

FROST & SULLIVAN



**2017 European Acoustic-based Industrial
Machine Diagnostics Entrepreneurial
Company of the Year Award**

FROST & SULLIVAN

BEST
2017 **PRACTICES**
AWARD

EUROPEAN ACOUSTIC BASED INDUSTRIAL
MACHINE DIAGNOSTICS ENTREPRENEURIAL
COMPANY OF THE YEAR AWARD

Contents

Background and Company Performance	3
<i>Industry Challenges</i>	3
<i>Entrepreneurial Innovation and Customer Impact</i>	3
<i>Conclusion</i>	6
Significance of Entrepreneurial Leadership.....	7
Understanding Entrepreneurial Leadership.....	7
<i>Key Benchmarking Criteria</i>	8
Best Practices Award Analysis for 3DSignals	8
<i>Decision Support Scorecard</i>	8
<i>Entrepreneurial Innovation</i>	9
<i>Customer Impact</i>	9
<i>Decision Support Matrix</i>	10
Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices	11
The Intersection between 360-Degree Research and Best Practices Awards.....	12
<i>Research Methodology</i>	12
About Frost & Sullivan	12

Background and Company Performance

Industry Challenges

In the modern industrial era, manufacturing is a key area where major Industrial Internet of Things (IIoT) investments are being made and benefits are becoming realized. Factories have become several times smarter, processes and operations have become faster and more efficient, and workers have become even more productive. The IIoT generates a tremendous amount of data; Frost & Sullivan observes how it also brings about a huge demand for converting this data into meaningful insights that have, to a great extent, transformed maintenance from being reactive to becoming predictive. The application of insights for preventive machine maintenance has become a market of its own—popularly known as machine diagnostics.

Despite its benefits, however, Frost & Sullivan independent analysis reveals that the market faces the following challenges:

- Despite awareness of the benefits of predictive machine diagnostics, fewer than 20% of manufacturers are using advanced systems; others are still on conventional legacy systems. Technology solution providers must persuade companies to bring these technologies to the factory floor.
- Factory machines are generally stored in places that do not have proper network connectivity. Getting information to the outside world is a major infrastructural challenge.
- Frost & Sullivan research confirms that companies are increasingly open to newer technologies. Stakeholders ranging from facility managers to service companies and original equipment manufacturers are looking at adding IoT diagnostics capabilities to their products. While they are very much engaged in looking for these solutions, they still lack clarity on how and where to start.
- The machine diagnostics market is flooded with products that demand significant installation costs and effort. Too many complex processes and technical jargon often confuse end users.

Entrepreneurial Innovation and Customer Impact

Founded in 2015, 3DSignals is a start-up based in Israel that uses machine sounds to train deep-learning neural networks (DLNNs) for the diagnosis of anomalies in machine behavior. These algorithms can analyze sounds from motors, pumps, generators, turbines, compressors, valves, gearboxes, bearings, and other components to determine whether a machine is about to fail. Remedial action can then be taken to minimize downtime.

3DSignals' founders were inspired to create this model by technicians' ability to sense that something is wrong with a machine just by listening to its sounds. Engineers superimposed these skills onto DLNNs, which can monitor sounds at ultrasonic frequencies. To achieve this, 3DSignals places ultrasonic sensors near machines to

continuously record sounds. Audio is sent via the cloud for further processing by the DLNN, which then classifies sounds as healthy or unhealthy. The system sends out alerts as needed to technicians who can attend to affected machines.

Market Gaps

3DSignals' primary objective is to reduce unscheduled and unexpected downtime by addressing the human limitations of not being able to listen to all machines all the time, or even to physically access some machines. The most common machine diagnostic methods include visual inspection and measurements of temperature, vibration, and power consumption. Yet interestingly, sound—the most common diagnostic method—has not gained much attention among diagnostics providers.

3DSignals properly identified this gap and developed an algorithm that it incorporated into its predictive maintenance platform. Acoustic monitoring is a more holistic method of machine diagnostics for a wide range of issues, as opposed to a sensor measurement that takes into account only one aspect of equipment operation.

3DSignals first implemented its solution and demonstrated its capability in a steel plant in Israel. It determined after routine production line maintenance that someone forgot to properly tighten a screw—a potentially dangerous human error once the line was reactivated. 3DSignals identified this loose part by the sound it made and alerted the production line manager, who was able to immediately fix the issue.

Competitive Differentiation

Several companies have applied deep learning technology to automatically identify human sounds and images, yet only a few have applied it to predict machine failure. Traditional sensors have had the ability to predict machine failures by measuring temperature of vibration, but Frost & Sullivan recognizes 3DSignals' unique ability to mimic human auditory perception as a true differentiator from other machine diagnostics solutions.

The 3DSignals offering is designed to go beyond human listening limitations. The ultrasonic audio analysis sensors equipped with deep learning algorithms and powered by predictive analytics are installed next to industrial machines for constant monitoring. These sensors deploy sophisticated filtering that separates out interfering sounds—especially noise from other machines—for more accurate and useful data. This data is then communicated to an embedded computing device that does all the anomaly detection. The acoustic sensors are nonintrusive and do not physically contact machines. They are connected to a central cloud using LTE cellular communication. Installation even on legacy assets is simple, without the need for any additional equipment. The software can be installed on premises or in the cloud, and includes cybersecurity features to ensure data security and integrity at all times. The fact that the product does not require physical contact with the machines being monitored is widely appreciated by industrial clients as being a non-intrusive solution for all predictive maintenance needs.

Customer Experience

All of the close-knit company's 15 employees contribute to customer service and support; client issues are quickly addressed directly by the experts themselves. Because the solution is simple to implement, most of the service value relates to data aggregation and the insights that the data can generate. 3DSignals has ensured a superior customer experience by incorporating usability in its product design itself, with an interactive dashboard that extracts and displays all data in a simple and intuitive format. Active account management and analysis are provided at no additional charge.

Case Study: Remote Monitoring with Deep Learning-Based Acoustic Sensors for the Metal and Steel Service Industry

The Problem: A leading metal and steel service and processing company's operational costs were alarmingly affected by downtime related to tool breakages due to a lack of proper predictive maintenance mechanisms.

The Solution: Within 2 months of 3DSignals' solution implementation, the client was able to save \$180,000 on 3 production lines through predictive maintenance, increase production yield by more than 40%, and reduce operator errors by 80%. Downtime is at the lowest level ever.

Passionate Persistence

3DSignals was founded less than 2 years ago but the company has exhibited a fairly fast growth rate through product installations, expanding predictive maintenance capabilities across the manufacturing, automotive and farm equipment verticals. The company has already started talking to leading European automakers, including those planning to produce autonomous cars, about deploying the solution to detect machine failures during the production process and when the cars are on road. With several customers across Europe already, the company has a pipeline of deals that could help expand its presence into the United States within the next 2 years. The company has displayed passionate persistence in building technology to improve predictive maintenance and has been quite bullish on partnering with companies that can enhance their capabilities and product functionalities. Its most recent partnership is with Samson AG, an established maker of control valve technology. Samson has been integrating sensors from 3DSignals into valves at critical locations in several industries, including petrochemicals and chemicals. Monitoring these valves and giving them the intelligence to clearly recognize a problem is a valuable process itself.

3DSignals is now pursuing additional partnerships, particularly in the hydroelectric industry.

Conclusion

3DSignals' innovative ultrasonic acoustic sensors, built with the objective of minimizing downtime through the use of intelligent deep-learning technologies, has given the company a distinct competitive edge over traditional predictive maintenance providers in Europe. The company's focus on leveraging evolving technologies has been quite instrumental in driving its growth in the European machine diagnostics space. Frost & Sullivan appreciates how 3DSignals has proven to the traditional predictive maintenance market that divergent thinking can result in novel technologies that have the potential to disrupt the industry.

With its strong overall performance, 3DSignals has earned the 2017 Frost & Sullivan Entrepreneurial Company of the Year Award.

Significance of Entrepreneurial Leadership

Ultimately, growth in any organization depends upon customers purchasing from a company and then making the decision to return time and again. In a sense, then, everything is truly about the customer—and making those customers happy is the cornerstone of any long-term successful innovation or growth strategy. To achieve these dual goals (customer engagement and growth), an organization must be best-in-class in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.



Understanding Entrepreneurial Leadership

Demand forecasting, branding, and differentiation underpin an entrepreneurial company's journey toward forming deep relationships with customers and permanently altering the market with their actions.

Key Benchmarking Criteria

For the Entrepreneurial Company of the Year Award, Frost & Sullivan analysts independently evaluated two key factors—Entrepreneurial Innovation and Customer Impact—according to the criteria identified below.

Entrepreneurial Innovation

- Criterion 1: Market Disruption
- Criterion 2: Competitive Differentiation
- Criterion 3: Market Gaps
- Criterion 4: Blue Ocean Strategy
- Criterion 5: Passionate Persistence

Customer Impact

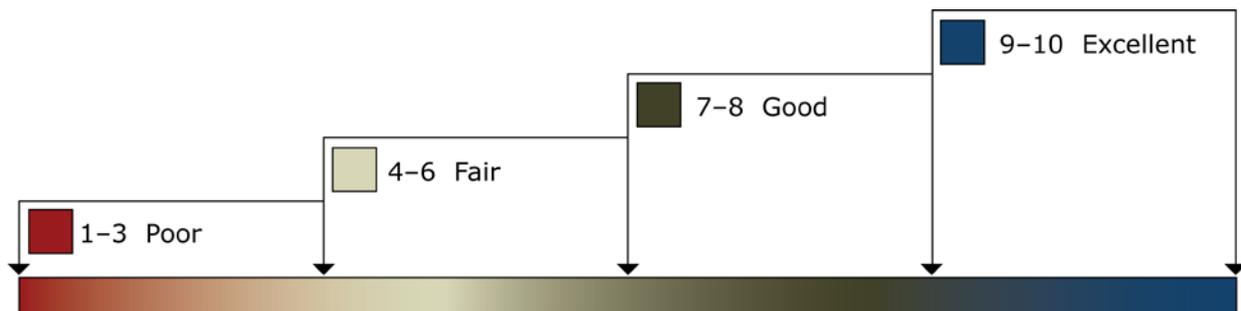
- Criterion 1: Price/Performance Value
- Criterion 2: Customer Purchase Experience
- Criterion 3: Customer Ownership Experience
- Criterion 4: Customer Service Experience
- Criterion 5: Brand Equity

Best Practices Award Analysis for 3DSignals

Decision Support Scorecard

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Scorecard. This tool allows our research and consulting teams to objectively analyze performance, according to the key benchmarking criteria listed in the previous section, and to assign ratings on that basis. The tool follows a 10-point scale that allows for nuances in performance evaluation. Ratings guidelines are illustrated below.

RATINGS GUIDELINES



The Decision Support Scorecard is organized by Entrepreneurial Innovation and Customer Impact (i.e., These are the overarching categories for all 10 benchmarking criteria; the definitions for each criterion are provided beneath the scorecard.). The research team confirms the veracity of this weighted scorecard through sensitivity analysis, which confirms 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.

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, we have chosen to refer to the other key participants as Competitor 2 and Competitor 3.

<i>Measurement of 1–10 (1 = poor; 10 = excellent)</i>			
Entrepreneurial Company of the Year	Entrepreneurial Innovation	Customer Impact	Average Rating
3DSignals	9.5	9.0	9.25
Competitor 2	8.0	7.5	7.75
Competitor 3	7.0	7.0	7.00

Entrepreneurial Innovation

Criterion 1: Market Disruption

Requirement: Innovative solutions that have genuine potential to disrupt the market, obsoleting current solutions and shaking up competition

Criterion 2: Competitive Differentiation

Requirement: Deep understanding of both current and emerging competition to create and communicate strong competitive differentiators in the market

Criterion 3: Market Gaps

Requirement: A clear understanding of customers’ desired outcomes, the products that currently help them achieve those outcomes, and where key gaps may exist

Criterion 4: Blue Ocean Strategy

Requirement: Strategic focus on creating a leadership position in a potentially “uncontested” market space, manifested by stiff barriers to entry for competitors

Criterion 5: Passionate Persistence

Requirement: A deep belief in the “rightness” of an idea and a commitment to pursuing it despite seemingly insurmountable obstacles

Customer Impact

Criterion 1: Price/Performance Value

Requirement: Products or services offer the best value for the price, compared to similar offerings in the market.

Criterion 2: Customer Purchase Experience

Requirement: Customers feel they are buying the most optimal solution that addresses both their unique needs and their unique constraints.

Criterion 3: Customer Ownership Experience

Requirement: Customers are proud to own the company’s product or service and have a positive experience throughout the life of the product or service.

Criterion 4: Customer Service Experience

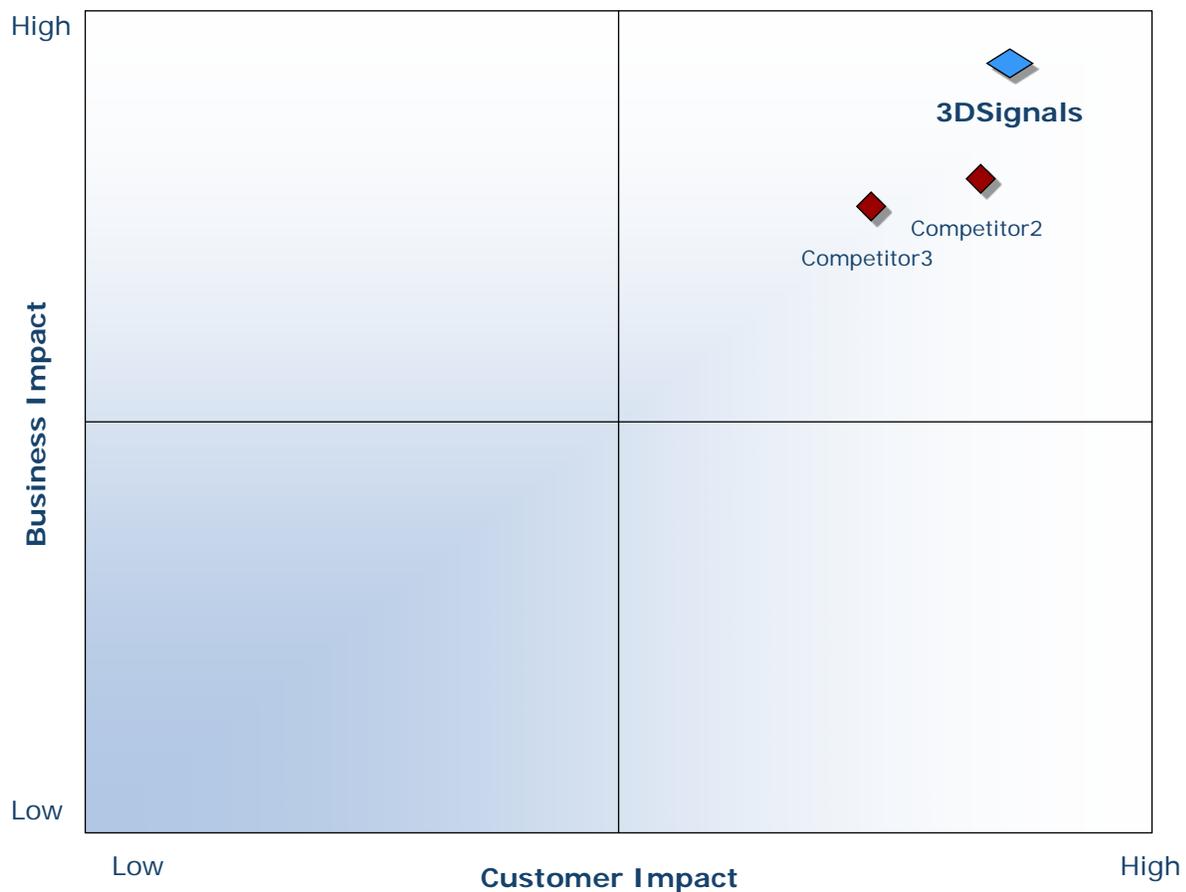
Requirement: Customer service is accessible, fast, stress-free, and of high quality.

Criterion 5: Brand Equity

Requirement: Customers have a positive view of the brand and exhibit high brand loyalty.

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts then position the candidates on the matrix shown below, enabling them to visualize which companies are truly breakthrough and which ones are not yet operating at best-in-class levels.



Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analysts follow a 10-step process to evaluate Award candidates and assess their fit with select best practice criteria. The reputation and integrity of the Awards are based on close adherence to this process.

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1 Monitor, target, and screen	Identify Award recipient candidates from around the globe	<ul style="list-style-type: none"> • Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies 	Pipeline of candidates who potentially meet all best-practice criteria
2 Perform 360-degree research	Perform comprehensive, 360-degree research on all candidates in the pipeline	<ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates 	Matrix positioning of all candidates' performance relative to one another
3 Invite thought leadership in best practices	Perform in-depth examination of all candidates	<ul style="list-style-type: none"> • Confirm best-practice criteria • Examine eligibility of all candidates • Identify any information gaps 	Detailed profiles of all ranked candidates
4 Initiate research director review	Conduct an unbiased evaluation of all candidate profiles	<ul style="list-style-type: none"> • Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles 	Final prioritization of all eligible candidates and companion best-practice positioning paper
5 Assemble panel of industry experts	Present findings to an expert panel of industry thought leaders	<ul style="list-style-type: none"> • Share findings • Strengthen cases for candidate eligibility • Prioritize candidates 	Refined list of prioritized Award candidates
6 Conduct global industry review	Build consensus on Award candidates' eligibility	<ul style="list-style-type: none"> • Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates 	Final list of eligible Award candidates, representing success stories worldwide
7 Perform quality check	Develop official Award consideration materials	<ul style="list-style-type: none"> • Perform final performance benchmarking activities • Write nominations • Perform quality review 	High-quality, accurate, and creative presentation of nominees' successes
8 Reconnect with panel of industry experts	Finalize the selection of the best-practice Award recipient	<ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select recipient 	Decision on which company performs best against all best-practice criteria
9 Communicate recognition	Inform Award recipient of Award recognition	<ul style="list-style-type: none"> • Present Award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance 	Announcement of Award and plan for how recipient can use the Award to enhance the brand
10 Take strategic action	Upon licensing, company is able to share Award news with stakeholders and customers	<ul style="list-style-type: none"> • Coordinate media outreach • Design a marketing plan • Assess Award's role in future strategic planning 	Widespread awareness of recipient's Award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree 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. Too often companies make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.



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 more than 50 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.