FROST & SULLIVAN

BEST PRACTICES AWARDS

SARCOS®

2020 NORTH AMERICAN DEXTEROUS ROBOTS & EXOSKELETONS COMPANY OF THE YEAR AWARD

Contents

Background and Company Performance

Industry Challenges

Dexterous robots and powered full-body exoskeletons have made leaps and bounds in the industrial sector. Because the fatigue and trauma caused by heavy load lifting can stymie workforce productivity, these robotic technologies are on the cusp of creating a tectonic shift in the future of work. A skilled labor shortage resulting from an aging population and fewer young people interested in jobs that involve physically demanding work has further triggered a search for safe and effective force-multiplying capabilities. Powered full-body robotic exoskeletons aid in lifting, manipulating, and assembling objects while reducing the stress and strain on a user's body. Industries such as industrial manufacturing, warehousing and logistics, repair and maintenance facilities, aviation, maritime, automobile manufacturing, construction, and defense increasingly turning to dexterous mobile robots, including powered full-body exoskeletons, that can do more than merely shuttle items from one place to another. The primary drivers for the adoption of powered full-body exoskeletons are: (i) a significant increase in productivity resulting from greater strength and endurance, and reduced errors due to fatigue, (ii) a reduction in work-related injuries, thereby eliminating medical expenses and leaves, and (iii) an ability to make more physically demanding jobs available to more people, irrespective of age, size, or strength.

Unpowered or passive partial-body industrial exoskeletons have been in the market for a number of years. These devices are intended to enhance human endurance, but they do not enhance strength. They generally shift the load from the arms and shoulders to the lower back and hips, contributing to multiple safety and operational concerns. Comfort has also proven an issue, as most of these systems are worn for extended periods. After more than twenty years of development, powered full-body robotic exoskeletons intended to overcome these challenges are now becoming a reality. This new class of wearable robotic exoskeleton is energy-efficient, intuitive to use, and adaptable to the dynamic movements of the human body.

The historical lack of commercially available components that meet size, weight, power, and performance requirements, as well as high production costs that result from incorporating multiple sensors, battery packs, motors, and controllers, have contributed to a lengthy commercialization process for powered full-body robotic exoskeletons. Lowering production costs or crafting new business models continue to be critical in achieving economies of scale in this market. In terms of design, powered full-body exoskeletons require an intuitive system that permits the operator to instantly control and react through an adequate sensory feedback system. Ideally, the system operates as an extension of the human operator, with instantaneous mirroring of the operator's movement as well as immediate sensory feedback to the operator, enabling the operator to rely on reflexes, muscle memory, and intuition to engage with, and respond to, the work environment.

Powering a fully-mobile robotic exoskeleton has historically been one of the biggest challenges hindering commercialization. Legged or bi-pedal robots, whether of the

humanoid or exoskeleton variety, generally consume significant amounts of power, limiting the time that these machines can run on batteries to 20-30 minutes, similar to consumer drones. Robotic systems with this limited runtime are unlikely to see significant adoption for commercial and industrial applications.

Visionary Innovation and Performance/Customer Impact

Founded in 1983, Sarcos Robotics' predecessor was spun out of the University of Utah, then acquired by Raytheon in 2007. Sarcos then spun out of Raytheon in late 2014 in a management buy-out transaction. Since its exit from Raytheon, its primary focus has been to commercialize dexterous robots and full-body powered robotic exoskeletons designed for those tasks that are too complex or unstructured for traditional automation. Through its products, the company combines the best of human intelligence, instinct, and judgment with the strength, endurance, and precision of machines. Unlike most other robotics players, Sarcos Robotics does not offer robots that perform repetitive, highly structured tasks. Instead, the company provides robotic solutions for unstructured tasks and more challenging environments.

Solving Pertinent Issues in the Industry

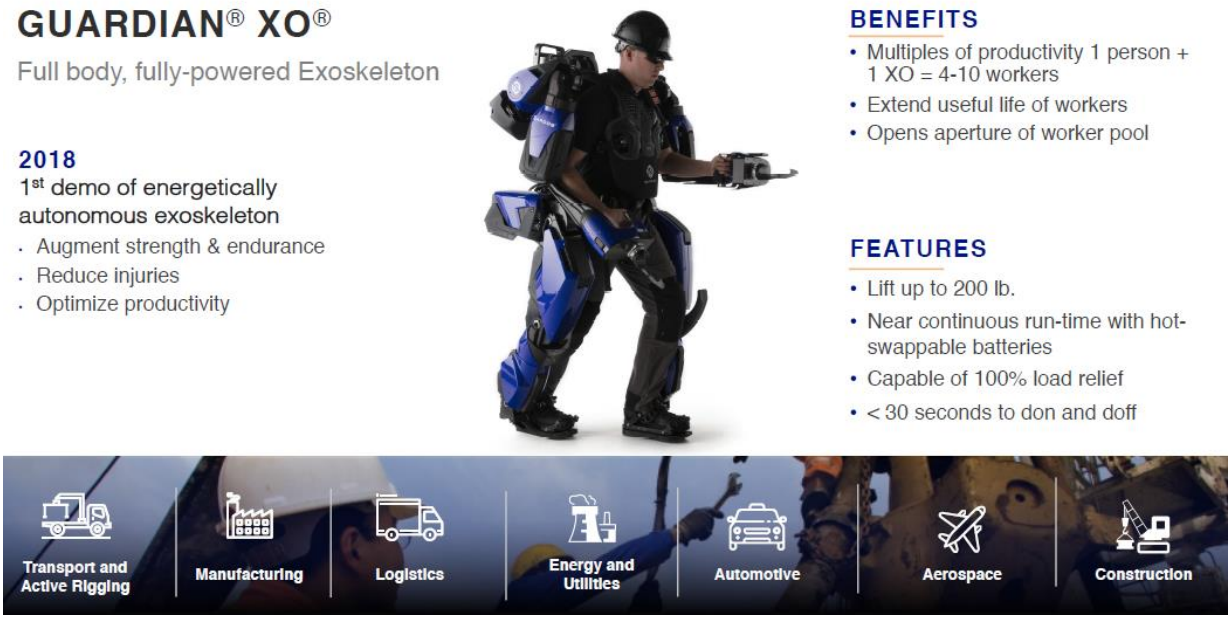
Through its robotic systems, Sarcos addresses many workforce problems currently miring industries. Industrial enterprises across different sectors have faced an acute shortage of labor due to the ongoing COVID-19 crisis. This raises several pertinent questions, such as how manufacturers can ensure business continuity. Even outside of these unprecedented times, labor shortages have been a consistent issue. Many workers are aging out while new workers shy away from work that involves manual labor. A persistent labor shortage, the threat of occupational injuries, a push for greater productivity and profitability, and high recruitment costs are forcing organizations to reconsider viable solutions. These include dexterous robots and powered exoskeletons.

Many industries are prone to workforce fatigue and injuries. In the US alone, it is estimated that back pain accounts for more than 264 million lost workdays per year. That's the equivalent of two workdays for every full-time worker in the country.[1] Low-back pain costs Americans at least $50 billion in healthcare each year.[2] Add in lost wages and decreased productivity, and that figure can easily rise to more than $100 billion.[3] This can cut a huge chunk out of a worker's annual compensation plan, along with lost time and opportunities. The combination of lost productivity, an aging workforce, and the onset of the COVID-19 pandemic have perfectly aligned the conditions necessary to introduce dexterous robots and powered exoskeletons.

While the market has many tools that can assist people with heavy lifting, current equipment comes with drawbacks. Forklifts, overhead cranes, portable cranes, and lift-assist devices are often inconvenient and inflexible. For example, overhead cranes require a construction crew to wait for long intervals until it arrives, as there is often a queue of other crews waiting to use the device. Such wait times result in lost productivity. Lift-assist devices also do not provide much in the way of agile manufacturing capability.

This is where powered exoskeletons find an opportunity. Sarcos Robotics operates in the full-body, fully powered dexterous robots and exoskeletons space. Sarcos Robotics has recently unveiled the alpha version of its Guardian® XO® industrial exoskeleton, which the company plans to make available for commercial usage soon. The Guardian XO exoskeleton addresses issues of insufficient tools alongside workforce inadequacy and fatigue. Further, the Guardian XO exoskeleton comes with the advantage of being extremely flexible and convenient, along with the ability to work in unstructured environments, compared to other products currently existent in the market.

How Can the Guardian XO Exoskeleton be a Viable Solution?



Source: Sarcos Robotics

The Guardian XO exoskeleton is a full-body, battery-powered wearable robotic system that can safely lift up to 200 pounds for extended work sessions. The fully-electric machine comes with an untethered runtime of several hours, and hot-swappable battery packs keep it running for a full workday. Frost & Sullivan forecasts that the Guardian XO exoskeleton will emerge as a key, differentiated product in the manufacturing and logistics industry. This industry maintains a strong demand for robotic systems that enable greater efficiencies for physically demanding unstructured tasks. The Guardian XO exoskeleton addresses this specific demand in a way that users can continue operating the suit even while removing and replacing the batteries, thus eliminating the need to power down the suit during its usage.

Sarcos Robotics began designing full-body, powered exoskeletons with a hydraulically-powered model, initially funded by DARPA, in 2000. Although the hydraulically-powered system allowed for a range of capabilities, the machine was power-hungry and tethered to a hydraulic source, meaning it couldn't walk very far. So the company began innovating and developed the battery-powered Guardian XO exoskeleton. The upgraded system

employs technology with enhanced energetically-autonomous capabilities and more efficient battery storage. While the original hydraulically-powered version consumed an average of 6800 watts of power per hour to operate, the electrically-powered Guardian XO exoskeleton requires less than 500 watts of power per hour for normal operation. The challenges that have historically vexed the mobile robotics industry associated with the size, weight, power, performance, and price of components have finally been sufficiently addressed to make these machines commercially viable.

Another unique feature of the Guardian XO exoskeleton is that it allows users to lift more and have the effective use of four arms. The user can lift and hold weight with the Guardian XO arms, and then remove their arms from the robot to perform other tasks while the load remains balanced and stable, supported solely by the exoskeleton. This facilitates more finite user tasks such as tightening bolts, using hand tools, and other small assembly tasks.

While in operation, the Guardian XO robot amplifies the operator's strength, enabling them to lift up to 200 pounds repeatedly without strain or injury. Although the Guardian XO exoskeleton can provide a true zero gravity, weightless experience, Sarcos has found through testing that users perform better, and have better situational awareness, when they can feel a small fraction of the load. So the Guardian XO suit has been designed to make 200 pounds feel like 10 pounds to the operator.

The Guardian XO robot sports other innovative features, such as its intuitive controls system, which enables the exoskeleton to respond to the operator’s movements in milliseconds. This enables operators to intuitively control the robot in a way that leverages their instincts and reflexes and minimizes the need for extensive training. Additionally, the natural, fluid, and intuitive movement through the Sarcos proprietary advanced control system (“Get-Out-of-the-Way” control) eliminates the perception of latency between human operator movement and the exoskeleton.

Pricing Strategy & Business Model Innovation

The go-to-market model followed by Sarcos Robotics is Robot-as-a-Service (RaaS). The company has priced the Guardian XO exoskeleton to be equivalent to the fully-burdened annual cost of a $25 per hour full-time employee, including typical G&A, overhead, benefits, and taxes. In the US, that comes to a rate of $100,000 to $150,000 a year per exoskeleton, depending on the number of units a company has at a single location and the RaaS contract duration. As part of the RaaS offering, Sarcos services, maintains, and upgrades the Guardian XO exoskeleton as necessary.

Based on its research, Sarcos has discovered that customers prefer the RaaS model because it eliminates high upfront costs. It also eliminates technology risks, which can be a concern with new, category-creating products like the Guardian XO exoskeleton. With the speed of emerging new technologies, customers are much more comfortable with the RaaS model because they don’t feel pressure to undertake maintenance as their responsibility. The RaaS model can be structured to give the customer the flexibility to account for the expense as either an operational expenditure (OPEX) or a capital

expenditure (CAPEX). This shift to OPEX enables companies to account for the exoskeleton as they would a traditional labor expense. At the same time, the CAPEX treatment has the benefit of moving a unit of labor out of EBITDA and below the line.

Product Value, Applications, and Use Cases

Source: Sarcos Robotics

Unique Selling Proposition (USP) and the Road Ahead

Sarcos Robotics stands alone with its launch of a powered full-body robotic exoskeleton. The company's unique selling proposition (USP) is its full-body design, optimized energy utilization, and ability to work in unstructured environments. Even within manufacturing, there are areas where companies require agile manufacturing or first-mile, last-mile logistics that simply cannot be solved by automation. In that, the Sarcos USP is dexterity, kinematics, ease-of-use, and the ability to operate in such environments. The company has also been fortunate to have some amazing investors in the form of GE, Caterpillar, Microsoft, and Schlumberger, each having helped Sarcos Robotics increase its visibility in the market.

With these investors and other leading companies, Sarcos has formed a group called the X-TAG (Exoskeleton Technical Advisory Group). Created in 2016, the X-TAG includes leading companies representing industries as diverse as industrial manufacturing, oil and gas, utilities, logistics, construction, automotive, aviation, and aerospace. All X-TAG members have been integral in assisting the company with design, performance, and safety requirements while also ensuring the Guardian XO exoskeleton meets the needs of different use cases. The group members provide Sarcos Robotics with inputs and guidance in terms of utility, safety, and usability.

Conclusion

Full-body, autonomously-powered robotic exoskeletons have immense potential to transform the industrial workforce and deliver on the promise of the workforce of the future. From improving worker strength, efficiency, and safety to reducing occupational injuries caused by repetitive heavy lifting, the Guardian XO exoskeleton is poised to be a game-changer for a wide variety of industries. In a market that has been dominated by traditional market players who offer less functional and efficient tools, Sarcos Robotics has been revolutionary in creating a product that is more energy-efficient, more functional, and offered at an optimal price. With its strong overall performance, Sarcos Robotics has earned Frost & Sullivan's 2020 Company of the Year Award.

Footnotes & References:

1. The US Bone and Joint Initiative, "The Hidden Impact of Musculoskeletal Disorders on Americans," https://www.boneandjointburden.org/docs/BMUS%20Impact%20of%20MSK%20on%20Americans%20booklet_4th%20Edition%20%282018%29.pdf (21 August 2020).
2. World Spine Day, "Key facts about back pain and spinal health," http://www.worldspineday.org/resources/spinal-health-and-spine-disorders/ (24 August 2020).
3. Katz, Jeffery N, "Lumbar disc disorders and low-back pain: socioeconomic factors and consequences," The Journal of Bone Joint Surgery, https://pubmed.ncbi.nlm.nih.gov/16595438/ (21 August 2020)

Significance of Company of the Year

To receive the Company of the Year Award (i.e., to be recognized as a leader not only in your industry, but among non-industry peers) requires a company to demonstrate excellence in growth, innovation, and leadership. This excellence typically translates into superior performance in three key areas—demand generation, brand development, and competitive positioning—that serve as the foundation of a company's future success and prepare it to deliver on the 2 factors that define the Company of the Year Award: Visionary Innovation and Performance, and Customer Impact).

Understanding Company of the Year

Driving demand, brand strength, and competitive differentiation all play critical roles in delivering unique value to customers. This three-fold focus, however, must ideally be complemented by an equally rigorous focus on Visionary Innovation and Performance to enhance Customer Impact.

Key Benchmarking Criteria

For the Company of the Year Award, Frost & Sullivan analysts independently evaluated each factor according to the criteria identified below.

Visionary Innovation and Performance

Criterion 1: Addressing Unmet Needs
Criterion 2: Visionary Scenarios through Mega Trends
Criterion 3: Implementation of Best Practices
Criterion 4: Blue Ocean Strategy
Criterion 5: Financial Performance

Customer Impact

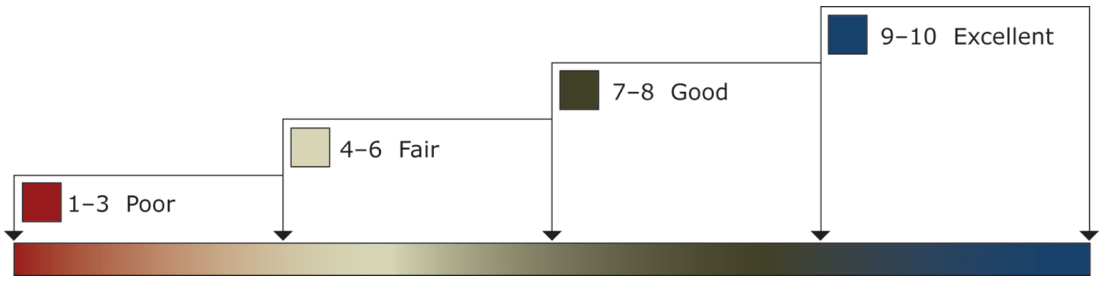
Criterion 1: Price/Performance Value
Criterion 2: Customer Purchase Experience
Criterion 3: Customer Ownership Experience
Criterion 4: Customer Service Experience
Criterion 5: Brand Equity

Best Practices Award Analysis for Sarcos Robotics

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 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 considers Visionary Innovation and Performance and Customer Impact (i.e., 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, Frost & Sullivan has chosen to refer to the other key participants as Competitor 1 and Competitor 2.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Company of the Year	Visionary Innovation & Performance	Customer Impact	**Average Rating**
Sarcos Robotics	**9.5**	**9**	**9.25**
Competitor 2	6	5	5.5
Competitor 3	7	5	6

Visionary Innovation & Performance

Criterion 1: Addressing Unmet Needs

Requirement: Implementing a robust process to continuously unearth customers' unmet or underserved needs, and creating the products or solutions to address them effectively.

Criterion 2: Visionary Scenarios through Mega Trends

Requirement: Incorporating long-range, macro-level scenarios into the innovation strategy, thereby enabling first-to-market growth opportunity solutions.

Criterion 3: Implementation of Best Practices

Requirement: Best-in-class strategy implementation characterized by processes, tools, or activities that generate a consistent and repeatable level of success.

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: Financial Performance

Requirement: Strong overall business performance in terms of revenue, revenue growth, operating margin, and other key financial metrics.

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 optimal solution that addresses both their unique needs and their unique constraints.

Criterion 3: Customer Ownership Experience

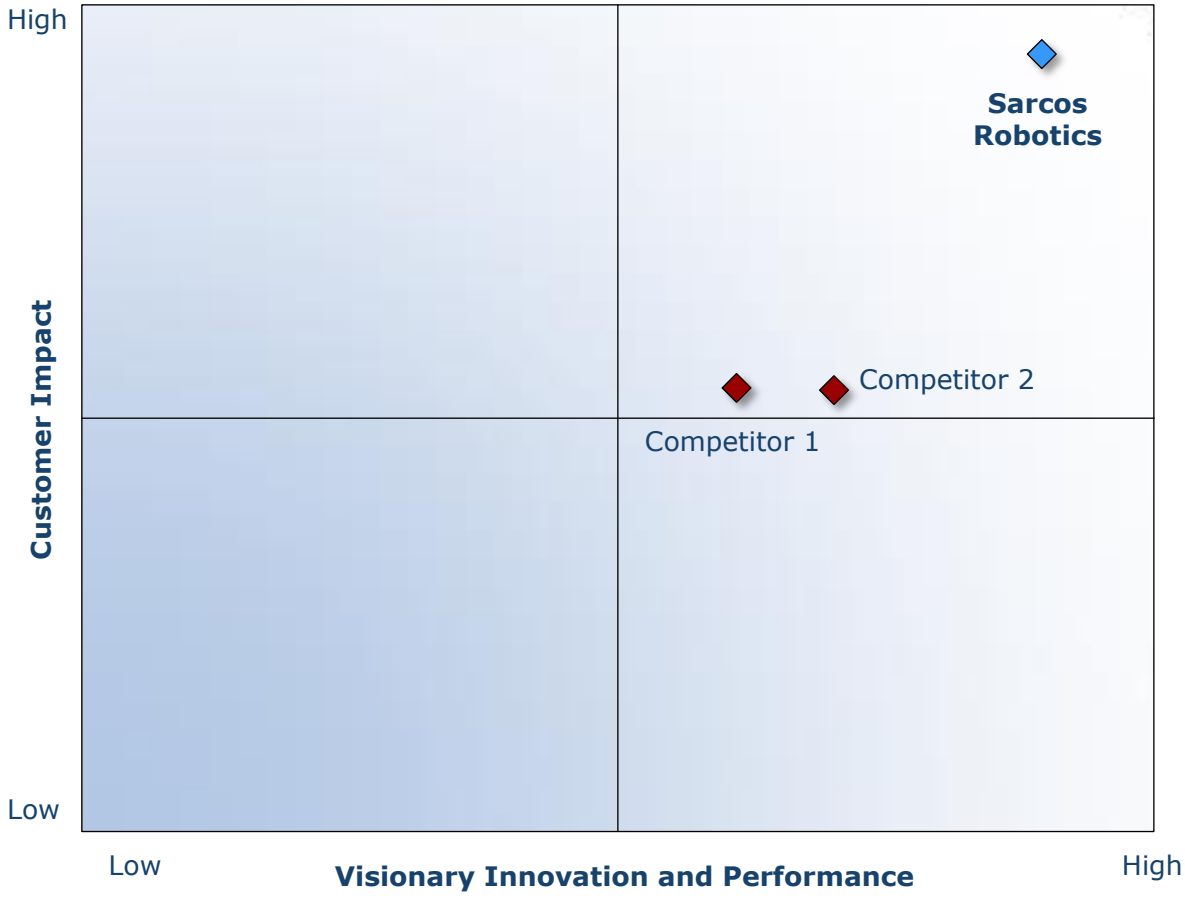
Requirement: Customers are proud to own the company's product or service and have a positive experience throughout the life of the product or service.

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 practices 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 world	• Conduct in-depth industry research • Identify emerging industries • Scan multiple regions	Pipeline of candidates that potentially meet all best-practice criteria
2	**Perform 360-degree research**	Perform comprehensive, 360-degree research on all candidates in the pipeline	• Interview thought leaders and industry practitioners • Assess candidates' fit with best practices 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	• Confirm best practices 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	• Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles	Final prioritization of all eligible candidates and companion best practices positioning paper
5	**Assemble panel of industry experts**	Present findings to an expert panel of industry thought leaders	• 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	• 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	• 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 practices award recipient	• Review analysis with panel • Build consensus • Select recipient	Decision on which company performs best against all best practices criteria
9	**Communicate recognition**	Inform award recipient of recognition	• 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	• Coordinate media outreach • Design a marketing plan • Assess award's role in 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 the 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, resulting in 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.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS

About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, helps clients 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 practices models to drive the generation, evaluation, and implementation of powerful growth strategies. Frost & Sullivan leverages nearly 60 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on 6 continents. To join Frost & Sullivan's Growth Partnership, visit http://www.frost.com.