compare its new fiber optic geophone technology with conventional geophones based on 50-year-old technology.

Criterion 5: Relevance of the Innovation to the Industry

US Sensor Systems' fiber optic sensor technology has three patents pending and a fourth application is in process. The industry currently requires permanently installed sensors to enable enhanced oil and gas recovery techniques. However, the currently available 50-year-old sensor technology is observed to be too costly and unreliable for permanent installations. The sensors based on the company's proprietary technology are powered only by light and are designed to replace the 50-year-old copper wire based sensor technology

currently in use. This technology has the ability to make permanent installations for oilfield monitoring practical, which in turn influences the widespread implementation of 4D seismic monitoring systems.

The CEO 360-Degree Perspective™ - Visionary Platform for Growth Strategies

The CEO 360-Degree Perspective model provides a clear illustration of the complex business universe in which CEOs and their management teams live today. It represents the foundation of Frost & Sullivan's global research organization and provides the basis on which companies can gain a visionary and strategic understanding of the market. The 360-Degree perspective is also a “must-have” requirement for the identification and analysis of best-practice performance by industry leaders.

The 360-Degree model enables our clients to gain a comprehensive, action-oriented understanding of market evolution and its implications for their companies’ growth strategies. As illustrated in Figure 5 below, the following six-step process outlines how our researchers and consultants embed the 360-Degree perspective into their analyses and recommendations:

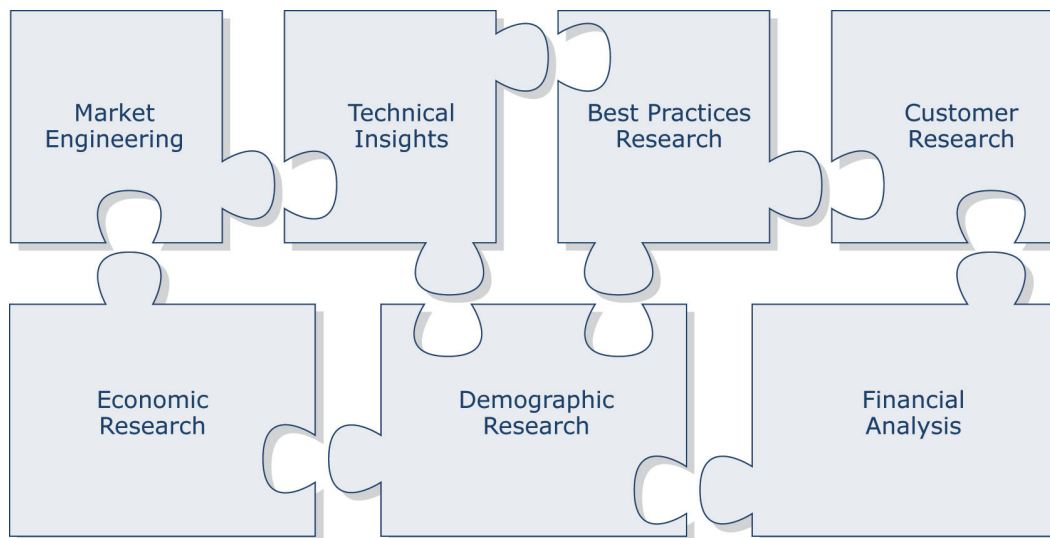
Chart 5: How the CEO's 360-Degree Perspective Model Directs Our Research



Critical Importance of TEAM Research

Frost & Sullivan's TEAM Research methodology represents the analytical rigor of our research process: it offers a 360-Degree view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Our experience has shown over the years that companies too often make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Frost & Sullivan contends that the successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices and demographic analyses. In that vein, the letters T, E, A and M reflect our core technical, economic, applied (financial and best practices) and market analyses. The integration of these research disciplines into the TEAM Research methodology provides an evaluation platform for benchmarking industry players and for creating high-potential growth strategies for our clients.

Chart 6: Benchmarking Performance with TEAM Research



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best in class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages almost 50 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from 31 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.