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FROST & SULLIVAN BEST PRACTICES AWARDS

ZERO-EMISSION POLYMER MATERIAL ADDITIVE MANUFACTURING - NORTH AMERICA

Technology Innovation 2019

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Background and Company Performance

Industry Challenges

3D printing, also referred to as additive manufacturing, is transforming engineers' abilities by providing them with a platform to create more functional prototypes of parts and functional parts made from metal and non-metal alloys. With a variety of printing technologies in the market, the compatible materials also vary from solid materials to liquid materials. This enables the technology to be used across a wide range of industries, including aerospace and defense, automotive, life sciences, consumer goods and industrial manufacturing. However, though impressive advancements have been made in additive manufacturing techniques and materials, a few main challenges still restrain this technology's growth potential.

Pre-processing and Post-processing Concerns: At present, a lot of time is spent before and after a part is printed. Often prior to printing of a part 3D computer aided design (CAD) models are developed. Making CAD files 3D printable can be tedious, time consuming and difficult. As a result, many engineers purchase file-fixing software in addition to their CAD software to alleviate this headache. But even those programs require additional time and expertise in order to get a 3D printable file. Rize software enables users to automatically print imperfect files, eliminating the need for tedious file fixing and the purchase of file-fixing software. CAD software programs like SOLIDWORKS enable the user to print to Rize directly from within SOLIDWORKS.

To obtain a useable part, multiple processing stages such as soaking parts in a corrosive solvent bath, cutting, sanding, welding, polishing, painting, or coating are required to ensure the final product's functionality. Cutting or soaking in a solvent is commonly used by a majority of 3D printers as the support structure that holds the final part has to be removed. There is a pressing need to minimize the non-value-added activities that increase the complexities, time and cost in a 3D printing process cycle.

Mimicking Industrial Parts: 3D printed parts are expected to have functional characteristics similar to those of an industrial part that is manufactured using subtractive techniques or plastic injection molding. This has been a persistent process challenge and a demand 3D printing companies must address.

Z-axis Strength: Besides having comparable appearance and function, another challenge has been to achieve a 3D printed part with strength along three axes the x, y, and z axes) of a part. Thus far, in 3D printing techniques such as fused deposition modeling (FDM), it has been possible to obtain strength along x and y axes but very difficult to achieve the z axis strength. This limits the variety of parts and applications that can be produced.

Traceability and Security: Another challenge with existing 3D printing is the risk of intellectual property (IP) loss. During printing, excess parts might be created that are not

used in the end application, such as an extra piece, which can get misplaced or lost. In such cases, it is important to ensure IP integrity and obtain process traceability from the digital world to the physical world.

Material Compatibility: The material used in a 3D printer is often placed in a dry box or in a moisture-controlled environment to ensure its properties remain intact. Many 3D printed materials absorb moisture from the environment. Moisture suction from parts creates pockets of moisture inside the piece being printed, reducing its strength and resulting in a dysfunctional final part.

Toxic Emission: Often harmful invisible particles are released from the 3D printer. These emissions are also known as volatile organic compounds (VOCs). Emission of highly toxic fumes occurs when the plastic melts during the extrusion process.

Each of these challenges is overcome by the innovative additive manufacturing Augmented Deposition process technology developed by US-based Rize Inc. (Rize). The technology has been proven capable of safely fabricating functional components with very high strength, minimizing pre- and post-processing stages. It boosts the ability of manufacturing engineers, product engineers, design engineers, and product development organizations to readily design and produce custom and replacement industrial tools and parts.

Technology Attributes and Future Business Value

Industry Impact & Product Impact

Rize's Augmented Deposition process is rooted in an established technology that comprises material extrusion and with material jetting, which have been in the marketplace for over 15 years. The hybridization of these two technologies to create a single new process, Augmented Deposition, has been developed to solve all the above-mentioned technological 3D printing challenges.

Technology Attributes:

The Augmented Deposition technology has overcome conventional cost and time issues that are involved in building a support system made from a different material as well as a second extruder. This is because the innovative Rize 3D printer builds the support structure using the same material that makes up the final part. By contrast, the use of two extruders for printing a single part and the need for secondary processing, such as use of chemical solutions, to remove the support system and obtain the final part slows down the process cycle, increases costs and limits the technology to an additive manufacturing lab. Rize has overcome this time-consuming processing step by introducing a proprietary release ink that enables removal of the support material similar to how a Velcro strip can be removed. The release ink minimizes post processing and provides a

final product with a smooth surface, thereby eliminating the need for additional finishing steps. The ink is able to be jetted between the support material and the part for easy, safe and clean support removal due to the ability of the Augmented Deposition process to simultaneously extrude a proprietary thermoplastic and jet functional inks where needed to alter the properties of the thermoplastic at the voxel level.

Besides obtaining a part with a smooth surface, the need to produce a part that has strength in all directions (x, y, and z axes) has been a long-standing industry concern, as only then will a part be completely functional and useable for many real-world industry applications. The hybrid Augmented Deposition process interlayer adhesion. Building an interlayer adhesion ensures strength in all 3 axes and enables a part to be printed with industrial-grade strength.

Rize's Augmented Deposition technology also addresses the issue of traceability and IP rights by using the proprietary "marking ink" that is jetted at a voxel level. The marking ink enables impregnation of a QR code, revision number, part number, brand, or even logo to be transferred from software onto the part to create an immutable digital thread between the physical part and its digital twin for compliance, traceability and complete authentication.

Product Attributes:

The Rize 3D printer prioritizes ease of use. Besides addressing the complexities around industrial 3D printing, such as pre-processing and post-processing, ensuring material compatibility in all kinds of climatic conditions has been another major concern that competitors have not overcome. The Augmented Deposition platform provides industrial users with an all-weather 3D printing solution that does not absorb moisture and can be used in all types of climatic conditions without any hassle. As properties of the material are directly proportional to the strength of the final part, the company has developed a technology that provides manufacturers the advantage of printing in virtually any environment with the liberty to print a variety of parts across a range of applications.

Moreover, the Augmented Deposition technology has been developed to provide users with a highly safe 3D printer. The Rize 3D printer produces absolutely zero harmful emissions. The company has enhanced this aspect by selecting material compatibility based on material emission rate measurement. The components of Rize's material, Rizium One, are all (FDA) USP Class VI approved and can be recycled.

Best Practice:

Frost & Sullivan recognizes that Rize eliminates the challenges faced by the majority of polymer additive manufacturing manufacturers by slashing production lead times and providing a well-assessed enterprise additive manufacturing platform to print zero-emission polymer materials, as well as a variety of other materials.

Rize designed the Augmented Deposition platform for integration with an industrial desktop 3D printer as an easy-to-operate, safe-to-handle machine that ensures part security in terms of IP and part strength. The hybridization of conventional techniques to deliver a versatile additive technology means this method can be employed by novice 3D printing users on demand at the point of consumption, cost-effectively and with minimal effort.

Frost & Sullivan is impressed with Rize for its ability to cater to the needs of the global manufacturing industry by providing highly functional 3D printing materials, which enables the company to boost its global presence in the additive manufacturing arena.

Visionary Innovation

Within the 3D printing industry, the majority of designs and materials developed are based on subtractive manufacturing and fine-tuned to suit additive manufacturing.

The unique and most attractive feature of Rize's additive manufacturing technology is its ability to change properties at a fine grain-level, also known as the voxel level. The hybrid and innovative Augmented Deposition technology by Rize can inject a variety of materials at the voxel level and even change the properties of thermoplastic materials at this level. As such, Rize 3D printer users are able to print parts that have unique material properties.

Voxel-level printing and voxel-level modification represent the single most significant innovation developed by Rize that creates opportunities to transform the additive manufacturing industry. In fact, the capability to change material properties on the go and create diverse types of materials and parts is only possible using voxel-level control. This power over 3D printing will widen the technology scope and market penetration, enabling it to be used for applications such as circuitry inside electronic parts or enhancing existing parts by integrating additional features.

Frost & Sullivan recognizes that voxel-level control enabled by the Augmented Deposition process is truly a unique technology feature that will catalyze the future of the additive manufacturing industry.

Application Diversity

The technology provided by Rize offers solutions to industries where small-scale as well as large-scale component manufacturing is necessary. The Augmented Deposition technology that powers the Rize One 3D printer is a single platform proprietary solution that provides industrial users with an easy-to-use desktop solution. Some of the industries impacted and applications include the following.

- **Manufacturing:** There is high potential for tooling, fixtures, and jig manufacturers. HMS Industries, Inc., a manufacturer of custom metal stamping and industrial tooling, has adopted the Rize One 3D printer. The 3D printer has enabled the customer to print parts on demand, reducing labor costs and improving productivity by up to 2 days per

fixture. The technology has also improved the cost of manufacturing a product from $1,000 to $40 per fixture, boosting company efficiency.

Life Sciences: The Rize 3D printer also finds opportunities in the life sciences sector to produce functional pre-clinical parts. The Rize printers use medical-grade Rizium One material. Each of the components of Rizium One is USP Class VI Certified (non-contaminated) and have been made resistant to chemicals such as alcohol, acid, and acetone. Companies such as CONMED have adopted the Rize 3D printer to produce unique mixing devices, medical instruments, molds for producing elastomeric products and more that are commonly used for applications such as testing drugs and for clinical purposes.

Aerospace and Defense: The opportunity in the aerospace industry is wide as the Augmented Deposition technology replaces traditional polymer manufacturing techniques by providing a zero-emission printing platform. The use of strong, thermoplastic material enables the Rize One 3D printer to be suitable for high-end prototyping and to print functional custom and replacement parts in the field. NASA, the US Army, and the US Navy are Rize customers.

Automotive: The enormous time and cost savings enabled by the adoption of a Rize 3D printer will have a very high impact in the automotive sector. Elimination of the post processing stage after 3D printing will enable automotive manufacturers to produce lightweight functional parts instantly on the production floor or in the lab within hours instead of weeks.

Education: The Rize 3D printer has found opportunity in the education sector as the Augmented Deposition technology provides a completely safe, clean, and easy-to-use 3D printer platform for students. The Rize One desktop industrial 3D printer was adopted by FIRST (For Inspiration and Recognition of Science and Technology) a global, non-profit youth organization that encourages young students to engage in programs that allow them to develop their science and engineering skills.

Frost & Sullivan finds that Rize's Augmented Deposition additive manufacturing technology and 3D printer offer a competitive advantage over its peers by eliminating the laborious, messy, and time-consuming post-processing stage in the form of an easy-to-use, safe platform.

Customer Acquisition

Rize has successfully emerged as one of the forerunners in developing a 3D printer that provides strength in all axes of the items produced. The company has demonstrated its novel technology, materials, and platform at the RAPID Conference, one of the largest additive manufacturing conferences held in North America that allows technology start-ups to establish business connections with potential clients in their respective industries.

Additionally, Rize has participated in the Consumer Electronics Show® (CES) to gain interest from original equipment manufacturers (OEMs) who are willing to adopt advanced technological solutions to reduce high initial investment costs, prototype production time, and improve manufacturing productivity.

Rize is expanding its customer base by launching its technology and product across the globe in countries such as Singapore, India, South Korea, and the Netherlands to capture customers mainly from the life sciences, aerospace and defense, and general manufacturing (e.g., automotive and industrial), sectors that will adopt advanced manufacturing technology solutions for maximum utilization.

The initiative to spread awareness about its innovative technology at global conferences and to attract customers from numerous industries worldwide enables Rize to best position itself among the top competitors in the additive manufacturing market.

Conclusion

Rize has overcome key challenges in the additive manufacturing arena, such as complex, costly and unsafe processes, insufficient material properties, lack of authenticity, and lack of high strength. This innovative company has identified and met the industry's most pressing needs commendably using its patented Augmented Deposition technology. The technology is safe, cost-effective, improves productivity, and has been proven feasible to print a single part with varying material properties at the voxel level. This breakthrough will enable the company to expand its opportunity across various industries, including automotive, aerospace, life sciences, consumer goods, building and construction, and retail.

With a business strategy anchored to demonstrating its additive manufacturing material expertise globally and a dedicated team focused on cutting-edge research, Rize has positioned itself as a leading player in the emission-free polymer additive manufacturing industry.

For its strong overall performance, Rize has earned Frost & Sullivan's 2018 Zero-Emission Polymer Material Additive Manufacturing Industry Innovation Award in the North American region.

Significance of Technology Innovation

Ultimately, growth in any organization depends upon finding new ways to excite the market and upon maintaining a long-term commitment to innovation. At its core, technology innovation, or any other type of innovation, can only be sustained with leadership in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.

Understanding Technology Innovation

Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole.

Key Benchmarking Criteria

For the Technology Innovation Award, Frost & Sullivan analysts independently evaluated two key factors—Technology Attributes and Future Business Value—according to the criteria identified below.

Technology Attributes

Criterion 1: Industry Impact
Criterion 2: Product Impact
Criterion 3: Scalability
Criterion 4: Visionary Innovation
Criterion 5: Application Diversity

Future Business Value

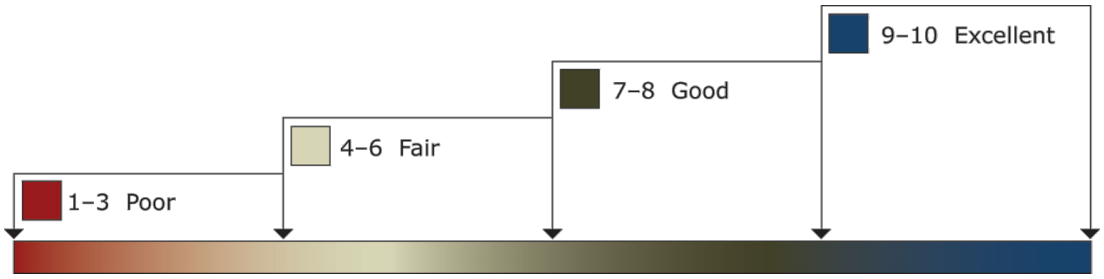
Criterion 1: Financial Performance
Criterion 2: Customer Acquisition
Criterion 3: Technology Licensing
Criterion 4: Brand Loyalty
Criterion 5: Human Capital

Best Practices Award Analysis for Rize Inc.

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 Technology Attributes and Future Business Value (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.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Innovation	Technology Attributes	Future Business Value	**Average Rating**
Rize Inc.	**9.00**	**8.00**	**8.5**
Competitor 2	7.25	8.50	7.8
Competitor 3	8.00	7.25	7.6

Technology Attributes

Criterion 1: Industry Impact

Requirement: Technology enables the pursuit of groundbreaking ideas, contributing to the betterment of the entire industry.

Criterion 2: Product Impact

Requirement: Specific technology helps enhance features and functionalities of the entire product line for the company.

Criterion 3: Scalability

Requirement: Technology is scalable, enabling new generations of products over time, with increasing levels of quality and functionality.

Criterion 4: Visionary Innovation

Requirement: Specific new technology represents true innovation based on a deep understanding of future needs and applications.

Criterion 5: Application Diversity

Requirement: New technology serves multiple products, multiple applications, and multiple user environments.

Future Business Value

Criterion 1: Financial Performance

Requirement: Potential is high for strong financial performance in terms of revenues, operating margins, and other relevant financial metrics.

Criterion 2: Customer Acquisition

Requirement: Specific technology enables acquisition of new customers, even as it enhances value to current customers.

Criterion 3: Technology Licensing

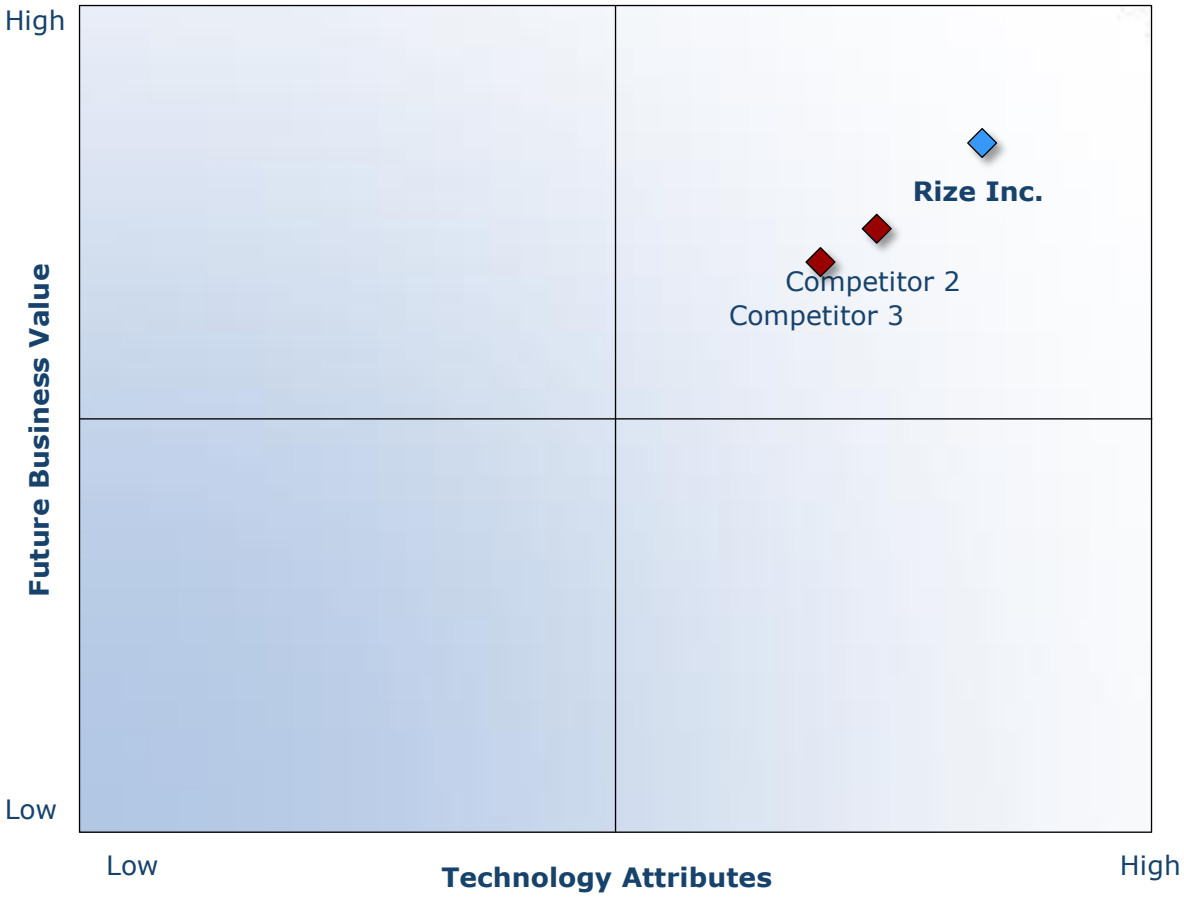
Requirement: New technology displays great potential to be licensed across many sectors and applications, thereby driving incremental revenue streams.

Criterion 4: Brand Loyalty
Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

Criterion 5: Human Capital
Requirement: Customer impact is enhanced through the leverage of specific technology, translating into positive impact on employee morale and retention.

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. (the axis points below should be in the chart)



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	• 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	• 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	• 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	• 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	• 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-practice Award recipient	• 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	• 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 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.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS

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.