**UNITED STATES**
**SECURITIES AND EXCHANGE COMMISSION**
**Washington, D.C. 20549**

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**FORM 10-K**

☒ **Annual report pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934**
**For the fiscal year ended December 31, 2019**
**or**
☐ **Transition report pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934**

**For the transition period from to**
**Commission File Number 001-33957**

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**HARVARD BIOSCIENCE, INC.**
(Exact Name of Registrant as Specified in Its Charter)

| **Delaware** | **04-3306140** |
|---|---|
| (State or other jurisdiction of Incorporation or organization) | (I.R.S. Employer Identification No.) |

**84 October Hill Road, Holliston, Massachusetts 01746**
(Address of Principal Executive Offices, including zip code)

**(508) 893-8999**
(Registrant's telephone number, including area code)
Securities registered pursuant to Section 12(b) of the Act:

| Title of each class | Trading Symbol(s) | Name of each exchange on which registered |
|---|---|---|
| Common Stock, $0.01 par value | HBIO | The NASDAQ Global Market |

Securities registered pursuant to Section 12(g) of the Act:
**None**

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. YES ☐ NO ☒

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. YES ☐ NO ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days.
YES ☒ NO ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). ☒ YES ☐ NO

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act. (Check one):

Large accelerated filer ☐
Non-accelerated filer ☐
Accelerated filer ☒
Smaller reporting company ☒
Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act. YES ☐ NO ☒

The aggregate market value of 36,265,029 shares of voting common equity held by non-affiliates of the registrant as of June 30, 2019 was approximately $72,530,058 based on the closing sales price of the registrant's common stock, par value $0.01 per share on that date. Shares of the registrant's common stock held by each officer and director and each person known to the registrant to own 10% or more of the outstanding voting power of the registrant have been excluded in that such persons may be deemed affiliates. This determination of affiliate status is not a determination for other purposes. The registrant has no shares of non-voting common stock authorized or outstanding.

At March 6, 2020, there were 38,347,658 shares of the registrant's common stock issued and outstanding.

**DOCUMENTS INCORPORATED BY REFERENCE**

Portions of the Company's definitive Proxy Statement in connection with the 2020 Annual Meeting of Stockholders (the "Proxy Statement"), to be filed within 120 days after the end of the Registrant's fiscal year, are incorporated by reference into Part III of this Form 10-K. Except with respect to information specifically incorporated by reference in this Form 10-K, the Proxy Statement is not deemed to be filed as part hereof.

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*This Annual Report on Form 10-K contains statements that are not statements of historical fact and are forward-looking statements within the meaning of Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934 (the "Exchange Act"), each as amended. The forward-looking statements are principally, but not exclusively, contained in "Item 1: Business" and "Item 7: Management's Discussion and Analysis of Financial Condition and Results of Operations." These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. Forward-looking statements include, but are not limited to, statements about management's confidence or expectations, our business strategy, our ability to raise capital or borrow funds to consummate acquisitions and the availability of attractive acquisition candidates, our expectations regarding future costs of product revenues, our anticipated compliance with the covenants contained in our credit facility, the adequacy of our financial resources and our plans, objectives, expectations and intentions that are not historical facts. In some cases, you can identify forward-looking statements by terms such as "may," "will," "should," "could," "would," "seek," "expects," "plans," "aim," "anticipates," "believes," "estimates," "projects," "predicts," "intends," "think," "strategy," "potential," "objectives," "optimistic," "new," "goal" and similar expressions intended to identify forward-looking statements. These statements reflect our current views with respect to future events and are based on assumptions and subject to risks and uncertainties. Given these uncertainties, you should not place undue reliance on these forward-looking statements. We discuss many of these risks in detail under the heading "Item 1A. Risk Factors" beginning on page 7 of this Annual Report on Form 10-K. You should carefully review all of these factors, as well as other risks described in our public filings, and you should be aware that there may be other factors, including factors of which we are not currently aware, that could cause these differences. Also, these forward-looking statements represent our estimates and assumptions only as of the date of this report. We may not update these forward-looking statements, even though our situation may change in the future, unless we have obligations under the federal securities laws to update and disclose material developments related to previously disclosed information. Harvard Bioscience, Inc. is referred to herein as "we," "our," "us," and "the Company."*

## PART I

### Item 1. *Business.*

### Overview

Harvard Bioscience, Inc., a Delaware corporation, is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and pre-clinical testing for drug development. Our customers range from renowned academic institutions and government laboratories, to the world's leading pharmaceutical, biotechnology and clinical research organizations. With operations in North America and Europe, we sell through a combination of direct and distribution channels to customers around the world.

### Our History and Strategy

Our business began in 1901 under the name Harvard Apparatus. It was founded by Dr. William T. Porter, a Professor of Physiology at Harvard Medical School and a pioneer of physiology education. We have grown over the years with the development and evolution of modern life science research and education. Our early inventions included ventilators based on Dr. Porter's design, the mechanical syringe pump for drug infusion in the 1950s, and the microprocessor controlled syringe pump in the 1980s.

In March of 1996, a group of investors acquired a majority of the then existing business of our predecessor, Harvard Apparatus, Inc. Following this acquisition, our focus was redirected to acquiring complementary companies with innovative technologies while continuing to grow the existing business through internal product development. Since 1996, we have completed multiple business or product line acquisitions related to our continuing operations.

Most recently, in January 2018, we acquired Data Sciences International, Inc. (DSI) for approximately $71.1 million. DSI, a St. Paul, Minnesota-based life science research company, is a recognized leader in physiologic monitoring focused on delivering preclinical products, systems, services and solutions to its customers. Its customers include pharmaceutical and biotechnology companies, as well as contract research organizations, academic labs and government researchers. This acquisition diversified our customer base deeper into the biopharmaceutical and contract research organization markets. The acquisition also provided opportunities to generate meaningful cost and revenue synergies.

In recent years, we continuously looked for opportunities to reduce operating costs, align global functions, optimize our global footprint, divest non-core businesses and reinvest in key areas such as sales and marketing and new product development. As part of these efforts, during the first quarter of 2018, we sold substantially all the assets of our wholly-owned subsidiary, Denville Scientific, Inc. (Denville). Denville was a laboratory products supplier that was no longer core to our strategy.

On July 8, 2019, we announced the departure of the previous President and Chief Executive Officer and the appointment by the Board of Directors of James Green as President and Chief Executive Officer. In addition, on July 18, 2019 we announced the appointment of Michael Rossi as Chief Financial Officer.

Immediately after the appointment of Mr. Green and Mr. Rossi, we began a process to identify opportunities to improve profitability, increase cash flow and enhance internal capabilities to position the business for organic growth. As a result of this assessment, in September 2019 we announced a strategic action plan and financial targets for 2020 and 2021. Key elements of this plan include:

- Capitalizing on the strong existing Harvard Bioscience and Data Science franchises and products;
- Adding new senior leadership with significant experience with turnarounds and driving growth and operational improvements within global, middle market life science manufacturing businesses;
- Consolidation of sub-scale operations and integration of existing functions and processes to drive scale and reduce fixed costs;
- Increasing effectiveness of sales and product management to deliver organic sales growth;
- Improve cash flow and reduce debt.

During the three months ended December 31, 2019, we committed to a restructuring program to deliver significant cost savings beginning in 2020 and support delivery of the strategic action plan communicated in September 2019. The restructuring program was initiated in the fourth quarter of 2019, and includes consolidation of our Connecticut manufacturing plant to our existing Massachusetts site, downsizing of operations in the United Kingdom and a reduction in force across the business amounting to a 10% reduction in headcount. A portion of the savings generated will be reinvested to drive profitable growth.

We believe these strategic actions will significantly improve our profitability and position the business for improved organic revenue growth in 2021. We do not expect to pursue new acquisitions until the operational and commercial improvement elements of the strategic action plan are achieved.

**Our Products**

Historically, our products have been marketed and sold under three commercial product families: Physiology, Cell, Molecular Instruments (PCMI), Data Sciences International (DSI), and Electrophysiology (Ephys). In 2019, as part of the strategic action plan we consolidated PCMI and Ephys into a single product family, Cellular and Molecular Technologies (CMT) focused primarily on technologies supporting new drug discovery and development. Our CMT products are primarily sold to academic and government institutions. DSI products support the pre-clinical research phase of drug development. DSI remains a separate product family, now called Pre-Clinical products. Our pre-clinical products are primarily sold to pharmaceutical, biotechnology and clinical research organizations.

We primarily sell our products under several brand names, including Harvard Apparatus, DSI, Ponemah, Buxco, Biochrom, BTX, and MCS.

Our products consist of instruments, consumables, systems and software. Our products include scientific instruments such as spectrophotometers and plate readers that analyze light to detect and quantify a wide range of molecular and cellular processes, or apparatus like gel electrophoresis units. Other products and services are wireless monitors, data acquisition and analysis products and software, and ancillary services including post-contract customer support, training and installation. Sales prices of these products and services range from under $100 to over $100,000.

In addition to our proprietary manufactured products, we sell many products that are made by other manufacturers. These distributed products accounted for approximately 16% of our revenues for the year ended December 31, 2019. Distributed products enable us to provide our customers with a single source for their research needs, and consist of a large variety of devices, instruments and consumable items used in experiments involving fluid handling, molecular and cell biology, tissue, organ and animal research. Many of our proprietary manufactured products are leaders in their fields; however, researchers often need complementary products in order to conduct particular experiments. Following is a description of each product family.

***Cellular and Molecular Technologies Product Family***

Our CMT product family includes products designed primarily to support the discovery phase of new drug development.

CMT products include our syringe pump and peristaltic pump product lines, as well as a broad range of instruments and accessories for tissue, organ and animal-based lab research, including surgical products, infusion systems, and behavior research systems.

The CMT product family also includes spectrophotometers, microplate readers, amino acid analyzers, gel electrophoresis equipment, electroporation and electrofusion instruments which primarily support molecular level testing and research.

We also develop and manufacture precision scientific measuring instrumentation and equipment in the field of electrophysiology including:

- Data acquisition systems, for use with custom amplifier configurations.
- Complete in vivo-systems, the solution for in vivo recordings with microelectrode arrays.
- Complete in vitro-systems for extracellular recordings from microelectrode arrays in vitro.

Our CMT product family made up approximately 63% of our global revenues for the year ended December 31, 2019.

***Pre-Clinical Products Family***

Our Pre-Clinical product family provides a complete preclinical platform to assess physiological data for research ranging from basic research, to drug discovery, and drug development services. The Pre-Clinical product family consists of the DSI and Buxco brands.

Our Pre-Clinical products and provides services for monitoring physiological parameters of animal models used in biomedical research including:

- The most comprehensive portfolio of implantable and externally-worn telemetry systems. These are commonly used in research to collect cardiovascular, central nervous system, respiratory, metabolic data.
- Turn-key respiratory system solutions encompassing plethysmograph chambers, data acquisition hardware, physiological signal analysis software, and final report generation.
- Inhalation and exposure systems providing precise, homogenous aerosol delivery for up to 42 subjects, while integrating respiratory parameters for the ultimate Delivered Dose system.
- Powerful, GLP-capable data acquisition and analysis systems, capable of integrating third party sensors for a more comprehensive study design.

DSI’s direct sales force supports North America, Europe, and China, with distributors supporting the rest of the world. Our Pre-Clinical products made up approximately 37% of our global revenues for the year ended December 31, 2019.

**Our Customers**

Our end-user customers are primarily research scientists at pharmaceutical and biotechnology companies, universities, hospitals, government laboratories, including the United States National Institute of Health (NIH), and contract research organizations (CROs). Our pharmaceutical and biotechnology customers have included pharmaceutical companies and research laboratories such as Pfizer, Amgen, Inc., AstraZeneca plc, Genentech, Inc. and Johnson & Johnson. Our academic customers include major colleges and universities such as Harvard University, Cambridge University, Johns Hopkins University, Massachusetts Institute of Technology, Yale University, the University of California system, Baylor College of Medicine, and the University of Texas - MD Anderson Center. Our CRO customers include Covance and Charles River Laboratories. We have a wide range of diverse customers worldwide and no customer accounted for more than 10% of our revenues in 2019.

**Sales and Marketing**

We conduct direct sales in the United States, the United Kingdom, Germany, France, Italy, Spain, Sweden, Canada and China. We sell primarily through distributors in other countries. For the year ended December 31, 2019, revenues from direct sales to end-users represented approximately 70% of our revenues; and revenues from sales of our products through distributors represented approximately 30% of our revenues.

***Direct Sales***

We have a global sales organization managing both direct sales and distributors. Our websites and catalogs serve as the primary sales tool for our product lines, which includes both proprietary manufactured products and complementary products from various suppliers. Our reputation as a leading producer of many of our manufactured products creates traffic to our websites, enables cross-selling and facilitates the introduction of new products.

***Distributors***

We engage distributors for the sales of our own branded and private label products in certain areas of the world and for certain product lines.

**Research and Development**

Our principal research and development mission is to develop products that address growth opportunities within the life science research process, as well as to maintain and optimize our existing product portfolios. We maintain development staff in many of our manufacturing facilities to design and develop new products and to re-engineer existing products to bring them to the next generation. Our research and development expenses from continuing operations were approximately $10.7 million, and $11.0 million for the years ended December 31, 2019 and 2018, respectively. We anticipate that we will continue to make investments in research and development activities as we deem appropriate. We plan to continue to pursue a balanced development portfolio strategy of originating new products from internal research and acquiring products through business and technology acquisitions.

**Manufacturing**

We manufacture and test the majority of our products in our principal manufacturing facilities located in the United States, Sweden, Spain and Germany. We have considerable manufacturing flexibility at our various facilities, and each facility can manufacture multiple products at the same time. We maintain in-house manufacturing expertise, technologies and resources. We seek to maintain multiple suppliers for key components that are not manufactured in-house, and while some of our products are dependent on sole-source suppliers, we do not believe our dependence upon these suppliers creates any significant risks. Our manufacturing operations primarily involve assembly and testing activities along with some machine based processes. Going forward we will continue to evaluate our manufacturing facilities and operations in order to optimize our manufacturing footprint.

See Part 1, Item 2. Of this report – “Properties” for additional information regarding our manufacturing facilities.

**Competition**

The markets into which we sell our products are highly competitive, and we expect the intensity of competition to continue or increase. We compete with many companies engaged in developing and selling tools for life science research. Many of our competitors have greater financial, operational, sales and marketing resources, and more experience in research and development and commercialization than we have. Moreover, our competitors may have greater name recognition than we do, and many offer discounts as a competitive tactic. These competitors and other companies may have developed or could in the future develop new technologies that compete with our products, which could render our products obsolete. We cannot assure you that we will be able to make the enhancements to our technologies necessary to compete successfully with newly emerging technologies. We believe that we offer one of the broadest selections of products to organizations engaged in life science research. We have numerous competitors on a product line basis. We believe that we compete favorably with our competitors on the basis of product performance, including quality, reliability and speed, technical support, price and delivery time.

We compete with several companies that provide instruments for life science research including, Lonza Group Ltd., Becton Dickinson, Eppendorf AG, Kent Scientific Corporation, Razel Scientific Instruments, Inc., Ugo Basile, Danaher Corporation, Bio-Rad Laboratories, Inc., PerkinElmer, Inc., Thermo Fisher Scientific, Inc. Notocord, Emka Technologies and TSE Systems.

We cannot forecast if or when these or other companies may develop competitive products. We expect that other products will compete with our products and potential products based on efficacy, safety, cost and intellectual property positions. While we believe that these will be the primary competitive factors, other factors include, in certain instances, availability of supply, manufacturing, marketing and sales expertise and capability.

**Seasonality**

Sales and earnings in our third quarter are usually flat or down from the second quarter primarily because there are a large number of holidays and vacations during such quarter, especially in Europe. Our fourth quarter revenues and earnings are often the highest in any fiscal year compared to the other three quarters, primarily because many of our customers tend to spend budgeted money before their own fiscal year ends.

**Intellectual Property**

To establish and protect our proprietary technologies and products, we rely on a combination of patent, copyright, trademark and trade-secret laws, as well as confidentiality provisions in our contracts. Patents or patent applications cover certain of our new technologies. Most of our more mature product lines are protected by trade names and trade secrets only.

We have implemented a patent strategy designed to provide us with freedom to operate and facilitate commercialization of our current and future products. Our success depends, to a significant degree, upon our ability to develop proprietary products and technologies. We intend to continue to file patent applications as we develop new products and technologies.

Patents provide some degree of protection for our intellectual property. However, the assertion of patent protection involves complex legal and factual determinations and is therefore uncertain. The scope of any of our issued patents may not be sufficiently broad to offer meaningful protection. In addition, our issued patents or patents licensed to us may be successfully challenged, invalidated, circumvented or unenforceable so that our patent rights would not create an effective competitive barrier. Moreover, the laws of some foreign countries may protect our proprietary rights to a greater or lesser extent than the laws of the United States. In addition, the laws governing patentability and the scope of patent coverage continue to evolve, particularly in areas of interest to us. As a result, there can be no assurance that patents will be issued from any of our patent applications or from applications licensed to us. As a result of these factors, our intellectual property positions bear some degree of uncertainty.

We also rely in part on trade-secret protection of our intellectual property. We attempt to protect our trade secrets by entering into confidentiality agreements with third parties, employees and consultants. Our employees and consultants also sign agreements requiring that they assign to us their interests in patents and copyrights arising from their work for us. Although many of our United States employees have signed agreements not to compete unfairly with us during their employment and after termination of their employment, through the misuse of confidential information, soliciting employees, soliciting customers and the like, the enforceability of these provisions varies from jurisdiction to jurisdiction and, in some circumstances, they may not be enforceable. In addition, it is possible that these agreements may be breached or invalidated and if so, there may not be an adequate corrective remedy available. Despite the measures we have taken to protect our intellectual property, we cannot assure you that third parties will not independently discover or invent competing technologies or reverse engineer our trade secrets or other technologies. Therefore, the measures we are taking to protect our proprietary rights may not be adequate.

We do not believe that our products infringe on the intellectual property rights of any third party. We cannot assure you, however, that third parties will not claim such infringement by us or our licensors with respect to current or future products. We expect that product developers in our market will increasingly be subject to such claims as the number of products and competitors in our market segment grows and the product functionality in different market segments overlaps. In addition, patents on production and business methods are becoming more common and we expect that more patents will be issued in our technical field. Any such claims, with or without merit, could be time-consuming, result in costly litigation and diversion of management's attention and resources, cause product shipment delays or require us to enter into royalty or licensing agreements. Moreover, such royalty or licensing agreements, if required, may not be on terms advantageous to us, or acceptable at all, which could seriously harm our business or financial condition.

"Harvard" is a registered trademark of Harvard University. The marks "Harvard Apparatus" and "Harvard Bioscience" are being used pursuant to a license agreement entered into in December 2002 between us and Harvard University.

**Government Regulation**

We are not subject to direct governmental regulation other than the laws and regulations generally applicable to businesses in the domestic and foreign jurisdictions in which we operate. In particular, our current products are not subject to pre-market approval by the United States Food and Drug Administration ("FDA") for use on human clinical patients. In addition, we believe we are currently in compliance with all relevant environmental laws.

**Employees**

As of December 31, 2019, we employed 505 employees. Some of our employees in Europe have statutory collective bargaining rights. We have never experienced a general work stoppage or strike, and management believes that our relations with our employees are good. Geographical residence information for these employees is summarized in the table below:

**As of December 31, 2019**

| | |
|---|---|
| United States | 301 |
| Germany | 96 |
| United Kingdom | 41 |
| Spain | 28 |
| China | 16 |
| Rest of World | 23 |
| Total | 505 |

**Geographic Area**

Financial information regarding geographic areas in which we operate is provided in Note 22 in the Consolidated Financial Statements included in Part IV, Item 15. of this report "Exhibits, Financial Statement Schedules."

**Available Information and Website**

Our website address is www.harvardbioscience.com. Our Annual Report on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K, and exhibits and amendments to those reports filed or furnished with the Securities and Exchange Commission pursuant to Section 13(a) of the Exchange Act are available for review on our website and the Securities and Exchange Commission's website at www.sec.gov. Any such materials that we file with, or furnish to, the SEC in the future will be available on our website as soon as reasonably practicable after they are electronically filed with, or furnished to, the SEC. The information on our website is not incorporated by reference into this Annual Report on Form 10-K.

**Item 1A.** ***Risk Factors.***

*The following factors should be reviewed carefully, in conjunction with the other information contained in this Annual Report on Form 10-K. As previously discussed, our actual results could differ materially from our forward-looking statements. Our business faces a variety of risks. These risks include those described below and may include additional risks and uncertainties not presently known to us or that we currently deem immaterial. If any of the events or circumstances described in the following risk factors occur, our business operations, performance and financial condition could be adversely affected and the trading price of our common stock could decline.*

***Reductions in customers' research budgets or government funding may adversely affect our business.***

Many of our customers representing a significant portion of our revenues are universities, government research laboratories, private foundations and other institutions who are dependent for their funding upon grants from U.S. government agencies, such as the United States National Institutes of Health (NIH), and similar agencies in other countries. Research and development spending of our customers can fluctuate based on spending priorities and general economic conditions. The level of government funding of research and development is unpredictable. There have been instances where NIH grants have been frozen or otherwise unavailable for extended periods or directed for certain products. Any reduction or delay in governmental spending could cause our customers to delay or forego purchases of our products. If government funding necessary to purchase our products were to decrease, our business and results of operations could be materially adversely affected. Spending by some of these customers fluctuates based on budget allocations and the timely passage of the annual federal budget. An impasse in federal government budget decisions could lead to substantial delays or reductions in federal spending.

***With respect to acquisitions we have completed or may seek to consummate in the future, we have and will incur a variety of costs, and may never realize the anticipated benefits of the acquisitions due in part to difficulties integrating the businesses, operations and product lines.***

Our business strategy includes the acquisition of businesses, technologies, services or products that we believe are a strategic fit with our business. Most recently, in January 2018, we completed the acquisition of Data Sciences International, Inc., (DSI) a privately held physiologic monitoring business with headquarters in St. Paul, Minnesota. If we undertake any future acquisition, the process of integrating the acquired business, technology, service or product may result in unforeseen operating difficulties and expenditures and may absorb significant management attention that would otherwise be available for ongoing development of our business. Moreover, we may fail to realize the anticipated benefits of any acquisition as rapidly as expected or at all. Such transactions are inherently risky, and any such recent or future acquisitions could reduce stockholders' ownership, cause us to incur debt, expose us to future liabilities and result in amortization expenses related to intangible assets with definite lives, which may adversely impact our ability to undertake future acquisitions on substantially similar terms. We may also incur significant expenditures in anticipation of an acquisition that is never realized.

Our ability to achieve the benefits of acquisitions depends in part on the integration and leveraging of technology, operations, sales and marketing channels and personnel. The integration process is a complex, time-consuming and expensive process and may disrupt our business if not completed in a timely and efficient manner. We may have difficulty successfully integrating acquired businesses, and their domestic and foreign operations or product lines, and as a result, we may not realize any of the anticipated benefits of the acquisitions we make. We cannot assure that our growth rate will equal the growth rates that have been experienced by us and these and other acquired companies, respectively, operating as separate companies in the past.

***We have substantial debt and other financial obligations and we may incur even more debt. Any failure to meet our debt and other financial obligations or maintain compliance with related covenants could harm our business, financial condition and results of operations.***

We have substantial debt and other financial obligations and significant unused borrowing capacity. On January 31, 2018, we entered into a Financing Agreement with Cerberus Business Finance, LLC, as agent and lender (the Financing Agreement). As of December 31, 2019, we had borrowings of $55.0 million under the Financing Agreement. The Financing Agreement includes financial covenants relating to leverage and fixed charges, as well as other customary affirmative and negative covenants, including limitations on our ability to incur additional indebtedness and requires lender approval for acquisitions funded with cash, promissory notes and/or other consideration in excess of $1.0 million and for acquisitions in excess of $0.5 million.

If we are not in compliance with certain of these covenants, in addition to other actions the creditor may require, the amounts outstanding under the Financing Agreement may become immediately due and payable. This immediate payment may negatively impact our financial condition. In addition, any failure to make scheduled payments of interest and principal on our outstanding indebtedness would likely harm our ability to incur additional indebtedness on acceptable terms. Our cash flow and capital resources may be insufficient to pay interest and principal on our debt in the future. If that should occur, our capital raising or debt restructuring measures may be unsuccessful or inadequate to meet our scheduled debt service obligations, which could cause us to default on our obligations and further impair our liquidity.

For example, on November 4, 2019, we entered into a Second Amendment of the Financing Agreement with Cerberus Business Finance, LLC, as collateral agent for the Lenders, and PNC Bank, National Association, as administrative agent for the Lenders which increased the maximum leverage ratio and amount of restructuring and related costs to be excluded from consolidated EBITDA and decreased the minimum fixed charge ratio. Such second amendment was effective for covenant calculations commencing with the period ended September 30, 2019, other than the change in minimum fixed charge ratio which is effective beginning the three months ended December 31, 2019. Prior to this second amendment, we exceeded the maximum leverage ratio covenant due primarily to costs associated with the resignation of the previous CEO in July 2019 and certain restructuring activity in the period. We are compliant with all covenants under the Financing Agreement as of December 31, 2019 with the completion of such second amendment.

The obligations under the Financing Agreement and related guarantees are secured on a first-priority basis (subject to certain liens permitted under the Financing Agreement) by a lien on substantially all the tangible and intangible assets of our company and the subsidiary guarantors, including all of the capital stock held by such obligors, subject to a 65% limitation on pledges of capital stock of certain foreign subsidiaries and certain other exceptions. Our Financing Agreement and related obligations:

- Require us to dedicate significant cash flow to the payment of principal and interest on our debt, which reduces the funds we have available for other purposes;

- May limit our flexibility in planning for or reacting to changes in our business and market conditions or funding our strategic growth plan;
- Impose on us additional financial and operational restrictions;
- Expose us to interest rate risk since a portion of our debt obligations is at variable rates (which is mitigated to a certain extent, by interest rate hedging transactions we entered into in connection with our Financing Agreement); and
- Restrict our ability to fund certain acquisitions.

In addition, investors may be apprehensive about investing in companies such as ours that carry a substantial amount of leverage on their balance sheets, and this apprehension may adversely affect the price of our common stock.

Further, based upon our actual performance levels, our covenants relating to leverage and fixed charges could limit our ability to incur additional debt, which could hinder our ability to execute our current business strategy.

Our ability to make scheduled payments on our debt and other financial obligations and comply with financial covenants depends on our financial and operating performance. Our financial and operating performance will continue to be subject to prevailing economic conditions and to financial, business and other factors, some of which are beyond our control. Failure within any applicable grace or cure periods to may such payments, comply with the financial covenants, or any other non-financial or restrictive covenant, would create a default under our Financing Agreement. The maturity date with respect to the loans under the Financing Agreement is currently January 31, 2023. Our cash flow and existing capital resources may be insufficient to repay our debt at maturity, in which such case prior thereto we would have to extend such maturity date, or otherwise repay, refinance and or restructure the obligations under the Financing Agreement, including with proceeds from the sale of assets, and additional equity or debt capital. If we are unsuccessful in obtaining such extension, or entering into such repayment, refinance or restructure prior to maturity, or any other default existed under the Financing Agreement, our lenders could accelerate the indebtedness under the Financing Agreement, foreclose against their collateral or seek other remedies, which would jeopardize our ability to continue our current operations.

***A portion of our revenues are derived from customers from the pharmaceutical and biotechnology industries and are subject to risks faced by those industries. Such risks may adversely affect our financial results.***

We derive a significant portion of our revenues from pharmaceutical and biotechnology companies. We expect that pharmaceutical and biotechnology companies will continue to be a significant source of our revenues for the foreseeable future, including in our Cellular and Molecular Technologies and Pre-Clinical Systems commercial product families. As a result, we are subject to risks and uncertainties that affect the pharmaceutical and biotechnology industries, such as government regulation, ongoing consolidation, uncertainty of technological change, and reductions and delays in research and development expenditures by companies in these industries.

In particular, the biotechnology industry is largely dependent on raising capital to fund its operations. If biotechnology companies that are our customers are unable to obtain the financing necessary to purchase our products, our business and results of operations could be adversely affected. In addition, we are dependent, both directly and indirectly, upon general health care spending patterns, particularly in the research and development budgets of the pharmaceutical and biotechnology industries, as well as upon the financial condition and purchasing patterns of various governments and government agencies. As it relates to both the biotechnology and pharmaceutical industries, many companies have significant patents that have expired or are about to expire, which could result in reduced revenues for those companies. If pharmaceutical or biotechnology companies that are our customers suffer reduced revenues as a result of these patent expirations, they may be unable to purchase our products, and our business and results of operations could be adversely affected.

***Customer, vendor and employee uncertainty about the effects of any of our acquisitions could harm us.***

The customers of any company we acquire, including DSI and others in the future, may, in response to the consummation of the acquisition, delay or defer purchasing decisions. Any delay or deferral in purchasing decisions by customers could adversely affect our business. Similarly, employees of acquired companies may experience uncertainty about their future role until or after we execute our post-acquisition strategies. This may adversely affect our ability to attract and retain key management, sales, marketing and technical personnel following an acquisition.

***Our business is subject to economic, political and other risks associated with international revenues and operations.***

We manufacture and sell our products worldwide and as a result, our business is subject to risks associated with doing business internationally. A substantial amount of our revenues is derived from international operations, and we anticipate that a significant portion of our sales will continue to come from outside the United States in the future. We anticipate that revenues from international operations will likely continue to increase as a result of our efforts to expand our business in markets abroad. In addition, a number of our manufacturing facilities and suppliers are located outside the United States. Our foreign operations subject us to certain risks, including: effects of fluctuations in foreign currency exchange rates (discussed below); the impact of local economic conditions; local product preferences and seasonality (discussed below) and product requirements; local difficulty to effectively establish and expand our business and operations in international markets; disruptions of capital and trading markets; restrictions and potentially negative tax implications of transfer of capital across borders; differing labor regulations; other factors beyond our control, including potential political instability, terrorism, acts of war, natural disasters and diseases, including the coronavirus discussed below; unexpected changes and increased enforcement of regulatory requirements and various state, federal and international, intellectual property, environmental, antitrust, anti-corruption, fraud and abuse (including anti-kickback and false claims laws) and employment laws; interruption to transportation flows for delivery of parts to us and finished goods to our customers; and laws and regulations on foreign investment in the United States under the jurisdiction of the Committee on Foreign Investment in the United States, or CFIUS, and other agencies, including the Foreign Investment Risk Review Modernization Act, or FIRRMA, adopted in August 2018.

Specifically with respect to the expansion of our business into China, our financial performance may be subject to the following risks, among others affecting companies that operate in China: the impact of declining economic growth in China; regulation of foreign investment and business activities by the Chinese government, including recent scrutiny of foreign companies, may limit our ability to expand our business in China; uncertainties with respect to the legal system in China may limit the legal protections available to us in China; government restrictions on the remittance of currency out of China and the ability of any subsidiary we may establish in China to pay dividends and make other distributions to us; potential unfavorable tax consequences as a result of our operations in China; and the recent outbreak of a novel strain of COVID-19 coronavirus, a respiratory illness,

The recent outbreak of coronavirus in China, North America, Europe, or other locations around the world, could adversely affect our workforce, supply chain and customer base, particularly those involving China and other affected regions. The outbreak of the coronavirus has caused several countries to implement quarantines and significant restrictions on travel, with many countries and airlines suspending flights to and from affected regions. In addition, certain affected regions have implemented work restrictions that prohibit many employees from going to work.

The extent to which the coronavirus will impact our business, results of operation or financial condition is difficult to assess at this stage as much depends on future developments, which are uncertain, including information concerning the severity of the coronavirus and the methods to contain and treat the virus. A significant interruption in our supply chains caused by any of the above factors could result in increased costs or delivery delays and result in a decrease in our net sales and profitability.

As a result of pandemic outbreaks, including the coronavirus, businesses can be shut down, supply chains can be interrupted, slowed, or rendered inoperable, and individuals can become ill, quarantined, or otherwise unable to work and/or travel due to health reasons or governmental restrictions. Governmental mandates may require forced shutdowns of our facilities for extended or indefinite periods. In addition, these widespread outbreaks of illness, particularly in China, North America, Europe, or other locations (especially Asia Pacific) significant to our operations, could adversely affect our workforce resulting in serious health issues and absenteeism. Pandemic outbreaks, including the coronavirus, could also substantially interfere with general commercial activity related to our supply chain and customer base, which could have a material adverse effect on our financial condition, results of operations, business, or prospects. If our operations are curtailed, we may need to seek alternate sources of supply for services and staff, which may be more expensive. Alternate sources may not be available or may result in delays in shipments to us from our supply chain and subsequently to our customers, each of which would affect our results of operations. Further, if our customers' businesses are similarly affected, they might delay or reduce purchases from us, which could adversely affect our results of operations.

***If we incur higher costs as a result of trade policies, treaties, government regulations or tariffs, we may become less profitable.***

There is currently significant uncertainty about the future relationship between the United States and China, including with respect to trade policies, treaties, government regulations and tariffs. The current U.S. administration has called for substantial changes to U.S. foreign trade policy including greater restrictions on international trade and significant increases in tariffs on goods imported into the U.S. Under the current status, we do not expect that this tariff will significantly impact any Harvard Bioscience products and thus the tariff should not have a material adverse effect on our business, financial condition or results of operations. We are unable to predict whether or when additional tariffs will be imposed or the impact of any such future tariff increases.

***Recently enacted U.S. government tax reform could have a negative impact on the results of future operations.***

On December 22, 2017, the President of the United States signed into law H.R. 1, originally known as the "Tax Cuts and Jobs Act", hereafter referred to as "the Tax Act", to be effective as of January 1, 2018. The Tax Act contained certain substantial changes to the Internal Revenue Code, some of which could have an adverse effect on our business. Among other things, the Tax Act reduces the U.S. corporate tax rate from 35% to 21%, imposes significant additional limitations on the deductibility of interest, and allows the expensing of capital expenditures. The Tax Act is highly complex and subject to interpretation. The presentation of our financial condition and results of operations is based upon our current interpretation of the provisions contained in the Tax Reform Act. The Treasury Department and the Internal Revenue Service continue to release regulations relating to and interpretive guidance of the legislation contained in the Tax Act. Any significant variance of our current interpretation of such legislation from any future regulations or interpretive guidance could result in a change to the presentation of our financial condition and results of operations and could negatively affect our business.

***Foreign currency exchange rate fluctuations may have a negative impact on our reported earnings.***

We are also subject to the risks of fluctuating foreign currency exchange rates, which could have an adverse effect on the sales price of our products in foreign markets, as well as the costs and expenses of our foreign subsidiaries. A substantial amount of our revenues is derived from international operations, and we anticipate that a significant portion of revenues will continue to come from outside the United States in the future. As a result, currency fluctuations among the United States dollar, British pound, euro and the other currencies in which we do business have caused and will continue to cause foreign currency translation and transaction gains and losses. We have not used forward exchange contracts to hedge our foreign currency exposures. We attempt to manage foreign currency risk through the matching of assets and liabilities. In the future, we may undertake to manage foreign currency risk through hedging methods, including foreign currency contracts. We recognize foreign currency gains or losses arising from our operations in the period incurred. We cannot guarantee that we will be successful in managing foreign currency risk or in predicting the effects of exchange rate fluctuations upon our future operating results because of the number of currencies involved, the variability of currency exposure and the potential volatility of currency exchange rates. We cannot predict with any certainty changes in foreign currency exchange rates or the degree to which we can address these risks.

***Economic conditions and regulatory changes caused by the United Kingdom's likely exit from the European Union could adversely affect our business.***

The House of Commons passed a Brexit deal on December 20, 2019 and the U.K. formally left the European Union on January 31, 2020. The U.K. is currently in a transition period until December 31, 2020, where agreements surrounding trade and other aspects of the U.K.'s future relationship with the European Union will need to be finalized. The announcement of Brexit has resulted in significant volatility in global stock market and currency exchange rate fluctuations that resulted in strengthening of the U.S. dollar relative to other foreign currencies in which we conduct business. The withdrawal of the U.K. from the E.U. may also create global economic uncertainty, including an uncertain funding environment for U.K. customers historically receiving funding from the E.U, which may cause our customers to reduce their spending budgets. The effects of Brexit will depend on any agreements the U.K. makes to retain access to E.U. markets either during the transitional period or more permanently. If the U.K. leaves the E.U. with no agreement, it will likely have an adverse impact on labor and trade in addition to creating further short-term uncertainty and currency volatility. Since a significant proportion of the regulatory framework in the U.K. is derived from E.U. directives and regulations, Brexit could materially change the regulatory regime applicable to the approval of any product candidates in the U.K. In addition, since the EMA is located in the U.K., the implications for the regulatory review process in the E.U. has not been clarified and could result in relocation of the EMA or a disruption in the EMA review process. Brexit is likely to lead to legal uncertainty and potentially divergent national laws and regulations as the U.K. determines which E.U. laws to replace or replicate. This could adversely affect our business, financial condition, operating results and cash flows.

***Domestic and global economic conditions could adversely affect our operations.***

We are subject to the risks arising from adverse changes in domestic and global economic conditions. If global economic and market conditions, or economic conditions in the United States, deteriorate, we may experience an adverse effect on our business, operating results and financial condition. Concerns about credit markets, consumer confidence, economic conditions, government spending to sponsor life science research, volatile corporate profits and reduced capital spending could negatively impact demand for our products. If economic growth in the United States and other countries slows or deteriorates, customers may delay or forego purchases of our products. Unstable economic, political and social conditions make it difficult for our customers, our suppliers and us to accurately forecast and plan future business activities. If such conditions exist, our business, financial condition and results of operations could suffer. We cannot project the extent of the impact of the economic environment on our industry or us.

***Changes in governmental regulations may reduce demand for our products, adversely impact our revenues, or increase our expenses.***

We compete in many markets in which we and our customers must comply with federal, state, local and international regulations. We develop, configure and market our products to meet customer needs created by those regulations. These requirements include, among other things, regulations regarding manufacturing practices, product labeling, and advertising and post marketing reporting. We must incur expense and spend time and effort to ensure compliance with these complex regulations. Possible regulatory actions for non-compliance could include warning letters, fines, damages, injunctions, civil penalties, recalls, seizures of our products, and criminal prosecution. These actions could result in, among other things, substantial modifications to our business practices and operations; refunds, recalls, or seizures of our products; a total or partial shutdown of production in one or more of our facilities while we or our suppliers remedy the alleged violation; and withdrawals or suspensions of current products from the market. Any of these events could disrupt our business and have a material adverse effect on our revenues, profitability and financial condition.

***We continue to expand our business into foreign countries and international markets. If our products are not accepted in these new markets our financial performance may suffer.***

We continue to aggressively expand our sales and marketing efforts in foreign countries and international markets. The cost and diversion of resources to these efforts may not result in an increase in revenues in our business. Expansion of our business into new markets may be more costly and require the devotion of more of our management's time than we anticipate, which may hurt our business performance in other markets. Our operating results may suffer to the extent that our efforts to expand our product sales in these new markets are delayed or prove to be unsuccessful.

***The life sciences industry is very competitive.***

We expect to encounter increased competition from both established and development-stage companies that continually enter the market. These include companies developing and marketing life science instruments, systems and lab consumables, health care companies that manufacture laboratory-based tests and analyzers, diagnostic and pharmaceutical companies, analytical instrument companies, and companies developing life science or drug discovery technologies. Currently, our principal competition comes from established companies that provide products that perform many of the same functions for which we market our products. Many of our competitors have substantially greater financial, operational, marketing and technical resources than we do. Moreover, these competitors may offer broader product lines and tactical discounts and may have greater name recognition. In addition, we may face competition from new entrants into the field. We may not have the financial resources, technical expertise or marketing, distribution or support capabilities to compete successfully in the future. In addition, we face changing customer preferences and requirements, including increased customer demand for more environmentally friendly products.

The life sciences industry is also subject to rapid technological change and discovery. The development of new or improved products, processes or technologies by other companies may render our products or proposed products obsolete or less competitive. In some instances, our competitors may develop or market products that are more effective or commercially attractive than our current or future products. To meet the evolving needs of customers, we must continually enhance our current and planned products and develop and introduce new products. However, we may experience difficulties that may delay or prevent the successful development, introduction and marketing of new products or product enhancements. In addition, our product lines are based on complex technologies that are subject to change as new technologies are developed and introduced in the marketplace. We may have difficulty in keeping abreast of the changes affecting each of the different markets we serve or intend to serve. Our failure to develop and introduce products in a timely manner in response to changing technology, market demands, or the requirements of our customers could cause our product sales to decline, and we could experience significant losses.

We offer and plan to offer a broad range of products and have incurred and expect to continue to incur substantial expenses for development of new products and enhanced versions of our existing products. The speed of technological change in our market may prevent us from being able to successfully market some or all of our products for the length of time required to recover development costs. Failure to recover the development costs of one or more products or product lines could decrease our profitability or cause us to experience significant losses.

***Ethical concerns surrounding the use of our products and misunderstanding of the nature of our business could adversely affect our ability to develop and sell our existing products and new products.***

Some of our products may be used in areas of research usage involving animal research and other techniques presently being explored in the life science industry. These techniques have drawn negative attention in the public forum. Government authorities may regulate or prohibit any of these activities. Additionally, the public may disfavor or reject these activities.

***If we are not able to manage our growth, our operating profits may be adversely impacted.***

Our success will depend on the expansion of our operations through both organic growth and acquisitions. Effective growth management will place increased demands on our management team, operational and financial resources and expertise. To manage growth, we must expand our facilities, optimize our operational, financial and management systems, and hire and train additional qualified personnel. Failure to manage this growth effectively could impair our ability to generate revenues or could cause our expenses to increase more rapidly than revenues, resulting in operating losses or reduced profitability.

***Failure or inadequacy of our information technology infrastructure or software could adversely affect our day-to-day operations and decision-making processes and have an adverse effect on our performance.***

We depend on accurate and timely information and numerical data from key software applications to aid our day-to-day business, financial reporting and decision-making and, in many cases, proprietary and custom-designed software is necessary to operate our business. We are upgrading our disaster recovery procedures for our critical systems. However, any disruption caused by the failure of these systems, the underlying equipment, or communication networks could delay or otherwise adversely impact our day-to-day business and decision making, could make it impossible for us to operate critical equipment, and could have an adverse effect on our performance, if our disaster recovery plans do not mitigate the disruption. Disruptions could be caused by a variety of factors, such as catastrophic events or weather, power outages, or cyber-attacks on our systems by outside parties.

***An information security incident, including a cybersecurity breach, could have a negative impact to our business or reputation***

To meet business objectives, we rely on both internal information technology (IT) systems and networks, and those of third parties and their vendors, to process and store sensitive data, including confidential research, business plans, financial information, intellectual property, and personal data that may be subject to legal protection. The extensive information security and cybersecurity threats, which affect companies globally, pose a risk to the security and availability of these IT systems and networks, and the confidentiality, integrity, and availability of our sensitive data. We continually assess these threats and make investments to increase internal protection, detection, and response capabilities, as well as ensure our third-party providers have required capabilities and controls, to address this risk. To date, we have not experienced any material impact to the business or operations resulting from information or cybersecurity attacks; however, because of the frequently changing attack techniques, along with the increased volume and sophistication of the attacks, there is the potential for us to be adversely impacted. This impact could result in reputational, competitive, operational or other business harm as well as financial costs and regulatory action. Additionally, the California Privacy Act of 2018 (CCPA), which was enacted in June 2018 and came into effect on January 1, 2020, provides a new private right of action for data breaches and requires companies that process information on California residents to make new disclosures to consumers about their data collection, use and sharing practices and allow consumers to opt out of certain data sharing with third parties. Compliance with the CCPA and other current and future applicable privacy, cybersecurity and related laws can be costly and time-consuming. Significant capital investments and other expenditures could also be required to remedy cybersecurity problems and prevent future breaches, including costs associated with additional security technologies, personnel, experts and credit monitoring services for those whose data has been breached. These costs, which could be material, could adversely impact our results of operations in the period in which they are incurred and may not meaningfully limit the success of future attempts to breach our information technology systems.

***We may experience difficulties implementing IT systems including enterprise resource planning systems.***

We have been engaged in a project to upgrade and harmonize our enterprise resource planning (ERP) systems. Our ERP systems are critical to our ability to accurately maintain books and records, record transactions, provide important information to our management and prepare our financial statements. The implementation of any IT systems, including ERP systems has required in the past, and may continue to require, the investment of significant financial and human resources. In addition, we may not be able to successfully complete the implementation of the ERP systems without experiencing difficulties. Any disruptions, delays or deficiencies in the design and implementation of any IT system, including ERP systems could adversely affect our ability to process orders, ship products, provide services and customer support, send invoices and track payments, fulfill contractual obligations or otherwise operate our business.

***We may incur additional restructuring costs or not realize the expected benefits of our initiatives to reduce operating expenses to date and in the future.***

We may not be able to implement all of the actions that we intend to take in the restructuring of our operations and we may not be able to fully realize the expected benefits from such realignment and restructuring plans or other similar restructurings in the future. In addition, we may incur additional restructuring costs in implementing such realignment and restructuring plans or other similar future plans in excess of our expectations. The implementation of our restructuring efforts, including the reduction of our workforce, may not improve our operational and cost structure or result in greater efficiency of our organization; and we may not be able to support sustainable revenue growth and profitability following such restructurings.

***Attractive acquisition opportunities may not be available to us in the future.***

We will consider the acquisition of other businesses. However, we may not have the opportunity to make suitable acquisitions on favorable terms in the future, which could negatively impact the growth of our business. In order to pursue such opportunities, we may require significant additional financing, which may not be available to us on favorable terms, if at all. We expect that our competitors, many of which have significantly greater resources than we do, will compete with us to acquire businesses. This competition could increase prices for acquisitions that we would likely pursue.

***We may be the subject of lawsuits from counterparties to acquisitions and divestitures, including an acquiring company or its stockholders, an acquired company's previous stockholders, a divested company's stockholders or our current stockholders.***

We may be the subject of lawsuits from either an acquiring company or its stockholders, an acquired company's previous stockholders, a divested company's stockholders or our current stockholders. Such lawsuits could result from the actions of the acquisition or divestiture target prior to the date of the acquisition or divestiture, from the acquisition or divestiture transaction itself or from actions after the acquisition or divestiture. Defending potential lawsuits could cost us significant expense and detract management's attention from the operation of the business. Additionally, these lawsuits could result in the cancellation of or the inability to renew certain insurance coverage that would be necessary to protect our assets.

***Failure to raise additional capital or generate the significant capital necessary to implement our acquisition strategy, expand our operations and invest in new products could reduce our ability to compete and result in less revenues.***

We anticipate that our financial resources, which include available cash, cash generated from operations, and debt and equity capacity, will be sufficient to finance operations and capital expenditures for at least the next twelve months. However, this expectation is premised on the current operating plan, which may change as a result of many factors, including market acceptance of new products and future opportunities with collaborators. Consequently, we may need additional funding sooner than anticipated. In addition, our Financing Agreement is not sufficient to fund our acquisition strategy. In such case, our inability to raise sufficient capital on favorable terms and in a timely manner (if at all) could seriously harm our business, product development, and acquisition efforts. In addition, our Financing Agreement contains limitations on our ability to incur additional indebtedness and requires lender approval for acquisitions funded with cash, promissory notes and/or other consideration in excess of $1.0 million and for acquisitions in excess of $0.5 million. If future financing is not available or is not available on acceptable terms, we may have to alter our operations or change our business strategy. We cannot assure you that the capital required to fund operations, or our acquisition strategy will be available in the future.

***If we raise additional funds through the sale of equity or convertible debt or equity-linked securities, existing percentages of ownership in our common stock will be reduced and these transactions may dilute the value of our outstanding common stock.***

We may raise additional funds through the sale of equity or convertible debt or equity-linked securities to repay our existing indebtedness, implement our acquisition strategy, expand our operations and/or invest in new products. If we so raise additional funds through such sales, existing percentages of ownership in our common stock will be reduced and these transactions may dilute the value of our outstanding common stock. We may issue securities that have rights, preferences and privileges senior to our common stock. If we raise additional funds through collaborations or licensing arrangements, we may relinquish rights to certain of our technologies or products, or grant licenses to third parties on terms that are unfavorable.

***Our stock price has fluctuated in the past and could experience substantial declines in the future.***

The market price of our common stock has experienced significant fluctuations and may become volatile and could decline in the future, perhaps substantially, in response to various factors including, but not limited to:

- Significant sales of our common stock, whether by us or our shareholders;
- volatility of the financial markets;
- uncertainty regarding the prospects of the domestic and foreign economies;
- technological innovations by competitors or in competing technologies;
- revenues and operating results fluctuating or failing to meet the expectations of management, securities analysts, or investors in any quarter;
- comments of securities analysts and mistakes by or misinterpretation of comments from analysts, downward revisions in securities analysts' estimates or management guidance;
- investment banks and securities analysts becoming subject to lawsuits that may adversely affect the perception of the market;
- conditions or trends in the biotechnology and pharmaceutical industries;
- announcements of significant acquisitions or financings or strategic partnerships;
- failure to realize the anticipated benefits of the DSI acquisition;
- non-compliance with the internal control standards pursuant to the Sarbanes-Oxley Act of 2002; and
- a decrease in the demand for our common stock.

In addition, public stock markets have experienced extreme price and trading volatility. The stock market and the NASDAQ Global Market in general, and the biotechnology industry and small cap markets in particular, have experienced significant price and volume fluctuations that at times may have been unrelated or disproportionate to the operating performance of those companies. These broad market and industry factors may further harm the market price of our common stock, regardless of our operating performance. In the past, securities class action litigation has often been instituted following periods of volatility in the market price of a company's securities. A securities class action suit against us could result in substantial costs, potential liabilities and the diversion of management's attention and resources.

***As a result of our spin-off of Harvard Apparatus Regenerative Technology, Inc., now known as Biostage, together with certain related transactions, third parties may seek to hold us responsible for Biostage's liabilities, including liabilities that Biostage has assumed from us.***

Third parties may seek to hold us responsible for Biostage's liabilities, including any of the liabilities that Biostage agreed to retain or assume in connection with the separation of the Biostage business from our businesses, and related spin-off distribution. On April 14, 2017, anticipated representatives for the estate of an individual plaintiff filed a wrongful death complaint with the Suffolk Superior Court, in the County of Suffolk, Massachusetts, against us and other defendants, including Biostage, as well as another third party. The complaint seeks payment for an unspecified amount of damages and alleges that the plaintiff sustained terminal injuries allegedly caused by products, including synthetic trachea scaffolds and bioreactors, provided by certain of the named defendants and utilized in connection with surgeries performed by third parties in 2012 and 2013. We continue to vigorously defend this case through our liability insurance carrier from whom we have requested defense and indemnification of any losses incurred in connection with this lawsuit. Any such product liability insurance coverage may not be sufficient to satisfy all liabilities resulting from this claim. If claims against us substantially exceed our coverage, then our business could be adversely impacted. While we believe that such claim is without merit, we are unable to predict the ultimate outcome of such litigation. Pursuant to our agreements with Biostage, Biostage has agreed to indemnify us for claims and losses relating to certain liabilities that it has assumed from us, including liabilities in connection with the sale of Biostage's products, intellectually property infringement and other liabilities related to the operation of Biostage's business. However, if those liabilities are significant and we are ultimately held liable for them, we cannot assure you that Biostage will have the ability to satisfy its obligations to us, in particular due to Biostage having limited revenues, products in early stage development and a need for additional funds in the future. If Biostage is unable to satisfy its obligations under its indemnity to us, we may have to satisfy these obligations, which could have an adverse impact on our financial condition, results of operations or cash flows.

***If our goodwill or intangible assets become impaired, we may be required to record a significant charge to earnings.***

Under accounting principles generally accepted in the United States, we review our goodwill and intangible assets for impairment when events or changes in circumstances indicate the carrying value may not be recoverable. Goodwill is also required to be tested for impairment at least annually. Factors that may be considered a change in circumstances indicating that the carrying value of our goodwill or other intangible assets may not be recoverable include a decline in our stock price and market capitalization, future cash flows, and slower growth rates in our industry. We may be required to record a significant charge to earnings in our financial statements during the period in which any impairment of our goodwill or other intangible assets is determined, which could adversely impact our results of operations.

***Accounting for goodwill, other intangible assets and long-lived assets may have an adverse effect on us.***

We assess the recoverability of identifiable intangibles with finite lives and other long-lived assets, such as property, plant and equipment, for impairment whenever events or changes in circumstances indicate that the carrying value may not be recoverable in accordance with the provisions of Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) 360, "Property, Plant and Equipment". In accordance with FASB ASC 350, "Intangibles-Goodwill and Other", goodwill and intangible assets with indefinite lives from acquisitions are evaluated annually, or more frequently, if events or circumstances indicate there may be an impairment, to determine whether any portion of the remaining balance of goodwill and indefinite lived intangibles may not be recoverable. If it is determined in the future that a portion of our goodwill and other intangible assets is impaired, we will be required to write off that portion of the asset according to the methods defined by FASB ASC 360 and FASB ASC 350, which could have an adverse effect on net income for the period in which the write-off occurs. At December 31, 2019, we had goodwill and intangible assets of $95.8 million, or 58%, of our total assets. At December 31, 2019, we concluded that none of our goodwill was impaired. During the year ended December 31, 2019 we recorded approximately $1.5 million of impairment charges against our intangible assets (see Note 6 in the Consolidated Financial Statements included in Part IV, Item 15. of this report "Exhibits, Financial Statement Schedules" for further discussion).

***If we fail to retain key personnel and hire, train and retain qualified employees, we may not be able to compete effectively, which could result in reduced revenue or increased costs.***

Our success is highly dependent on the continued services of key management, technical and scientific personnel. Our management and other employees may voluntarily terminate their employment at any time upon short notice. The loss of the services of any member of the senior management team, including the Chief Executive Officer, James Green; the Chief Financial Officer, Michael Rossi; or any of the managerial, technical or scientific staff may significantly delay or prevent the achievement of product development, our growth strategies and other business objectives. Our future success will also depend on our ability to identify, recruit and retain additional qualified scientific, technical and managerial personnel. We operate in several geographic locations where labor markets are particularly competitive, including the Boston, Massachusetts and Minneapolis, MN metropolitan areas, England, and Germany where demand for personnel with these skills is extremely high and is likely to remain high. As a result, competition for qualified personnel is intense, particularly in the areas of general management, finance, information technology, engineering and science, and the process of hiring suitably qualified personnel is often lengthy and expensive, and may become more expensive in the future. If we are unable to hire and retain a sufficient number of qualified employees, our ability to conduct and expand our business could be seriously reduced.

***If we are unable to effectively protect our intellectual property, third parties may use our technology, which would impair our ability to compete in our markets.***

Our continued success will depend in significant part on our ability to obtain and maintain meaningful patent protection for certain of our products throughout the world. Patent law relating to the scope of claims in the technology fields in which we operate is still evolving. The degree of future protection for our proprietary rights is uncertain. We also own numerous United States registered trademarks and trade names and have applications for the registration of trademarks and trade names pending. We rely on patents to protect a significant part of our intellectual property and to enhance our competitive position. However, any pending or future patent applications may not be accepted and patents might not be issued, and any patent previously issued to us may be challenged, invalidated, held unenforceable or circumvented. Furthermore, the claims in patents which have been issued or which may be issued to us in the future may not be sufficiently broad to prevent third parties from producing competing products similar to our products. In addition, the laws of various foreign countries in which we compete may not protect our intellectual property to the same extent, as do the laws of the United States. If we fail to obtain adequate patent protection for our proprietary technology, our ability to be commercially competitive could be materially impaired.

In addition to patent protection, we also rely on protection of trade secrets, know-how and confidential and proprietary information. To maintain the confidentiality of trade-secrets and proprietary information, we generally seek to enter into confidentiality agreements with our employees, consultants and strategic partners upon the commencement of a relationship. However, we may not be able to obtain these agreements in all circumstances in part due to local regulations. In the event of unauthorized use or disclosure of this information, these agreements, even if obtained, may not provide meaningful protection for our trade-secrets or other confidential information. In addition, adequate remedies may not exist in the event of unauthorized use or disclosure of this information. The loss or exposure of our trade secrets and other proprietary information would impair our competitive advantages and could have an adverse effect on our operating results, financial condition and future growth prospects.

***The manufacture, sale and use of products and services may expose us to product liability claims for which we could have substantial liability.***

We face an inherent business risk of exposure to product liability claims if our products, services or product candidates, including without limitation, any of our life science research tools are alleged or found to have caused injury, damage or loss. We may in the future be unable to obtain insurance with adequate levels of coverage for potential liability on acceptable terms or claims of this nature may be excluded from coverage under the terms of any insurance policy that we can obtain. If we are unable to obtain such insurance or the amounts of any claims successfully brought against us substantially exceed our coverage, then our business could be adversely impacted.

***We may be involved in lawsuits to protect or enforce our patents that would be expensive and time-consuming.***

In order to protect or enforce our patent rights, we may initiate patent litigation against third parties. We may also become subject to interference proceedings conducted in the patent and trademark offices of various countries to determine the priority of inventions. Several of our products are based on patents that are closely surrounded by patents held by competitors or potential competitors. As a result, we believe there is a greater likelihood of a patent dispute than would be expected if our patents were not closely surrounded by other patents. The defense and prosecution, if necessary, of intellectual property suits, interference proceedings and related legal and administrative proceedings would be costly and divert our technical and management personnel from their normal responsibilities. We may not prevail in any of these suits should they occur. An adverse determination of any litigation or defense proceedings could put our patents at risk of being invalidated or interpreted narrowly and could put our patent applications at risk of being rejected and no patents being issued.

Furthermore, because of the substantial amount of discovery required in connection with intellectual property litigation, there is a risk that some of our confidential information could be compromised by disclosure during this type of litigation. For example, during the course of this kind of litigation, there could be public announcements of the results of hearings, motions or other interim proceedings or developments in the litigation. Securities analysts or investors may perceive these announcements to be negative, which could cause the market price of our stock to decline.

***Our success will depend partly on our ability to operate without infringing on or misappropriating the intellectual property rights of others.***

We may be sued for infringing on the intellectual property rights of others, including the patent rights, trademarks and trade names of third parties. Intellectual property litigation is costly, and the outcome is uncertain. If we do not prevail in any intellectual property litigation, in addition to any damages we might have to pay, we could be required to stop the infringing activity, or obtain a license to or design around the intellectual property in question. If we are unable to obtain a required license on acceptable terms, or are unable to design around any third-party patent, we may be unable to sell some of our products and services, which could result in reduced revenue.

***Rising commodity and precious metals costs could adversely impact our profitability.***

Raw material commodities such as resins, and precious metal commodities such as platinum are subject to wide price variations. Increases in the costs of these commodities and the costs of energy, transportation and other necessary services may adversely affect our profit margins if we are unable to pass along any higher costs in the form of price increases or otherwise achieve cost efficiencies such as in manufacturing and distribution.

***Regulations related to conflict minerals may force us to incur additional expenses and otherwise adversely impact our business.***

The SEC has promulgated final rules mandated by the Dodd-Frank Act regarding disclosure of the use of tin, tantalum, tungsten and gold, known as conflict minerals, in products manufactured by public companies. These new rules require ongoing due diligence to determine whether such minerals originated from the Democratic Republic of Congo (the DRC) or an adjoining country and whether such minerals helped finance the armed conflict in the DRC. Reporting obligations for the rule began on May 31, 2014 and are required annually thereafter. There will be costs associated with complying with these disclosure requirements, including costs to determine the origin of conflict minerals in our products. The implementation of these rules and their effect on customer, supplier and/or consumer behavior could adversely affect the sourcing, supply and pricing of materials used in our products. As a result, we may also incur costs with respect to potential changes to products, processes or sources of supply. We may face disqualification as a supplier for customers and reputational challenges if the due diligence procedures we implement do not enable us to verify the origins for all conflict minerals used in our products, including that such minerals did not originate from any of the covered conflict countries. Accordingly, the implementation of these rules could have an adverse effect on our business, results of operations and/or financial condition.

***We could be negatively affected as a result of a proxy contest and the actions of activist stockholders.***

We have received a notice of director nominations from Engine Capital, L.P. If Engine Capital does not withdraw their nominations, a proxy contest is likely to occur. A proxy contest with respect to election of our directors, or other activist stockholder activities, could adversely affect our business because: (1) responding to a proxy contest and other actions by activist stockholders can be costly and time-consuming, disruptive to our operations and divert the attention of management and our employees; (2) perceived uncertainties as to our future direction caused by activist activities may result in the loss of potential business opportunities, and may make it more difficult to attract and retain qualified personnel and business partners; and (3) if individuals are elected to our Board of Directors with a specific agenda, it may adversely affect our ability to effectively and timely implement our strategic plans.

***Provisions of Delaware law, of our charter and bylaws may make a takeover more difficult, which could cause our stock price to decline.***

Provisions in our certificate of incorporation and bylaws and in the Delaware corporate law may make it difficult and expensive for a third party to pursue a tender offer, change in control or takeover attempt, which is opposed by management and the board of directors. Public stockholders who might desire to participate in such a transaction may not have an opportunity to do so. We have a staggered board of directors that makes it difficult for stockholders to change the composition of the board of directors in any one year. These anti-takeover provisions could substantially impede the ability of public stockholders to change our management and board of directors. Such provisions may also limit the price that investors might be willing to pay for shares of our common stock in the future.

***Your percentage ownership will be diluted in the future because of equity award issuances.***

Your percentage ownership will be diluted in the future because of equity awards that we expect will be granted to our directors, officers and employees, as well as shares of common stock, or securities convertible into common stock, we issue in connection with future capital raising or strategic transactions. Our Third Amended and Restated 2000 Stock Option and Incentive Plan provides for the grant of equity-based awards, including restricted stock, restricted stock units, stock options, stock appreciation rights and other equity-based awards to our directors, officers and other employees, advisors and consultants. The issuance of any shares of our stock would dilute the proportionate ownership and voting power of existing security holders.

***Any issuance of preferred stock in the future may dilute the rights of our common stockholders.***

Our board of directors has the authority to issue up to 5,000,000 shares of preferred stock and to determine the price, privileges and other terms of these shares. The board of directors may exercise this authority without any further approval of stockholders. The rights of the holders of common stock may be adversely affected by the rights of future holders of preferred stock.

***Cash dividends will not likely be paid on our common stock.***

Currently, we intend to retain all of our earnings to finance the expansion and development of our business and do not anticipate paying any cash dividends to holders of our common stock in the near future. As a result, capital appreciation, if any, of our common stock will be a stockholder’s sole source of gain for the near future.

***Changes in the European regulatory environment regarding privacy and data protection regulations could have a material adverse impact on our results of operations.***

The E.U. has recently adopted a comprehensive overhaul of its data protection regime in the form of the General Data Protection Regulation (GDPR), which comes into effect in May 2018. GDPR extends the scope of the existing E.U. data protection law to foreign companies processing personal data of E.U. residents. The regulation imposes a strict data protection compliance regime with severe penalties of 4% of worldwide turnover or €20 million, whichever is greater, and includes new rights such as the right of erasure of personal data. Although the GDPR will apply across the E.U., as has been the case under the current data protection regime, E.U. Member States have some national derogations and local data protection authorities (DPAs) will still have the ability to interpret the GDPR, which has the potential to create inconsistencies on a country-by-country basis. Implementation of, and compliance with the GDPR could increase our cost of doing business and/or force us to change our business practices in a manner adverse to our business. In addition, violations of the GDPR may result in significant fines, penalties and damage to our brand and business which could, individually or in the aggregate, materially harm our business and reputation.

***We are subject to new U.S. foreign investment regulations which may impose additional burdens on or may limit certain investors' ability to purchase our common stock, potentially making our common stock less attractive to investors.***

In October 2018, the U.S. Department of Treasury announced a pilot program to implement part of the Foreign Investment Risk Review Modernization Act, or FIRRMA, effective November 10, 2018. The pilot program expands the jurisdiction of the Committee on Foreign Investment in the United States, or CFIUS, to include certain direct or indirect foreign investments in a defined category of U.S. companies. Among other things, FIRRMA empowers CFIUS to require certain foreign investors to make mandatory filings and permits CFIUS to charge filing fees related to such filings. Such filings are subject to review by CFIUS. Any such restrictions on the ability to purchase shares of our common stock that have the effect of delaying or deterring a change in control could limit the opportunity for our stockholders to receive a premium for their shares of our common stock and could also affect the price that some investors are willing to pay for our common stock

**Item 1B.** ***Unresolved Staff Comments.***

None.

**Item 2.** ***Properties.***

Our facilities incorporate manufacturing, research and development, sales and marketing, and administration functions. As of December 31, 2019, we leased the following principal facilities:

| Location | Description of Facility | Approximate Square Footage | Expiration |
|---|---|---|---|
| New Brighton, Minnesota | Manufacturing facility for Pre-Clinical products | 95,529 | 2030 |
| Holliston, Massachusetts | Manufacturing facility for Cellular and Molecular Technologies products and corporate headquarters | 83,123 | 2024 |
| Reutlingen, Germany | Manufacturing facility for Cellular and Molecular Technologies products | 22,449 | 2024 |
| Barcelona, Spain | Manufacturing facility for Cellular and Molecular Technologies products | 20,853 | 2020 - 2021 |
| March-Hugstetten, Germany | Manufacturing facility for Cellular and Molecular Technologies products | 12,031 | 2024 |

We also lease additional facilities in Cambourne, England; Hamden, Connecticut; Kista, Sweden; Shanghai, China; Les Ulis, France; St. Augustin, Germany; and Montreal, Canada.

We believe our current facilities are adequate for our needs for the foreseeable future.

**Item 3.** ***Legal Proceedings.***

From time to time, we are a party to various legal proceedings or claims arising in the ordinary course of business. For information related to legal proceedings, see the discussion in Note 21 in the Consolidated Financial Statements included in Part IV, Item 15. of this report “Exhibits, Financial Statement Schedules,” which information is incorporated by reference into this Item 3.

**Item 4.** **Mine Safety Disclosures**

Not Applicable.

## PART II

**Item 5.** ***Market for Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities***

**Market Information**

Our common stock has been quoted on the NASDAQ Global Market since our initial public offering on December 7, 2000, and trades under the symbol "HBIO."

**Shareholders**

There were 104 holders of record of our common stock as of March 5, 2020. We believe that the number of beneficial owners of our common stock at that date was substantially greater.

**Dividend Policy**

We have never declared or paid cash dividends on our common stock in the past and do not intend to pay cash dividends on our common stock in the foreseeable future. Any future determination to pay cash dividends will be at the discretion of our Board of Directors and will depend on our financial condition, results of operations, capital requirements and other factors our Board of Directors deems relevant.

**Item 6.** **Selected Financial Data**

Not applicable.

**Item 7.** ***Management's Discussion and Analysis of Financial Condition and Results of Operations.***

**Forward-Looking Statements**

*The following section of this Annual Report on Form 10-K entitled "Management's Discussion and Analysis of Financial Condition and Results of Operations" contains statements that are not statements of historical fact and are forward-looking statements within the meaning of federal securities laws. These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. These statements reflect our current views with respect to future events and are based on assumptions and subject to risks and uncertainties. Factors that may cause our actual results to differ materially from those in the forward-looking statements include those factors described in "Item 1A. Risk Factors" beginning on page 7 of this Annual Report on Form 10-K. You should carefully review all of these factors, as well as the comprehensive discussion of forward-looking statements on page 1 of this Annual Report on Form 10-K.*

**Overview**

Harvard Bioscience, Inc., a Delaware corporation, is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and pre-clinical testing for drug development. Our customers range from renowned academic institutions and government laboratories, to the world's leading pharmaceutical, biotechnology and clinical research organizations. With operations in North America and Europe, we sell through a combination of direct and distribution channels to customers around the world.

In January 2018, we acquired Data Sciences International, Inc. (DSI) for approximately $71.1 million. DSI, a St. Paul, Minnesota-based life science research company, is a recognized leader in physiologic monitoring focused on delivering preclinical products, systems, services and solutions to its customers. Its customers include pharmaceutical and biotechnology companies, as well as contract research organizations, academic labs and government researchers. This acquisition diversifies our customer base into the biopharmaceutical and contract research organization markets and offers revenue and cost synergies. The acquisition also helped to increase our gross profit margins.

See Part I, Item 1. of this report "Our History and Strategy" for a discussion of recent significant acquisitions, divestitures and other developments.

In the table below, we provide an overview of selected operating metrics.

| | 2019 | % of Revenues | 2018 | % of Revenues |
|---|---|---|---|---|
| | (dollars in thousands) | | | |
| Revenues | $ 116,176 | | $ 120,774 | |
| Cost of revenues | 51,854 | 44.6% | 57,593 | 47.7% |
| Sales and marketing expenses | 23,264 | 20.0% | 24,443 | 20.2% |
| General and administrative expenses | 22,760 | 19.6% | 21,382 | 17.7% |
| Research and development expenses | 10,715 | 9.2% | 10,988 | 9.1% |
| Amortization of intangible assets | 5,746 | 4.9% | 5,384 | 4.5% |
| Impairment charges | 1,460 | 1.3% | - | |
| Interest expense | 5,410 | 4.7% | 5,367 | 4.4% |
| Other expense, net | 469 | 0.4% | 3,592 | 3.0% |
| Income from discontinued operations | - | | 1,377 | 1.1% |

**Components of Operating Income**

On January 22, 2018, we sold substantially all the assets of our operating subsidiary, Denville. The sale of Denville represented a strategic shift that had a major effect on our operations and financial results. As such and pursuant to the accounting standards, the operating results of Denville for the year ended December 31, 2018 have been presented in discontinued operations in the consolidated statements of operations. Therefore, the amounts and percentages discussed below exclude the revenues and expenses of Denville unless otherwise described.

*Revenues.* We generate revenues by selling apparatus, instruments, devices, systems, software and consumables through our distributors, direct sales force, websites and catalogs. These product lines include both proprietary manufactured products and complementary products from various suppliers. Our reputation as a leading producer in many of our manufactured products creates traffic to our website, enables cross-selling and facilitates the introduction of new products. We have field sales teams in the U.S., Canada, the United Kingdom, Germany, France, Spain and China. In those regions where we do not have a direct sales team, we use distributors. Revenues from direct sales to end users included in continuing operations represented approximately 70% and 59% of our revenues for the years ended December 31, 2019 and 2018, respectively.

Our products consist of instruments, consumables, and systems that are made up of several individual products. Sales prices of these products range from under $100 to over $100,000, although are mostly priced in the range of $5,000 to $15,000. They are mainly scientific instruments like spectrophotometers and plate readers that analyze light to detect and quantify a wide range of molecular and cellular processes, or apparatus like gel electrophoresis units. Our products and services also include wireless monitors, data acquisition and analysis products and software, and ancillary services including post-contract customer support, training and installation.

We use distributors for both our catalog products and our higher priced products, as well as for sales in locations where we do not have subsidiaries or where we have existing distributors in place from acquired businesses. For the years ended December 31, 2019 and 2018, approximately 30% and 41% of our total revenues from continuing operations, respectively, were derived from sales to distributors.

For the years ended December 31, 2019 and 2018, approximately 84% and 85% of our revenues from continuing operations, respectively, were derived from products we manufacture and approximately 16% and 15%, respectively, were derived from complementary products we distribute in order to provide the researcher with a single source for all equipment needed to conduct a particular experiment.

For the years ended December 31, 2019 and 2018, approximately 29% and 30% of our revenues from continuing operations, respectively, were derived from sales made by our non-United States operations.

*Cost of revenues.* Cost of revenues includes material, labor and manufacturing overhead costs, obsolescence charges, packaging costs, warranty costs, shipping costs and royalties. Our cost of revenues may vary over time based on the mix of products sold. We sell products that we manufacture and products that we purchase from third parties. The products that we purchase from third parties typically have a higher cost of revenues as a percent of revenues because the profit is effectively shared with the original manufacturer. We anticipate that our manufactured products will continue to have a lower cost of revenues as a percentage of revenues as compared with the cost of non-manufactured products for the foreseeable future. Additionally, our cost of revenues as a percent of revenues will vary based on mix of direct to end user sales and distributor sales, mix by product line and mix by geography.

*Sales and marketing expenses.* Sales and marketing expense consists primarily of salaries and related expenses for personnel in sales, marketing and customer support functions. We also incur costs for travel, trade shows, demonstration equipment, public relations and marketing materials, consisting primarily of the printing and distribution of catalogs, supplements and the maintenance of our websites. We may from time to time expand our marketing efforts by employing additional technical marketing specialists in an effort to increase sales of selected categories of products. We may also from time to time expand our direct sales organizations in an effort to concentrate on key accounts or promote certain product lines.

*General and administrative expenses.* General and administrative expense consists primarily of salaries and other related costs for personnel in executive, finance, accounting, information technology and human resource functions. Other costs include professional fees for legal and accounting services, information technology infrastructure, facility costs, investor relations, insurance and provision for doubtful accounts.

*Research and development expenses.* Research and development expenses consists primarily of salaries and related expenses for personnel and spending to develop and enhance our products. Other research and development expenses include fees for consultants and outside service providers, and material costs for prototype and test units. We expense research and development costs as incurred. Grants received from governmental entities related to research projects are accounted for as a reduction in research and development expense over the period of the project. We believe that investment in product development is a competitive necessity and plan to continue to make these investments in order to realize the potential of new technologies that we develop, license or acquire for existing markets.

**Selected Results of Operations**

***Year ended December 31, 2019 compared to year ended December 31, 2018***

Unless otherwise described, the amounts and percentages in the table above and those amounts and percentages discussed below exclude the revenues and expenses of Denville.

***Revenues***

Revenues for the year ended December 31, 2019 were $116.2 million, a decrease of (3.8)%, or $4.6 million, compared to revenues of $120.8 million for the same period in 2018.

The decrease in revenue for the year ended December 31, 2019 is due to lower sales volume in Europe as well as lower volume with contract research organizations due to customer consolidation. These reductions were partially offset by growth in sales of cellular and molecular discovery technologies in North America. Additionally, revenues for the year ended December 31, 2019 included twelve months of revenues from DSI as compared to eleven months of revenues from DSI included in the year ended December 31, 2018. The impact of currency translation negatively impacted revenues in the year ended December 31, 2019 by approximately $1.8 million.

***Cost of revenues***

Cost of revenues decreased $5.7 million, or 10.0%, to $51.9 million for the year ended December 31, 2019 compared with $57.6 million for the year ended December 31, 2018. Gross margin as a percentage of revenues increased to 55.4% for the year ended December 31, 2019 compared with 52.3% for the year ended December 31, 2018. Cost of revenues for the year ended December 31, 2018 included approximately $3.8 million related to a purchase accounting inventory fair value step up amortization. This inventory fair value step-up was fully recognized into cost of revenues over one inventory turn, or approximately six months. Excluding the effect of the step-up amortization, gross profit decreased by approximately $2.7 million which was primarily due to reduced fixed cost absorption associated with lower revenue as well as product mix.

***Sales and marketing expenses***

Sales and marketing expenses decreased $1.1 million, or 4.8%, to $23.3 million for the year ended December 31, 2019 compared with $24.4 million for the year ended December 31, 2018. Sales and marketing expenses for the year ended December 31, 2019 included twelve months of costs from DSI as compared to eleven months of costs from DSI in the year ended December 31, 2018. The overall decrease in costs in the year ended December 31, 2019, was primarily due to decreases in employee-related expenses and commission, lower stock-based compensation, and lower consulting services as compared to the prior period.

***General and administrative expenses***

General and administrative expenses increased $1.4 million, or 6.4%, to $22.8 million for the year ended December 31, 2019 compared with $21.4 million for the year ended December 31, 2018. Costs for the year ended December 31, 2019 included twelve months of costs from DSI as compared to eleven months of costs from DSI in the year ended December 31, 2018. Other changes in the year ended December 31, 2019 included decreases in variable compensation costs, increases in restructuring expenses and turnaround costs, and increased stock-based compensation as compared to the year ended December 31, 2018.

***Research and development expenses***

Research and development expenses were $10.7 million for the year ended December 31, 2019, a decrease of $0.3 million, or 2.5%, compared with $11.0 million for the year ended December 31, 2018. Costs for the year ended December 31, 2019 included twelve months of costs from DSI as compared to eleven months of costs from DSI in the year ended December 31, 2018. The changes in the year ended December 31, 2019 was primarily driven by decreases in consulting and purchased services as compared to the year ended December 31, 2018.

***Amortization of intangible assets***

Amortization of intangible asset expenses was $5.7 million and $5.4 million for the years ended December 31, 2019 and 2018, respectively. The increase of $0.3 million in amortization of intangible assets expense was primarily due to the impact of the DSI acquisition, as the year ended December 31, 2019 included twelve months of amortization expenses from DSI as compared to eleven months of such expenses in the year ended December 31, 2018.

***Impairment charges***

Impairment charges were $1.5 million for the year ended December 31, 2019, primarily consisting of a charge of $0.9 million related to our in-process research and development intangible assets as a result of our on-going evaluation of our research and development activities, and a charge of $0.5 million related to the impairment of certain intangible assets due to the decision to discontinue one of our product lines and to cease operations in our facility in Raleigh, North Carolina. There were no similar impairment charges recognized in the same period in the prior year.

***Interest expense***

Interest expense was $5.4 million for each of the years ended December 31, 2019 and 2018. Borrowings under our Financing Agreement increased significantly as of January 31, 2018 due to borrowings associated with the acquisition of DSI. Although debt has been reduced from $68.8 million as of January 31, 2018 to $55.0 million as of December 31, 2019, average daily balances outstanding under our Financing Agreement were relatively unchanged due to only eleven months of borrowings related to the acquisition of DSI during 2018.

***Other expense, net***

Other expense, net, were $0.5 million for the year ended December 31, 2019, a decrease of $3.1 million, or 86.9%, compared with $3.6 million for the year ended December 31, 2018. The decrease in other expense, net was primarily due to transaction costs incurred in 2018 of approximately $3.4 million, related to the acquisition of DSI and the divestiture of Denville.

***Income taxes***

Income tax from continuing operations was a benefit of $0.8 million and $3.7 million for the years ended December 31, 2019 and 2018, respectively. The effective income tax rate was 14.8% for the year ended December 31, 2019, compared with 46.1% for the same period in 2018. The difference between our effective rates in 2019 as compared to 2018 is primarily due to the mix of pre-tax income and losses at individual subsidiaries as well as the impact of different tax rates in certain foreign jurisdictions, impact of stock compensation deductions and windfalls in 2018.

***Income from discontinued operations***

On January 22, 2018, we sold substantially all the assets of our wholly owned subsidiary, Denville, for approximately $20.0 million, which included a $3.0 million earn-out provision (the Denville Transaction). Upon the closing of the transaction, the Company received $15.7 million, net of transaction costs. The earn-out provision represented contingent consideration of up to $2.0 million based on Denville achieving certain performance metrics with respect to 2018 operating results and up to $1.0 million based on Denville achieving certain performance metrics with respect to 2019 operating results. We have determined that the 2018 performance metrics were not achieved and expect that the 2019 performance metrics will not be achieved.

Discontinued operations resulted in income of $1.4 million for the year ended December 31, 2018. The results of Denville were presented in discontinued operations and included a gain on sale of Denville of $1.3 million and an income tax benefit of $0.4 million. The income tax benefit was mainly due to the reversal of deferred tax liabilities associated with indefinite lived intangibles following the Denville Transaction.

***Liquidity and Capital Resources***

Historically, we have financed our business through cash provided by operating activities, bank borrowings, and the issuance of common stock. Our liquidity requirements arise primarily from investing activities, including funding of acquisitions, and other capital expenditures.

On January 22, 2018, we sold the operations of Denville, and received approximately $15.8 million, net of cash on hand. Simultaneously, we retired the existing debt balances of approximately $11.9 million. On January 31, 2018, we entered into the Financing Agreement, which comprised of a $64.0 million term loan and up to a $25.0 million line of credit. Finally, on January 31, 2018, we acquired DSI for approximately $68.0 million, net of cash acquired.

As of December 31, 2019, we held cash and cash equivalents of $8.3 million, compared with $8.2 million at December 31, 2018. As of December 31, 2019 and December 31, 2018, we had $55.0 million and $62.4 million of borrowings outstanding under our credit facility, respectively. Total debt, net of cash and cash equivalents was $46.7 million at December 31, 2019, compared to $54.2 million at December 31, 2018. In addition, we have a United Kingdom pension obligation that was overfunded (underfunded) by approximately $1.1 million and $(0.9) million as of December 31, 2019 and December 31, 2018, respectively.

As of December 31, 2019 and December 31, 2018, cash and cash equivalents held by our foreign subsidiaries was $3.5 million and $3.2 million, respectively. As a result of the 2017 Tax Act, post-2017 dividends from qualifying Controlled Foreign Corporations are no longer taxed in the U.S. However, any dividends to the U.S. must still be assessed for withholding tax liability as well as income state tax liability. As a result of our assertion, we determined the potential state income tax liability related to available cash balances at foreign subsidiaries would be immaterial in both 2019 and 2018.

**Condensed Consolidated Cash Flow Statements**
**(unaudited, in thousands)**

| | Year Ended December 31, 2019 | 2018 |
|---|---|---|
| Cash flows from operations: | | |
| Net loss | $ (4,687) | $ (2,922) |
| Other adjustments to operating cash flows | 12,722 | 7,481 |
| Changes in operating assets and liabilities | 10 | (1,675) |
| Net cash provided by operating activities | 8,045 | 2,884 |
| | | |
| Cash flows from investing activities: | | |
| Additions to property, plant and equipment | (1,216) | (986) |
| Acquisitions, net of cash acquired | - | (68,548) |
| Dispositions, net of cash sold | 1,002 | 15,754 |
| Other investing activities | (15) | (16) |
| Net cash used in investing activities | (229) | (53,796) |
| | | |
| Cash flows from financing activities: | | |
| Net proceeds from issuance of debt | 4,300 | 70,700 |
| Repayments of debt | (11,703) | (20,198) |
| Other financing activities | (221) | 2,551 |
| Net cash provided by (used in) financing activities | (7,624) | 53,053 |
| | | |
| Effect of exchange rate changes on cash | (30) | 299 |
| | | |
| Increase in cash and cash equivalents | $ 162 | $ 2,440 |

Our operating activities provided cash of $8.0 million and $2.9 million for the year ended December 31, 2019 and 2018, respectively. The increase in net cash flow from operations was primarily due to the effect of reductions in inventory levels in 2019 and to deal fees, integration costs and other payments associated with the DSI acquisition and Denville sale in the first half of 2018.

Our investing activities used cash of $(0.2) million and $(53.8) million for the years ended December 31, 2019 and 2018, respectively. Investing activities during the year ended December 31, 2019 primarily consisted of cash used for capital expenditures, and the receipt of $1.0 million in connection with the release of an escrow amount associated with the Denville Transaction. Investing activities during the year ended December 31, 2018 primarily consisted of $68.5 million paid for the acquisition of DSI and $15.8 million received from the disposition of Denville. We spent $1.2 million and $1.0 million on capital expenditures during the year ended December 31, 2019 and 2018, respectively.

Our financing activities have historically consisted of borrowings and repayments under our revolving credit facility and term loans, payments of debt issuance costs and the issuance of common stock. During the year ended December 31, 2019, financing activities used cash of $7.6 million, compared with $53.1 million of cash provided by financing activities for the year ended December 31, 2018. During the year ended December 31, 2019, we borrowed $4.3 million and repaid $11.7 million of debt, including an excess cash flow payment of $4.0 million and a payment of $1.0 million in connection with the release of an escrow amount associated with the Denville Transaction as required by the Financing Agreement, and ended the year with $55.0 million of borrowings. During the year ended December 31, 2018 wev borrowed $70.7 million, repaid $20.2 million of debt and ended the year with $62.4 million of borrowings. Net cash paid for tax withholdings from the issuance from common stock related to the vesting of restricted stock units was $0.2 million for the year ended December 31, 2019. Net cash proceeds from the issuance of common stock for the year ended December 31, 2018 was $4.6 million.

***Borrowing Arrangements***

On January 31, 2018, we entered into a Financing Agreement with Cerberus Business Finance, LLC, as agent and lender (the Financing Agreement). The obligations under the Financing Agreement and related guarantees are secured on a first-priority basis (subject to certain liens permitted under the Financing Agreement) by a lien on substantially all the tangible and intangible assets of our company and the subsidiary guarantors, including all of the capital stock held by such obligors, subject to a 65% limitation on pledges of capital stock of certain foreign subsidiaries and certain other exceptions. See Note 14 in the Consolidated Financial Statements included in Part IV, Item 15. of this report “Exhibits, Financial Statement Schedules” for additional details regarding the Financing Agreement and our credit facilities.

As of December 31, 2019 and December 31, 2018, we had borrowings of $55.0 million and $62.4 million respectively, outstanding. We had available borrowing capacity under the revolving line of credit of $8.7 million as of December 31, 2019. As of December 31, 2019, the weighted effective interest rate, net of the impact of our interest rate swap, on our borrowings was 8.5%.

On November 4, 2019, we entered into a Second Amendment to the Financing Agreement with Cerberus Business Finance, LLC, which modified certain provisions effective as of September 30, 2019 related to our quarterly leverage ratio financial covenant amongst other provisions.

In anticipation of the restructuring and related costs in the third quarter and future periods associated with the actions described in the accompanying consolidated financial statements, we began discussions in September 2019 with our lender to request a modification of the terms of the Credit Agreement to exclude the impact of these costs from the maximum leverage ratio covenant. On November 4, 2019, we entered into a Second Amendment of the Financing Agreement with Cerberus Business Finance, LLC, as collateral agent for the Lenders, and PNC Bank, National Association, as administrative agent for the Lenders. This second amendment increases the maximum leverage ratio and amount of restructuring and related costs to be excluded from consolidated EBITDA and decreases the minimum fixed charge ratio. Additionally, the applicable interest rate margin was modified to adjust based on our leverage ratio. We also agreed to extend the prepayment penalty periods and paid a $50,000 amendment fee. Such second amendment is effective for covenant calculations commencing with the period ended September 30, 2019, other than the change in minimum fixed charge ratio which is effective beginning the three months ended December 31, 2019.

Prior to this second amendment, we exceeded the maximum leverage ratio covenant due primarily to costs associated with the resignation of the previous CEO in July 2019 and certain restructuring activity in the period. We are compliant with all covenants under the Financing Agreement as of December 31, 2019 with the completion of such second amendment. We expect to be in compliance with covenants and other terms under the amended credit agreement for at least the next 12 months.

Based on our current operating plans, we expect that our available cash, cash generated from operations and debt capacity will be sufficient to finance current operations, any costs associated with restructuring activities resulting from initiatives described in Part I, Item 1. of this report “Overview” above and capital expenditures for the next 12 months and beyond. Our forecast of the period of time through which our financial resources will be adequate to support our operations is a forward-looking statement that involves risks and uncertainties, and actual results could vary as a result of a number of factors.

**Critical Accounting Policies**

The preparation of financial statements in conformity with accounting principles generally accepted in the United States requires the use of management estimates. Such estimates include the determination and establishment of certain accruals and provisions, including those for inventory excess and obsolescence, income tax and reserves for bad debts. In addition, certain estimates are required in order to determine the value of assets and liabilities associated with acquisitions, as well as defined benefit pension obligations. Estimates are also required to evaluate the value and recoverability of existing long-lived and intangible assets, including goodwill. On an ongoing basis, we review our estimates based upon currently available information. Actual results could differ materially from those estimates.

We believe that our critical accounting policies are as follows:

- revenue recognition;
- accounting for income taxes;
- inventory;
- valuation of identifiable intangible assets in business combinations;
- valuation of long-lived and intangible assets and goodwill; and
- stock-based compensation.

*Revenue recognition.* We follow the provisions of FASB ASC 606, “Revenue from Contracts with Customers”. We recognize revenue of our products when transfer of control of these products to the customer occurs. Transfer of control occurs when the Company has a right to payment, and the customer has legal title to the asset and the customer or their selected carrier has possession, which is typically upon shipment. Revenues on products are generally recognized at a point in time. We recognize revenue on our services when services are performed or over the period of time over which the customer benefits from the service.

For sales for which transfer of control occurs upon shipment, we account for shipping and handling costs as fulfilment costs. As such, we record the amounts billed to the customer for shipping costs as revenue and the costs within cost of revenues upon shipment. For sales, for which control transfers to customers after shipment, we have elected to account for shipping and handling as activities to fulfill the promise to transfer the goods to the customer. We therefore accrue for the costs of shipping undelivered items in the period of shipment.

We make estimates evaluating our allowance for doubtful accounts. On an ongoing basis, we monitor collections and payments from our customers and maintain a provision for estimated credit losses based upon our historical experience and any specific customer collection issues that we have identified. Historically, such credit losses have not been significant, and they have been within our expectations and the provisions established, however, there is no assurance that we will continue to experience the same credit loss rates that we have in the past. A significant change in the liquidity or financial position of our customers could have a material adverse impact on the collectability of our accounts receivable and our future operating results.

*Accounting for income taxes.* We determine our annual income tax provision in each of the jurisdictions in which we operate. This involves determining our current and deferred income tax expense that reflects accounting for differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax bases. The future tax consequences attributable to these differences result in deferred tax assets and liabilities, which are included in our consolidated balance sheets. We assess the recoverability of the deferred tax assets by considering whether it is more likely than not that some portion or all of the deferred tax assets will not be realized. To the extent we believe that recovery does not meet this “more likely than not” standard as required in FASB ASC 740, “Income Taxes”, we must establish a valuation allowance. If a valuation allowance is established, increased or decreased in a period, we allocate the related income tax expense or benefit to income from continuing operations in the consolidated statement of operations.

Management’s judgment and estimates are required in determining our income tax provision, deferred tax assets and liabilities and any valuation allowance recorded against deferred tax assets. We review the recoverability of deferred tax assets during each reporting period by reviewing estimates of future taxable income, future reversals of existing taxable temporary differences, and tax planning strategies that would, if necessary, be implemented to realize the benefit of a deferred tax asset before expiration. Due to our three year cumulative loss position, we concluded that a full valuation allowance was required to offset most U.S. deferred tax assets, net of deferred tax liabilities except deferred tax liabilities related to indefinite lived intangible assets. At December 31, 2019, we have a valuation allowance of $13.7 million, of which $13.2 million relates to our U.S. deferred tax assets. The remainder relates to deferred tax assets in certain foreign jurisdictions.

We assess tax positions taken on tax returns, including recognition of potential interest and penalties, in accordance with the recognition thresholds and measurement attributes outlined in FASB ASC 740. Interest and penalties recognized, if any, would be classified as a component of income tax expense.

*Inventory.* We value our inventory at the lower of the actual cost to purchase (first-in, first-out method) and/or manufacture the inventory or the net realizable value of the inventory. We regularly review inventory quantities on hand and record a provision to write down excess and obsolete inventory to its estimated net realizable value if less than cost, based primarily on historical inventory usage and estimated forecast of product demand. Since forecasted product demand quite often is a function of previous and current demand, a significant decrease in demand could result in an increase in the charges for excess inventory quantities on hand. In addition, our industry is subject to technological change and new product development, and technological advances could result in an increase in the amount of obsolete inventory quantities on hand. Therefore, any significant unanticipated changes in demand or technological developments could have a significant adverse impact on the value of our inventory and our reported operating results.

*Valuation of identifiable intangible assets acquired in business combinations.* The determination of the fair value of intangible assets, which represents a significant portion of the purchase price in our acquisitions, requires the use of significant judgment with regard to (i) the fair value; and (ii) whether such intangibles are amortizable or not amortizable and, if the former, the period and the method by which the intangibles asset will be amortized. We estimate the fair value of acquisition-related intangible assets principally based on projections of cash flows that will arise from identifiable assets of acquired businesses. The projected cash flows are discounted to determine the present value of the assets at the dates of acquisitions. At December 31, 2019, amortizable intangible assets include existing technology, trade names, distribution agreements, customer relationships and patents. These amortizable intangible assets are amortized on a straight-line basis over 7 to 15 years, 10 to 15 years, 4 to 5 years, 5 to 15 years and 5 to 15 years, respectively.

*Valuation of long-lived and intangible assets.* In accordance with the provisions of FASB ASC 360, *"Property, Plant and Equipment"*, we assess the value of identifiable intangibles with finite lives and long-lived assets for impairment whenever events or changes in circumstances indicate that the carrying value may not be recoverable. Factors we consider important which could trigger an impairment review include the following: significant underperformance relative to expected historical or projected future operating results; significant changes in the manner of our use of the acquired assets or the strategy for our overall business; significant negative industry or economic trends; significant changes in who our competitors are and what they do; significant changes in our relationship with our distributors; significant decline in our stock price for a sustained period; and our market capitalization relative to net book value.

If we were to determine that the value of long-lived assets and identifiable intangible assets with finite lives was not recoverable based on the existence of one or more of the aforementioned factors, then the recoverability of those assets to be held and used would be measured by a comparison of the carrying amount of those assets to undiscounted future net cash flows before tax effects expected to be generated by those assets. If such assets are considered to be impaired, the impairment to be recognized would be measured by the amount by which the carrying value of the assets exceeds the fair value of the assets.

*Goodwill and Other Intangible Assets.* FASB ASC 350, *"Intangibles-Goodwill and Others"* addresses financial accounting and reporting for acquired goodwill and other intangible assets. Among other things, FASB ASC 350 requires that goodwill and intangible assets with indefinite useful lives no longer be amortized, but rather tested annually for impairment or more frequently if events or circumstances indicate that there may be impairment. Goodwill is also subject to an annual impairment test, or more frequently, if indicators of potential impairment arise. ASU 2011-08 intends to simplify goodwill impairment testing by permitting an assessment of qualitative factors to determine when events and circumstances lead to the conclusion that it is necessary to perform the two-step goodwill impairment test required under ASC 350. The two-step goodwill impairment test consists of a comparison of the fair value of our reporting units with their carrying amount. If the carrying amount exceeds its fair value, we are required to perform the second step of the impairment test, as this is an indication that goodwill may be impaired. The impairment loss is measured by comparing the implied fair value of the reporting unit's goodwill with its carrying amount. If the carrying amount exceeds the implied fair value, an impairment loss shall be recognized in an amount equal to the excess. After an impairment loss is recognized, the adjusted carrying amount of the intangible asset shall be its new accounting basis. Subsequent reversal of a previously recognized impairment loss is prohibited. For unamortizable intangible assets, if the carrying amount were to exceed the fair value of the asset, we would write down the unamortizable intangible asset to fair value. For the purpose of our goodwill analysis, we have one reporting unit.

We conducted our annual impairment analysis using the income approach, the discounted cash flow method, to derive the fair value in preparing its goodwill impairment assessment. We selected this method as being the most meaningful in preparing the goodwill assessment because the use of the income approach typically generates a more precise measurement of fair value than the market approach. In applying the income approach, we made assumptions about the amount and timing of future expected cash flows, terminal value growth rates and appropriate discount rates. The amount and timing of future cash flows within our discounted cash flow analysis is based on our most recent operational budgets, long range strategic plans and other estimates. The terminal value growth rate is used to calculate the value of cash flows beyond the last projected period in the discounted cash flow analysis and reflects our best estimates for stable, perpetual growth. We used an estimate of market-participant risk adjusted weighted average cost of capital as a basis for determining the discount rate to apply to the future expected cash flows. The results of our test for goodwill impairment showed that the estimated fair value of our business substantially exceeded its carrying value. We concluded that none of our goodwill was impaired.

During the year ended December 31, 2019 we recorded impairment charges against our intangible assets of approximately $1.5 million. See Note 6 in the Consolidated Financial Statements included in Part IV, Item 15. of this report "Exhibits, Financial Statement Schedules" for further discussion regarding impairment charges.

*Stock-based compensation.* We account for stock-based payment awards in accordance with the provisions of FASB ASC 718, *"Compensation—Stock Compensation"*, which requires us to recognize compensation expense for all stock-based payment awards made to employees and directors including stock options, restricted stock units and restricted stock units with a market condition related to our Third Amended and Restated 2000 Stock Option and Incentive Plan, as well as employee stock purchases related to our Employee Stock Purchase Plan (as amended, ESPP). We issue new shares upon stock option exercises, upon the vesting of restricted stock units and restricted stock units with a market condition, and under our ESPP.

FASB ASC 718 requires companies to estimate the fair value of stock-based payment awards on the date of grant using an option-pricing model. The value of the award that vests is recognized as expense over the requisite service periods in our consolidated statement of operations. We account for forfeitures for service-based awards as they occur, with no adjustment for estimated forfeitures.

We value stock-based payment awards, except restricted stock awards, at the grant date using the Black-Scholes option-pricing model. We value the restricted stock units with a market condition at the grant date using a Monte-Carlo valuation simulation. Our determination of fair value of stock-based payment awards on the date of grant using an option-pricing model or Monte-Carlo valuation simulation is affected by our stock price as well as assumptions regarding a number of highly complex and subjective variables. These variables include, but are not limited to, our expected stock price volatility over the term of the awards and actual and projected stock option exercise behaviors.

The fair value of restricted stock units is based on the market price of our common stock on the date of grant and are recorded as compensation expense ratably over the applicable service period, which ranges from one to four years. Unvested restricted stock units are forfeited in the event of termination of employment or engagement with our Company.

We record stock compensation expense on a straight-line basis over the requisite service period for all awards granted.

**Impact of Foreign Currencies**

Our international operations in some instances operate in a natural hedge as we sell our products in many countries and a substantial portion of our revenues, costs and expenses are denominated in foreign currencies, primarily the British pound, the euro, the Canadian dollar and the Swedish krona.

During the year ended December 31, 2019, changes in foreign currency exchange rates resulted in an unfavorable translation effect on our consolidated revenues and on our consolidated net loss. Changes in foreign currency exchange rates resulted in an unfavorable effect on revenues of approximately $1.9 million and a favorable effect on expenses of approximately $1.1 million.

The loss associated with the translation of foreign equity into U.S. dollars included as a component of comprehensive loss during the year ended December 31, 2019, was approximately $(0.5) million, compared to a loss of $(2.9) million for the year ended December 31, 2018.

In addition, the currency exchange rate fluctuations included as a component of net loss resulted in approximately $(0.1) million in currency loss and $0.1 million in currency gain during the year ended December 31, 2019 and 2018, respectively.

**Recent Accounting Pronouncements**

For information on recent accounting pronouncements impacting our business, see “Recent Accounting Pronouncements” included in Note 2 in the Consolidated Financial Statements included in Part IV, Item 15. of this report “Exhibits, Financial Statement Schedules.”

**Item 7A.** ***Quantitative and Qualitative Disclosures about Market Risk.***

The majority of our manufacturing and testing of products occurs in our facilities in the United States, Germany, Sweden and Spain. We sell our products globally through our distributors, direct sales force, websites and catalogs. As a result, our financial results are affected by factors such as changes in foreign currency exchange rates and weak economic conditions in foreign markets.

We collect amounts representing a substantial portion of our revenues and pay amounts representing a substantial portion of our operating expenses in foreign currencies. As a result, changes in currency exchange rates from time to time may affect our operating results.

We are exposed to market risk from changes in interest rates primarily through our financing activities. As of December 31, 2019, we had $55.0 million outstanding under our Financing Agreement. We entered into an interest rate swap contract with PNC bank with a notional amount of $36.0 million and a termination date of January 31, 2023 in order to hedge a portion of the risk of changes in the effective benchmark interest rate (LIBOR) associated with the Financing Agreement. The swap contract converted specific variable-rate debt into fixed-rate debt and fixed the LIBOR rate associated with a portion of the term loan under the Financing Agreement at 2.72%.

As of December 31, 2019, the weighted effective interest rates, net of the impact of our interest rate swaps, on our Term Loan was 8.48%. Assuming no other changes which would affect the margin of the interest rate, the estimated effect of interest rate fluctuations on outstanding borrowings under our Financing Agreement as of December 31, 2019 is quantified and summarized as follows:

| If compared to the rate as of December 31, 2019 | Interest expense increase |
|---|---|
| | (in thousands) |
| Interest rates increase by 1% | $ 262 |
| Interest rates increase by 2% | $ 524 |

**Item 8.** ***Financial Statements and Supplementary Data.***

The information required by this item is contained in the financial statements referenced in Part IV, Item 15. of this report under the caption "Financial Statements, Schedules, and Exhibits," which such financial statements are appended to this report. An index of those financial statements is found on page F-1.

**Item 9.** ***Changes in and Disagreements with Accountants on Accounting and Financial Disclosure.***

None.

**Item 9A.** ***Controls and Procedures.***

This Report includes the certifications of our Chief Executive Officer and Chief Financial Officer required by Rule 13a-14 of the Securities Exchange Act of 1934, as amended (the "Exchange Act"). See Exhibits 31.1 and 31.2. This Item 9A includes information concerning the controls and control evaluations referred to in those certifications.

**(a) Evaluation of Disclosure Controls and Procedures**

Disclosure controls and procedures refer to controls and other procedures designed to ensure that information required to be disclosed in the reports we file or submit under the Exchange Act is recorded, processed, summarized and reported, within the time periods specified in the rules and forms of the U.S. Securities and Exchange Commission. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by us in our reports that we file or submit under the Exchange Act is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer, as appropriate to allow timely decisions regarding our required disclosure. In designing and evaluating our disclosure controls and procedures, our management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving the desired control objectives, and management was required to apply its judgment in evaluating and implementing possible controls and procedures.

We carried out an evaluation, under the supervision and with the participation our Chief Executive Officer and Chief Financial Officer, of the effectiveness of the design and operation of our disclosure controls and procedures (as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act) as of the end of the period covered in this Report. Based upon the evaluation described above, our Chief Executive Officer and Chief Financial Officer have concluded that they believe that our disclosure controls and procedures were effective, as of December 31, 2019, in providing reasonable assurance that information required to be disclosed by us in the reports that we file or submit under the Exchange Act is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer, to allow timely decisions regarding required disclosures, and is recorded, processed, summarized and reported within the time periods specified in the Securities and Exchange Commission's rules and forms.

**(b) Management's Report on Internal Control Over Financial Reporting**

Our management is responsible for establishing and maintaining adequate internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act). Our internal control over financial reporting is a process designed by and under the supervision of our Chief Executive Officer and Chief Financial Officer and effected by our management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of consolidated financial statements for external purposes in accordance with generally accepted accounting principles. Our internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect transactions and dispositions of assets, (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of consolidated financial statements for external purposes in accordance with generally accepted accounting principles, (3) provide reasonable assurance that receipts and expenditures are being made only in accordance with authorizations of management and directors, and (4) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of assets that could have a material effect on the consolidated financial statements.

Because of inherent limitations, internal control over financial reporting may not prevent or detect misstatements. It is a process that involves human diligence and compliance and is therefore subject to human error and misjudgment. In general, evaluations of effectiveness for future periods are subject to risk as controls may become inadequate due to changes in conditions or the degree of compliance with key processes or procedures could deteriorate.

Our management evaluated the effectiveness of our internal control over financial reporting as of December 31, 2018 using the criteria set forth in Internal Control – Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). As a result of that evaluation, management has concluded that our internal control over financial reporting was effective as of December 31, 2019.

The effectiveness of our internal control over financial reporting as of December 31, 2019 has also been audited by Grant Thornton LLP, our independent registered public accounting firm, as stated in their report, which is included below in Item 9A(e).

**(c) Changes in Internal Controls Over Financial Reporting**

There has been no change in the Company's internal control over financial reporting as of December 31, 2019, that has materially affected, or is reasonably likely to materially affect, the Company's internal control over financial reporting.

**(d) Inherent Limitations on Effectiveness of Controls**

The design of any system of control is based upon certain assumptions about the likelihood of future events, and there can be no assurance that any design will succeed in achieving its stated objectives under all future events, no matter how remote, that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may not deteriorate. Because of their inherent limitations, systems of control may not prevent or detect all misstatements. Accordingly, even effective systems of control can provide only reasonable assurance of achieving their control objectives.

**(e) Report of Independent Registered Public Accounting Firm**

**REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM**

Board of Directors and Shareholders
Harvard Bioscience, Inc.

**Opinion on internal control over financial reporting**
We have audited the internal control over financial reporting of Harvard Bioscience, Inc. (a Delaware corporation) and subsidiaries (the "Company") as of December 31, 2019, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2019, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by COSO.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the consolidated financial statements of the Company as of and for the year ended December 31, 2019, and our report dated March 16, 2020 expressed an unqualified opinion on those financial statements.

**Basis for opinion**
The Company's management is responsible for maintaining effective internal control over financial reporting and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report on Internal Control over Financial Reporting ("Management's Report"). Our responsibility is to express an opinion on the Company's internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. Our audit included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, testing and evaluating the design and operating effectiveness of internal control based on the assessed risk, and performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

**Definition and limitations of internal control over financial reporting**
A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ GRANT THORNTON LLP

Boston, Massachusetts
March 16, 2020

**Item 9B. Other Information.**

None.

**PART III**

**Item 10.** ***Directors, Executive Officers and Corporate Governance.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act, in connection with our 2020 Annual Meeting of Stockholders.

**Item 11.** ***Executive Compensation.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2020 Annual Meeting of Stockholders.

**Item 12.** ***Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2020 Annual Meeting of Stockholders.

**Item 13.** ***Certain Relationships and Related Transactions, and Director Independence.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2020 Annual Meeting of Stockholders.

**Item 14.** ***Principal Accounting Fees and Services.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2020 Annual Meeting of Stockholders.

## PART IV

**Item 15.** ***Exhibits, Financial Statement Schedules***

The following documents are filed as part of this Annual Report on Form 10-K or incorporated by reference as indicated

(a) *Financial Statements, Schedules, and Exhibits.* We have listed our consolidated financial statements filed as part of this annual report in the index to consolidated financial statements on page F-1.

(b) *Exhibits.* We have listed the exhibits filed as part of this annual report in the accompanying exhibit index, which follows the signature page to this annual report.

(c) *Financial Statement Schedules.* We have omitted all financial statement schedules because they are not applicable or not required or because we have included the necessary information in our consolidated financial statements or related notes.

**Item 16.** **Form 10-K Summary**

None.

**INDEX TO CONSOLIDATED FINANCIAL STATEMENTS**
**HARVARD BIOSCIENCE, INC.**

**REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM**

Board of Directors and Shareholders
Harvard Bioscience, Inc.

**Opinion on the financial statements**
We have audited the accompanying consolidated balance sheets of Harvard Bioscience, Inc. (a Delaware corporation) and subsidiaries (the "Company") as of December 31, 2019 and 2018, the related consolidated statements of operations, comprehensive loss, changes in stockholders' equity, and cash flows for each of the two years in the period ended December 31, 2019, and the related notes (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2019 and 2018, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2019, in conformity with accounting principles generally accepted in the United States of America.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the Company's internal control over financial reporting as of December 31, 2019, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"), and our report dated March 16, 2020 expressed an unqualified opinion.

**Change in accounting principle**
As discussed in Note 2 to the consolidated financial statements, the Company has changed its method of accounting for leases as of January 1, 2019, due to the adoption of Accounting Standards Codification (ASC) Topic 842, *Leases*.

**Basis for opinion**
These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audits. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

/s/ GRANT THORNTON LLP
We have served as the Company's auditor since 2017.

Boston, Massachusetts
March 16, 2020

**HARVARD BIOSCIENCE, INC.**
**CONSOLIDATED BALANCE SHEETS**
**(In thousands, except share and per share data)**

| | December 31, 2019 | December 31, 2018 |
|---|---|---|
| **Assets** | | |
| Current assets: | | |
| Cash and cash equivalents | $ 8,335 | $ 8,173 |
| Accounts receivable, net | 20,704 | 21,463 |
| Inventories | 22,061 | 25,087 |
| Other current assets | 2,472 | 3,109 |
| Total current assets | 53,572 | 57,832 |
| | | |
| Property, plant and equipment, net | 4,776 | 5,898 |
| Operating lease right-of-use assets | 8,463 | - |
| Goodwill | 57,381 | 57,304 |
| Intangible assets, net | 38,405 | 45,764 |
| Other long-term assets | 2,273 | 1,815 |
| Total assets | $ 164,870 | $ 168,613 |
| | | |
| **Liabilities and Stockholders' Equity** | | |
| Current liabilities: | | |
| Current portion of long-term debt | $ 6,900 | $ 5,982 |
| Current portion of operating lease liabilities | 2,424 | - |
| Accounts payable | 5,339 | 7,359 |
| Deferred revenue | 3,949 | 3,820 |
| Accrued income taxes | 609 | 978 |
| Other current liabilities | 6,091 | 7,350 |
| Total current liabilities | 25,312 | 25,489 |
| | | |
| Long-term debt | 46,917 | 54,813 |
| Deferred tax liability | 1,974 | 2,301 |
| Operating lease liabilities | 8,224 | - |
| Other long-term liabilities | 749 | 3,286 |
| Total liabilities | 83,176 | 85,889 |
| | | |
| Commitments and contingencies | | |
| | | |
| Stockholders' equity: | | |
| Preferred stock, par value $0.01 per share, 5,000,000 shares authorized | - | - |
| Common stock, par value $0.01 per share, 80,000,000 shares authorized; 45,933,715 and 45,124,309 shares issued and 38,188,208 and 37,378,802 shares outstanding, respectively | 438 | 436 |
| Additional paid-in-capital | 229,189 | 226,377 |
| Accumulated deficit | (124,576) | (119,889) |
| Accumulated other comprehensive loss | (12,689) | (13,532) |
| Treasury stock at cost, 7,745,507 common shares | (10,668) | (10,668) |
| Total stockholders' equity | 81,694 | 82,724 |
| Total liabilities and stockholders' equity | $ 164,870 | $ 168,613 |

See accompanying notes to consolidated financial statements.

**HARVARD BIOSCIENCE, INC.**
**CONSOLIDATED STATEMENTS OF OPERATIONS**
**(In thousands, except per share data)**

| | Year Ended December 31, | |
|---|---|---|
| | **2019** | **2018** |
| Revenues | $ 116,176 | $ 120,774 |
| Cost of revenues | 51,854 | 57,593 |
| Gross profit | 64,322 | 63,181 |
| | | |
| Sales and marketing expenses | 23,264 | 24,443 |
| General and administrative expenses | 22,760 | 21,382 |
| Research and development expenses | 10,715 | 10,988 |
| Amortization of intangible assets | 5,746 | 5,384 |
| Impairment charges | 1,460 | - |
| Total operating expenses | 63,945 | 62,197 |
| | | |
| Operating income | 377 | 984 |
| | | |
| Other expense: | | |
| Interest expense, net | (5,410) | (5,367) |
| Other expense, net | (469) | (3,592) |
| Total other expense | (5,879) | (8,959) |
| | | |
| Loss from continuing operations before income taxes | (5,502) | (7,975) |
| Income tax benefit | (815) | (3,676) |
| Loss from continuing operations | (4,687) | (4,299) |
| Discontinued operations: | | |
| Income from discontinued operations before income taxes | - | 936 |
| Income tax benefit | - | (441) |
| Income from discontinued operations | - | 1,377 |
| Net loss | $ (4,687) | $ (2,922) |
| | | |
| (Loss) earnings per share: | | |
| Basic loss per common share from continuing operations | $ (0.12) | $ (0.12) |
| Basic earnings per common share from discontinued operations | - | 0.04 |
| Basic loss per common share | $ (0.12) | $ (0.08) |
| | | |
| Diluted loss per common share from continuing operations | $ (0.12) | $ (0.12) |
| Diluted earnings per common share from discontinued operations | - | 0.04 |
| Diluted loss per common share | $ (0.12) | $ (0.08) |
| | | |
| Weighted-average common shares: | | |
| | | |
| Basic | 37,814 | 36,453 |
| Diluted | 37,814 | 36,453 |

See accompanying notes to consolidated financial statements.

**HARVARD BIOSCIENCE, INC.**
**CONSOLIDATED STATEMENTS OF COMPREHENSIVE LOSS**
**(In thousands)**

| | Year Ended December 31, | |
|---|---|---|
| | **2019** | **2018** |
| Net loss | $ (4,687) | $ (2,922) |
| Other comprehensive income (loss): | | |
| Foreign currency translation adjustments | (543) | (2,875) |
| Derivatives qualifying as hedges, net of tax: | | |
| (Loss) gain on derivative instruments designated and qualifying as cash flow hedges | (572) | (343) |
| Amounts reclassified from accumulated other comprehensive loss to net loss | 139 | 136 |
| Derivatives qualifying as hedges, net of tax | (433) | (207) |
| Defined benefit pension plans, net of tax: | | |
| Amortization of net losses included in net periodic pension costs, net of tax expense of $- 0 - and $56 in 2019 and 2018, respectively | 561 | 275 |
| Net (loss) gain, net of tax benefit of $- 0 - and $10 in 2019 and 2018, respectively | 1,258 | (49) |
| Defined benefit pension plans, net of tax | 1,819 | 226 |
| Other comprehensive income (loss) | 843 | (2,856) |
| Comprehensive loss | $ (3,844) | $ (5,778) |

See accompanying notes to consolidated financial statements.

**HARVARD BIOSCIENCE, INC.**
**CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY**
**(In thousands)**

| | Number of Shares Issued | Common Stock | Additional Paid-in Capital | Accumulated Deficit | Accumulated Other Comprehensive Loss | Treasury Stock | Total Stockholders' Equity |
|---|---|---|---|---|---|---|---|
| **Balance at December 31, 2017** | 42,764 | $ 419 | $ 218,792 | $ (116,967) | $ (10,676) | $ (10,668) | $ 80,900 |
| Stock option exercises | 1,696 | 17 | 5,149 | - | - | - | 5,166 |
| Shares issued under employee stock purchase plan | 89 | 1 | 159 | - | - | - | 160 |
| Vesting of restricted stock units | 915 | - | - | - | - | - | - |
| Shares withheld for taxes | (340) | (1) | (767) | - | - | - | (768) |
| Stock compensation expense | - | - | 3,044 | - | - | - | 3,044 |
| Net loss | - | - | - | (2,922) | - | - | (2,922) |
| Other comprehensive loss | - | - | - | - | (2,856) | - | (2,856) |
| **Balance at December 31, 2018** | 45,124 | $ 436 | $ 226,377 | $ (119,889) | $ (13,532) | $ (10,668) | $ 82,724 |
| Stock option exercises | 4 | - | 11 | - | - | - | 11 |
| Shares issued under employee stock purchase plan | 191 | 2 | 323 | - | - | - | 325 |
| Vesting of restricted stock units | 818 | - | - | - | - | - | - |
| Shares withheld for taxes | (203) | - | (556) | - | - | - | (556) |
| Stock compensation expense | - | - | 3,034 | - | - | - | 3,034 |
| Net loss | - | - | - | (4,687) | - | - | (4,687) |
| Other comprehensive income | - | - | - | - | 843 | - | 843 |
| **Balance at December 31, 2019** | 45,934 | $ 438 | $ 229,189 | $ (124,576) | $ (12,689) | $ (10,668) | $ 81,694 |

See accompanying notes to consolidated financial statements.

**HARVARD BIOSCIENCE, INC.**
**CONSOLIDATED STATEMENTS OF CASH FLOWS**
**(In thousands)**

| | Year Ended December 31, | |
|---|---|---|
| | **2019** | **2018** |
| Cash flows from operating activities: | | |
| Net loss | $ (4,687) | $ (2,922) |
| Adjustments to reconcile net loss to net cash provided by operating activities: | | |
| Depreciation | 1,987 | 2,423 |
| Amortization of intangible assets | 5,746 | 5,431 |
| Amortization of deferred financing costs | 385 | 645 |
| Stock-based compensation expense | 3,034 | 3,044 |
| Impairment charges | 1,460 | - |
| Gain on sale of Denville | - | (1,251) |
| Provision for allowance for doubtful accounts | 288 | 25 |
| Deferred income taxes | (398) | (2,861) |
| Other non-cash charges | 188 | 25 |
| Changes in operating assets and liabilities: | | |
| Accounts receivable | 468 | (2,792) |
| Inventories | 3,260 | 2,554 |
| Other current assets | 165 | (124) |
| Accounts payable | (2,048) | 1,593 |
| Accrued income taxes | (363) | 612 |
| Other current liabilities | (1,256) | (3,149) |
| Deferred revenue | 121 | 2,492 |
| Other long-term liabilities | (305) | (2,861) |
| Net cash provided by operating activities | 8,045 | 2,884 |
| | | |
| Cash flows from investing activities: | | |
| Additions to property, plant and equipment | (1,216) | (986) |
| Other | (15) | (16) |
| Acquisition, net of cash acquired | - | (68,548) |
| Disposition, net of cash sold | 1,002 | 15,754 |
| Net cash used in investing activities | (229) | (53,796) |
| | | |
| Cash flows from financing activities: | | |
| Proceeds from issuance of debt | 4,300 | 70,700 |
| Repayments of debt | (11,703) | (20,198) |
| Payments of debt issuance costs | - | (2,006) |
| (Net taxes paid) net proceeds from issuance of common stock | (221) | 4,557 |
| Net cash (used in) provided by financing activities | (7,624) | 53,053 |
| | | |
| Effect of exchange rate changes on cash | (30) | 299 |
| Increase in cash and cash equivalents | 162 | 2,440 |
| Cash and cash equivalents at beginning of period | 8,173 | 5,733 |
| Cash and cash equivalents at end of period | $ 8,335 | $ 8,173 |
| | | |
| Supplemental disclosures of cash flow information: | | |
| Cash paid for interest | $ 5,496 | $ 4,987 |
| Cash paid for income taxes, net of refunds | $ 374 | $ 98 |

See accompanying notes to consolidated financial statements.

**HARVARD BIOSCIENCE, INC.**
**NOTES TO CONSOLIDATED FINANCIAL STATEMENTS**

## 1. Organization

Harvard Bioscience, Inc., a Delaware corporation, is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and pre-clinical testing for drug development. The Company's products and services are sold globally to customers ranging from renowned academic institutions and government laboratories, to the world's leading pharmaceutical, biotechnology and clinical research organizations. With operations in North America and Europe, the Company has sales through a combination of direct and distribution channels to customers around the world.

## 2. Summary of Significant Accounting Policies

### *(a) Principles of Consolidation*

The consolidated financial statements include the accounts of Harvard Bioscience, Inc. and its wholly-owned subsidiaries. All intercompany balances and transactions have been eliminated in consolidation.

### *(b) Use of Estimates*

The preparation of financial statements in conformity with accounting principles generally accepted in the United States requires the use of management estimates. Such estimates include the determination and establishment of certain accruals and provisions, including those for inventory excess and obsolescence, income tax and reserves for bad debts. In addition, certain estimates are required in order to determine the value of assets and liabilities associated with acquisitions, as well as the Company's defined benefit pension obligations. Estimates are also required to evaluate the value and recoverability of existing long-lived and intangible assets, including goodwill. On an ongoing basis, the Company reviews its estimates based upon currently available information. Actual results could differ materially from those estimates.

### *(c) Cash and Cash Equivalents*

The Company considers all highly liquid instruments with original maturities of three months or less to be cash equivalents. Cash and cash equivalents include cash on hand and amounts due from banks. The Company maintains a portion of its cash in bank deposits, which at times, may exceed federally insured limits. The Company has not experienced any losses in such accounts. The Company does not believe it is exposed to any significant risk with respect to these accounts.

### *(d) Allowance for Doubtful Accounts*

The allowance for doubtful accounts reflects the Company's best estimate of probable losses inherent in the accounts receivable balance. The Company determines the allowance based on considering factors such as historical experience, credit quality, known troubled accounts, historical experience, factors that may affect a customer's ability to pay and other currently available evidence.

### *(e) Inventories*

The Company values its inventories at the lower of the actual cost to purchase (first-in, first-out method) and/or manufacture the inventories or the net realizable value of the inventories. The Company regularly reviews inventory quantities on hand and records a provision to write down excess and obsolete inventories to its estimated net realizable value if less than cost, based primarily on historical inventory usage and estimated forecast of product demand.

### *(f) Property, Plant and Equipment*

Property, plant and equipment are stated at cost and depreciated using the straight-line method over the estimated useful lives of the assets as follows:

| | |
|---|---|
| Machinery and equipment | 3 - 10 years |
| Computer equipment and software | 3 - 7 years |
| Furniture and fixtures | 5 - 10 years |

Property and equipment held under capital leases and leasehold improvements are amortized using the straight-line method over the shorter of the lease term or estimated useful life of the asset.

***(g) Leases***

The Company accounts for its leases in accordance with ASC 842 Leases. The Company leases office space, manufacturing facilities, automobiles and equipment. The Company concludes on whether an arrangement is a lease at inception. This determination as to whether an arrangement contains a lease is based on an assessment as to whether a contract conveys the right to the Company to control the use of identified property, plant or equipment for period of time in exchange for consideration. Leases with an initial term of 12 months or less are not recorded on the balance sheet. The Company recognizes these lease expenses on a straight-line basis over the lease term.

The Company has assessed its contracts and concluded that its leases consist of operating leases. Operating leases are included in operating lease right-of-use (ROU) assets, current portion of operating lease liabilities, and operating lease liabilities in the Company's consolidated balance sheets.

ROU assets represent the Company's right to use an underlying asset for the lease term and lease liabilities represent the Company's obligation to make lease payments arising from the lease. Operating lease ROU assets and liabilities are recognized at commencement date based on the present value of lease payments over the lease term. As most of the Company's leases do not provide an implicit rate, the Company determines an incremental borrowing rate based on the information available at commencement date in determining the present value of lease payments. The incremental borrowing rate represents a significant judgment that is based on an analysis of the Company's credit rating, country risk, treasury and corporate bond yields, as well as comparison to the Company's borrowing rate on its most recent loan. The Company uses the implicit rate when readily determinable. The operating lease ROU asset also includes any lease payments made and excludes lease incentives. Lease expense for lease payments is recognized on a straight-line basis over the lease term. The Company has lease agreements with lease and non-lease components, which are generally accounted for separately. Additionally, for its leases, the Company applies a portfolio approach to effectively account for the operating lease ROU assets and liabilities.

***(h) Income Taxes***

Income taxes are accounted for under the asset and liability method. Deferred tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax bases. Deferred tax assets and liabilities are measured using enacted tax rates expected to be applied to taxable income in the years in which those temporary differences are expected to be recovered or settled. The effect on deferred tax assets and liabilities of a change in tax rates is recognized in income in the period that includes the enactment date.

The Company recognizes the effect of income tax positions only if those positions are more likely than not of being sustained. Recognized income tax positions are measured at the largest amount that is more than 50% likely of being realized. Changes in recognition are reflected in the period in which the judgement occurs.

***(i) Foreign Currency Translation***

The functional currency of the Company's foreign subsidiaries is generally their local currency. All assets and liabilities of its foreign subsidiaries are translated at exchange rates in effect at period-end. Income and expenses are translated at rates which approximate those in effect on the transaction dates. The resulting translation adjustment is recorded as a separate component of stockholders' equity in accumulated other comprehensive (loss) income ("AOCI") in the consolidated balance sheets. Gains and losses resulting from foreign currency transactions are included in net (loss) income.

***(j) Earnings per Share***

Basic earnings per share is computed by dividing net income by the weighted average number of shares of common stock outstanding during the periods presented. The computation of diluted earnings per share is similar to the computation of basic earnings per share, except that the denominator is increased for the assumed exercise of dilutive options and other potentially dilutive securities using the treasury stock method unless the effect is antidilutive. Since the Company is reporting discontinued operations, it used income from continuing operations as the control number in determining whether those potential dilutive securities are dilutive or antidilutive.

***(k) Comprehensive (Loss) Income***

The Company follows the provisions of Financial Accounting Standards Board ("FASB") Accounting Standards Codification ("ASC") 220, "Comprehensive Income". FASB ASC 220 requires companies to report all changes in equity during a period, resulting from net (loss) income and transactions from non-owner sources, in a financial statement in the period in which they are recognized. The Company has chosen to disclose comprehensive (loss) income, which encompasses net (loss) income, foreign currency translation adjustments, gains and losses on derivatives, the underfunded status of its pension plans, and pension minimum additional liability adjustments, net of tax, in the consolidated statements of comprehensive (loss) income.

***(l) Revenue Recognition***

*Nature of contracts and customers*

The Company's contracts are primarily of short duration and are mostly based on the receipt and fulfilment of purchase orders. The purchase orders are binding and include pricing and all other relevant terms and conditions.

The Company's customers are primarily research scientists at pharmaceutical and biotechnology companies, universities, hospitals, government laboratories, including the United States National Institute of Health (NIH) and contract research organizations. The Company also has global and regional distribution partners, and original equipment manufacturer (OEM) customers who incorporate its products into their products under their own brands.

*Performance obligations*

The Company's performance obligations under its revenue contracts consist of its instruments, equipment, accessories, services, maintenance and extended warranties. Equipment also includes software that functions together with the tangible equipment to deliver its essential functionality. Contracts with customers may contain multiple promises such as delivery of hardware, software, professional services or post-contract support services. These promises are accounted for as separate performance obligations if they are distinct. For contracts with customers that contain multiple performance obligations, the transaction price is allocated to the separate performance obligations based on estimated relative standalone selling price, which does not materially differ from the stated price in the contract. In general, the Company's list prices are indicative of standalone selling price.

Instruments, equipment and accessories consist of a range of products that are used in life sciences research. Revenues from the sales of these items are recognized when transfer of control of these products to the customer occurs. Transfer of control occurs when the Company has a right to payment, and the customer has legal title to the asset and the customer or their selected carrier has possession, which is typically upon shipment. Sales on these items are therefore generally recognized at a point in time.

The Company's equipment revenue also includes the sale of wireless implantable monitors that are used for life science research purposes. The Company sells these wireless implantable monitors to pharmaceutical companies, contract research organizations and academic laboratories. In addition to sales generated from new and existing customers, these implantable devices are also sold under a program called the "exchange program". Under this program, customers may return an implantable monitor to the Company after use, and if the returned monitor can be reprocessed and resold, they may, in exchange, purchase a replacement implantable monitor of the same model at a lower price than a new monitor. The implantable monitors that are returned by customers are reprocessed and made available for future sale. The initial sale of implantable monitors and subsequent sale of replacement implantable monitors are independent transactions. The Company has no obligation in connection with the initial sale to sell replacement implantable monitors at any future date under any fixed terms and may refuse returned implantable monitors that cannot be recovered or are obsolete. The Company has concluded that the offer to its customers that they may purchase a discounted product in the future is not a material right based on the applicable guidance within ASC 606.

Service revenues consist of installation, training, data analysis, and surgeries performed on research animals. Maintenance revenue consists of post-contract support provided in relation to software that is embedded within the equipment that is sold to the customer. The Company provides standard warranties that promise the customer that the product will work as promised. These standard warranties are not a separate performance obligation. Extended warranties relate to warranties that are separately priced, and purchased in addition to a standard warranty, and are therefore a separate performance obligation. The Company has made the judgment that the customer benefits as the Company performs over the period of the contract, and therefore revenues from service, maintenance and warranty contracts are recognized over time. The Company uses the input method to recognize revenue over time, based on time elapsed, which is generally on a straight-line basis over the service period. The period over which maintenance and warranty contracts is recognized is typically one year. The period over which service revenues is recognized is generally less than one month.

For sales for which transfer of control occurs upon shipment, the Company accounts for shipping and handling costs as fulfilment costs. As such, the Company records the amounts billed to the customer for shipping costs as revenue and the costs within cost of revenues upon shipment. For sales, for which control transfers to customers after shipment, the Company has elected to account for shipping and handling as activities to fulfill the promise to transfer the goods to the customer. The Company therefore accrues for the costs of shipping undelivered items in the period of shipment.

Revenues expected to be recognized related to any and all remaining performance obligations are generally expected to be recognized in one year or less, as the majority of the Company's contracts have a term of less than one year.

*Variable Consideration*

The nature of the Company's contracts gives rise to certain types of variable consideration, including in limited cases volume and payment discounts. The Company analyzes sales that could include variable consideration and estimates the expected or most likely amount of revenue after returns, trade-ins, discounts, rebates, credits, and incentives. Product returns are estimated and accrued for, based on historical information. In making these estimates, the Company considers whether the amount of variable consideration is constrained and is included in revenue only to the extent that it is probable that a significant reversal of the revenue recognized will not occur when the uncertainty associated with the variable consideration is subsequently resolved. Variable consideration, and its impact on the Company’s revenue recognition, was not material in any of the periods presented.

The Company’s payment terms are generally from zero to sixty days from the time of invoicing, which generally occurs at the time of shipment or prior to services being performed. Payment terms vary by the type of its customers and the products or services offered.

Sales taxes, value added taxes, and certain excise taxes collected from customers and remitted to governmental authorities are accounted for on a net basis and are therefore excluded from revenues.

*Deferred revenue*

The Company records deferred revenue when cash is collected from customers prior to satisfaction of the Company’s performance obligation to the customer. Deferred revenue consists of amounts deferred related to service contracts and revenue deferred as a result of payments received in advance from customers. Deferred revenue is generally expected to be recognized within one year.

The amounts included in deferred revenue from advanced payments relate to amounts that are prepaid for wireless implantable monitors under the exchange program. The Company has made the judgment that these payments do not represent a significant financing component as the customer can exercise their discretion as to when they can obtain the products that they have made a prepayment for.

Advanced payments received from customers are recorded as a liability, and revenue is recognized when the Company’s performance obligations are completed. Performance obligations are completed when the product is shipped or delivered to the customer, or at the end of the exchange program if goods are not acquired prior to the termination of the contract period.

*Disaggregation of revenue*

Refer to Note 18 for revenue disaggregated by type and by geographic region as well as further information about the deferred revenue balances.

***(m) Valuation of Identifiable Intangible Assets Acquired in Business Combinations***

The determination of the fair value of intangible assets, which represents a significant portion of the purchase price in the Company’s acquisitions, requires the use of significant judgment with regard to (i) the fair value; and (ii) whether such intangibles are amortizable or not amortizable and, if the former, the period and the method by which the intangibles asset will be amortized. The Company estimates the fair value of acquisition-related intangible assets principally based on projections of cash flows that will arise from identifiable assets of acquired businesses. The projected cash flows are discounted to determine the present value of the assets at the dates of acquisitions. At December 31, 2019, amortizable intangible assets include existing technology, trade names, distribution agreements, customer relationships and patents. These amortizable intangible assets are amortized on a straight-line basis over 7 to 15 years, 10 to 15 years, 4 to 5 years, 5 to 15 years and 5 to 15 years, respectively.

***(n) Goodwill and Other Intangible Assets***

Goodwill and unamortizable intangible assets acquired in a business combination and determined to have an indefinite useful life are not amortized, but instead are tested for impairment annually or more frequently if events or changes in circumstances indicate that the asset might be impaired, in accordance with the provisions of FASB ASC 350, “Intangibles—Goodwill and Other”.

For the purpose of its goodwill analysis, the Company has one reporting unit. The Company conducted its annual impairment analysis in the fourth quarter of fiscal year 2019. The goodwill impairment test is a two-step process. The first step of the impairment analysis compares the Company’s fair value to its carrying value to determine if there is any indication of impairment. Step two of the analysis compares the implied fair value of goodwill to its carrying amount in a manner similar to a purchase price allocation for business combination. If the carrying amount of goodwill exceeds its implied fair value, an impairment loss is recognized equal to that excess. For indefinite-lived intangible assets if the carrying amount exceeds the fair value of the asset, the Company would write down the indefinite-lived intangible asset to fair value.

At December 31, 2019, the fair value of the Company significantly exceeded the carrying value. The Company concluded that none of its goodwill was impaired.

The Company evaluates indefinite-lived intangible assets for impairment annually and when events occur, or circumstances change that may reduce the fair value of the asset below its carrying amount. Events or circumstances that might require an interim evaluation include unexpected adverse business conditions, economic factors, unanticipated technological changes or competitive activities, loss of key personnel and acts by governments and courts. Refer to Note 6 for further details regarding impairment of indefinite-lived intangible assets.

***(o) Impairment of Long-Lived Assets***

The Company assesses recoverability of its long-lived assets that are held for use, such as property, plant and equipment and amortizable intangible assets in accordance with FASB ASC 360, “Property, Plant and Equipment” when events or changes in circumstances indicate that the carrying amount of an asset or asset group may not be recoverable. Recoverability of assets or an asset group to be held and used is measured by a comparison of the carrying amount of an asset or asset group to estimated undiscounted future cash flows expected to be generated by the asset or the asset group. Cash flow projections are based on trends of historical performance and management’s estimate of future performance. If the carrying amount of the asset or asset group exceeds the estimated future cash flows, an impairment charge is recognized by the amount by which the carrying amount of the asset or asset group exceeds its estimated fair value. At December 31, 2019, the Company concluded that none of its long-lived assets were impaired.

***(p) Derivatives***

The Company uses interest-rate-related derivative instruments to manage its exposure related to changes in interest rates on its variable-rate debt instruments. The Company does not enter into derivative instruments for any purpose other than cash flow hedging. The Company does not speculate using derivative instruments. The Company recognizes all derivative instruments as either assets or liabilities in the balance sheet at their respective fair values. For derivatives designated in hedging relationships, changes in the fair value are either offset through earnings against the change in fair value of the hedged item attributable to the risk being hedged or recognized in AOCI, to the extent the derivative is effective at offsetting the changes in cash flows being hedged until the hedged item affects earnings.

The Company only enters into derivative contracts that it intends to designate as a hedge of a forecasted transaction or the variability of cash flows to be received or paid related to a recognized asset or liability (cash flow hedge). For all hedging relationships, the Company formally documents the hedging relationship and its risk-management objective and strategy for undertaking the hedge, the hedging instrument, the hedged transaction, the nature of the risk being hedged, how the hedging instrument’s effectiveness in offsetting the hedged risk will be assessed prospectively and retrospectively, and a description of the method used to measure ineffectiveness. The Company also formally assesses, both at the inception of the hedging relationship and on an ongoing basis, whether the derivatives that are used in hedging relationships are highly effective in offsetting changes in cash flows of hedged transactions. For derivative instruments that are designated and qualify as part of a cash flow hedging relationship, the effective portion of the gain or loss on the derivative is reported as a component of other comprehensive income and reclassified into earnings in the same period or periods during which the hedged transaction affects earnings. Gains and losses on the derivative representing either hedge ineffectiveness or hedge components excluded from the assessment of effectiveness are recognized in current earnings.

The Company discontinues hedge accounting prospectively when it determines that the derivative is no longer effective in offsetting cash flows attributable to the hedged risk, the derivative expires or is sold, terminated, or exercised, the cash flow hedge is de-designated because a forecasted transaction is not probable of occurring, or management determines to remove the designation of the cash flow hedge.

In all situations in which hedge accounting is discontinued and the derivative remains outstanding, the Company continues to carry the derivative at its fair value on the balance sheet and recognizes any subsequent changes in its fair value in earnings. When it is probable that a forecasted transaction will not occur, the Company discontinues hedge accounting and recognizes immediately in earnings gains and losses that were accumulated in other comprehensive income related to the hedging relationship.

***(q) Fair Value of Financial Instruments***

The carrying values of the Company's cash and cash equivalents, trade accounts receivable and trade accounts payable and short-term debt approximate their fair values because of the short maturities of those instruments. The fair value of the Company's long-term debt approximates its carrying value and is based on the amount of future cash flows associated with the debt discounted using current borrowing rates for similar debt instruments of comparable maturity.

Financial reporting standards define a fair value hierarchy that consists of three levels:

- Level 1 includes instruments for which quoted prices in active markets for identical assets or liabilities accessible to the Company at the measurement date.

- Level 2 includes instruments for which the valuations are based on quoted prices for similar assets or liabilities, quoted prices in markets that are not active, or other inputs that are observable or can be corroborated by observable data for substantially the full term of the assets or liabilities.

- Level 3 includes valuations based on inputs that are unobservable and significant to the overall fair value measurement.

***(r) Stock-based Compensation***

The Company accounts for stock-based payment awards in accordance with the provisions of FASB ASC 718, "Compensation—Stock Compensation", which requires it to recognize compensation expense for all stock-based payment awards made to employees and directors including stock options, restricted stock units, and restricted stock units with a market condition related to our Third Amended and Restated 2000 Stock Option and Incentive Plan (as amended, the "Third A&R Plan") as well as employee stock purchases ("employee stock purchases") related to its Employee Stock Purchase Plan (as amended, the "ESPP"). The Company issues new shares upon stock option exercises, upon vesting of restricted stock units and restricted stock units with a market condition, and under the Company's ESPP.

Stock-based compensation expense recognized is based on the value of the portion of stock-based payment awards that is ultimately expected to vest. The Company values stock-based payment awards, except restricted stock units at grant date using the Black-Scholes option-pricing model ("Black-Scholes model"). The Company values restricted stock units with a market condition using a Monte-Carlo valuation simulation. The determination of fair value of stock-based payment awards on the date of grant using an option-pricing model or Monte-Carlo valuation simulation is affected by its stock price as well as assumptions regarding certain variables. These variables include, but are not limited to its expected stock price volatility over the term of the awards and actual and projected stock option exercise behaviors.

The fair value of restricted stock units is based on the market price of the Company's stock on the date of grant and are recorded as compensation expense on a straight-line basis over the applicable service period, which ranges from one to four years. Unvested restricted stock units are forfeited in the event of termination of employment with the Company.

Stock-based compensation expense recognized under FASB ASC 718 for the years ended December 31, 2019 and 2018 consisted of stock-based compensation expense related to stock options, the employee stock purchase plan, and the restricted stock units and was recorded as a component of cost of product revenues, sales and marketing expenses, general and administrative expenses, research and development expenses and discontinued operations. Refer to Note 13 for further details.

***(s) Recent Accounting Pronouncements***

*Accounting Pronouncements to be Adopted*

In June 2016, the FASB issued ASU No. 2016-13, *Financial Instruments—Credit Losses (Topic 326): Measurement of Credit Losses on Financial Instruments*, which amends the impairment model by requiring entities to use a forward-looking approach based on expected losses rather than incurred losses to estimate credit losses on certain types of financial instruments, including trade receivables. This may result in the earlier recognition of allowances for losses. The FASB issued several ASUs after ASU 2016-13 to clarify implementation guidance and to provide transition relief for certain entities. ASU 2016-13 is effective for the Company for fiscal years beginning after December 15, 2022, with early adoption permitted. The Company is evaluating the impact of adopting ASU 2016-13 and related amendments will have on its consolidated financial position, results of operations and cash flows.

In August 2018, the FASB issued ASU No. 2018-14, *Disclosure Framework—Changes to the Disclosure Requirements for Defined Benefit Plans*, which amends ASC 715 to add, remove and clarify disclosure requirements related to defined benefit pension and other postretirement plans. The ASU is effective for public entities for fiscal years beginning after December 15, 2020, with early adoption permitted. Management has not yet completed its assessment of the impact of the new standard on the Company's Consolidated Financial Statements.

In December 2019, the FASB issued ASU 2019-12, *Income Taxes (Topic 740): Simplifying the Accounting for Income Taxes*, which enhances and simplifies various aspects of the income tax accounting guidance related to intra-period tax allocation, interim period accounting for enacted changes in tax law, and the year-to-date loss limitation in interim period tax accounting. ASU 2019-12 also amends other aspects of the guidance to reduce complexity in certain areas. ASU 2019-12 will become effective for the Company on January 1, 2021. Early adoption is permitted. The Company is evaluating the impact of adopting this guidance to its financial statements and related disclosures.

*Accounting Pronouncements Recently Adopted*

In August 2017, the FASB issued ASU No. 2017-12, Derivatives and Hedging (Topic 815) which amends the hedge accounting recognition and presentation requirements in ASC 815, Derivatives and Hedging. The Board's objectives in issuing the ASU are to (1) improve the transparency and understandability of information conveyed to financial statement users about an entity's risk management activities by better aligning the entity's financial reporting for hedging relationships with those risk management activities and (2) reduce the complexity of and simplify the application of hedge accounting by preparers. The ASU is effective for annual reporting periods, including interim periods within those annual reporting periods, beginning after December 15, 2018. The Company adopted this guidance as of January 1, 2019, and it did not have a material impact on its consolidated financial position, results of operations and cash flows.

In February 2016, the FASB issued ASU No. 2016-02, Leases, which is intended to improve financial reporting about leasing transactions. The update requires a lessee to record on its balance sheet the assets and liabilities for the rights and obligations created by lease terms of more than 12 months. The update is effective for fiscal years beginning after December 15, 2018. A modified retrospective transition approach is required for leases existing at, or entered into after, the beginning of the earliest comparative period presented in the financial statements, with certain practical expedients available. The Company elected to utilize a practical expedient in its method of adoption of the standard and adopted the guidance as of January 1, 2019. Under this expedient, which is a "current-period adjustment method," the Company applied ASC 842 as of January 1. 2019, and recognized operating lease liabilities of $11.7 million and right of use assets of $9.4 million for all leases with lease terms of more than 12 months. There was no impact to retained earnings as of that date. In addition, the Company adopted the guidance by electing the following practical expedients: (1) the Company did not reassess whether any expired or existing contracts contained leases, (2) the Company did not reassess the lease classification for any expired or existing leases, and (3) the Company excluded variable payments from the lease contract consideration and recorded those as incurred. The Company's future commitments under lease obligations and additional disclosures are summarized in Note 12.

***(t) Discontinued Operation***

As disclosed in Note 5, on January 22, 2018, the Company sold substantially all the assets of its operating subsidiary, Denville Scientific, Inc. (Denville). The sale of Denville represented a strategic shift that had a major effect on the Company's operations and financial results. As such and pursuant to Accounting Standards Codification (ASC) 205-20 – *Presentation of Financial Statements - Discontinued Operations*, the operating results of Denville for the year ended December 31, 2018 has been presented in discontinued operations in the consolidated statements of operations. These adjustments had no effect on total amounts within the consolidated balance sheet, consolidated statements of operations and comprehensive income (loss), consolidated statements of cash flows for any of the periods presented.

***(u) Prior Period Financial Statement Correction of Immaterial Error***

During the quarter ended March 31, 2019, the Company identified an immaterial misclassification error in the Company's consolidated balance sheet as of December 31, 2018. The immaterial misclassification understated the current portion of the long term debt balance and overstated the long-term debt balance, less current installments. This misclassification, in the amount of approximately $4.0 million, related to the classification of the Company's excess cash flow payment made to its lenders during the month ended April 30, 2019 as long term instead of current on its consolidated balance sheet at December 31, 2018. The misclassification had no impact on the total reported debt. Refer to footnote 14 for further details. The Company assessed the materiality of this error on the financial statements for prior periods in accordance with the SEC Staff Accounting Bulletin (SAB) No. 99, Materiality, codified in Accounting Standards Codification (ASC) 250, Presentation of Financial Statements, and concluded that it was not material to any prior annual or interim periods. The Company recorded an adjustment to decrease the long term debt balance, less current installments and increase the current portion of the long term debt balance in the consolidated balance sheet at December 31, 2018 with no impact on total reported debt.

**3. Accumulated Other Comprehensive Loss**

Changes in each component of accumulated other comprehensive loss, net of tax are as follows:

| (in thousands) | Foreign currency translation adjustments | Derivatives qualifying as hedges | Defined benefit pension plans | Total |
|---|---|---|---|---|
| **Balance at December 31, 2017** | $ (9,755) | $ 37 | $ (958) | $ (10,676) |
| Other comprehensive (loss) income before reclassifications | (2,875) | (343) | (49) | (3,267) |
| Amounts reclassified from AOCI | - | 136 | 275 | 411 |
| Net other comprehensive (loss) income | (2,875) | (207) | 226 | (2,856) |
| **Balance at December 31, 2018** | $ (12,630) | $ (170) | $ (732) | $ (13,532) |
| Other comprehensive income (loss) before reclassifications | (543) | (572) | 1,258 | 143 |
| Amounts reclassified from AOCI | - | 139 | 561 | 700 |
| Net other comprehensive (loss) income | (543) | (433) | 1,819 | 843 |
| **Balance at December 31, 2019** | $ (13,173) | $ (603) | $ 1,087 | $ (12,689) |

The amounts reclassified out of accumulated other comprehensive (loss) income are as follows:

| (in thousands) | Affected line item in the Statements of Operations | Year Ended December 31, 2019 | 2018 |
|---|---|---|---|
| **Amounts Reclassified From AOCI** | | | |
| Derivatives qualifying as hedges | | | |
| Realized loss on derivatives qualifying as hedges | Interest expense, net | $ 139 | $ 136 |
| Income tax | Income tax (benefit) expense | - | - |
| | | 139 | 136 |
| Defined benefit pension plans | | | |
| Amortization of net losses included in net periodic pension costs | General and administrative expenses | 561 | 331 |
| Income tax | Income tax (benefit) expense | - | (56) |
| | | 561 | 275 |
| Total reclassifications | | $ 700 | $ 411 |

## 4. Acquisition

On January 31, 2018, the Company acquired all of the issued and outstanding shares of Data Sciences International, Inc. (DSI), a Delaware corporation, for approximately $71.1 million. The Company funded the acquisition from its existing cash balances, excess proceeds from the Denville Transaction discussed in Note 5, and proceeds from the Financing Agreement discussed in Note 14.

DSI, a St. Paul, Minnesota-based life science research company, is a recognized leader in physiologic monitoring focused on delivering preclinical products, systems, services and solutions to its customers. Its customers include pharmaceutical and biotechnology companies, as well as contract research organizations, academic labs and government researchers. This acquisition diversifies the Company's customer base into the biopharmaceutical and contract research organization markets.

The results of operations for DSI have been included in the Company's consolidated financial statements from the date of acquisition. Included in the net loss for the year ended December 31, 2018 was a $3.8 million charge recognized in cost of revenues related to purchase accounting inventory fair value step up amortization. The total inventory fair value step up was recognized into cost of revenues over one inventory turn, or approximately six months. Also included in the net loss of DSI for that period was $2.9 million of intangible asset amortization expense.

The following consolidated pro forma information is based on the assumption that was used at the time of the acquisition of DSI. Accordingly, the historical results have been adjusted to reflect amortization expense, interest expense and other purchase accounting adjustments that would have been recognized on such a pro forma basis. The pro forma information is presented for comparative purposes only and is not necessarily indicative of the financial position or results of operations which would have been reported had the Company completed the acquisition during these periods or which might be reported in the future.

| | Year Ended December 31, 2018 (in thousands, unaudited) |
|---|---|
| Pro Forma | |
| Revenues | $ 124,319 |
| Income from continuing operations | 3,614 |

Direct acquisition costs recorded in other expense, net in the Company's consolidated statements of operations were $3.4 million for the year ended December 31, 2018.

## 5. Discontinued Operations

On January 22, 2018, the Company sold substantially all the assets of its wholly owned subsidiary, Denville, for approximately $20.0 million, which included a $3.0 million earn-out provision (the Denville Transaction). Upon the closing of the transaction, the Company received net cash proceeds of $15.7 million. The earn-out provision represented contingent consideration of up to $2.0 million based on Denville achieving certain performance metrics with respect to 2018 operating results and up to $1.0 million based on Denville achieving certain performance metrics with respect to 2019 operating results. The Company has determined that the 2018 performance metrics were not achieved and expects that the 2019 performance metrics will not be achieved.

The following table is a reconciliation of the major line items of income from discontinued operations presented within the Company's consolidated statements of operations for the years ended December 31, 2018.

| | Year Ended December 31, 2018 |
|---|---|
| | (in thousands) |
| Revenues | $ 893 |
| Cost of revenues | (534) |
| Operating and other expenses | (674) |
| Gain on disposal of discontinued operations | 1,251 |
| Income from discontinued operations before income taxes | $ 936 |
| Income tax benefit | (441) |
| Income from discontinued operations | 1,377 |

During the year ended December 31, 2019, the Company received a release of an escrow amount of $1.0 million related to the Denville Transaction, which is included in the investing cash flows from disposition in the Company's consolidated statements of cash flows for the year ended December 31, 2019. Total operating cash flows for Denville in the Company's consolidated statements of cash flows for the year ended December 31, 2018, were immaterial.

## 6. Goodwill and Intangible Assets

*Goodwill*

The change in the carrying amount of goodwill for the year ended December 31, 2019 and 2018 are as follows:

| | December 31, 2019 | December 31, 2018 |
|---|---|---|
| | (in thousands) | |
| Carrying amount at beginning of year | $ 57,304 | $ 36,336 |
| Goodwill arising from business combination | - | 21,865 |
| Effect of change in currency translation | 77 | (897) |
| Carrying amount at end of year | $ 57,381 | $ 57,304 |

*Intangible assets*

| | | December 31, 2019 | | | December 31, 2018 | | |
|---|---|---|---|---|---|---|---|
| | | (in thousands) | | | | | |
| Amortizable intangible assets: | Weighted Average Life* (Years) | Gross | Accumulated Amortization | Net | Gross | Accumulated Amortization | Net |
| Distribution agreements/customer relationships | 9.8 | $ 17,891 | $ (6,340) | $ 11,551 | $ 22,657 | $ (9,509) | $ 13,148 |
| Existing technology | 6.1 | 41,222 | (19,698) | 21,524 | 41,268 | (16,215) | 25,053 |
| Trade names | 6.8 | 7,692 | (3,497) | 4,195 | 7,828 | (2,861) | 4,967 |
| In-process R&D | - | - | - | - | 1,387 | (30) | 1,357 |
| Patents | - | 218 | (218) | - | 211 | (204) | 7 |
| Total amortizable intangible assets | | $ 67,023 | $ (29,753) | $ 37,270 | $ 73,351 | $ (28,819) | $ 44,532 |
| Indefinite-lived intangible assets: | | | | 1,135 | | | 1,232 |
| Total intangible assets | | | | $ 38,405 | | | $ 45,764 |

* Weighted average life as of December 31, 2019.

Intangible asset amortization expense from continuing operations was $5.7 million and $5.4 million for the years ended December 31, 2019 and 2018, respectively. Amortization expense of existing amortizable intangible assets is currently estimated to be $5.5 million for the year ending December 31, 2020, $5.5 million for the year ending December 31, 2021, $5.5 million for the year ending December 31, 2022, $5.3 million for the year ending December 31, 2023, and $5.3 million for the year ending December 31, 2024.

During the year ended December 31, 2019, the Company recorded (i) an impairment charge of $0.9 million related to certain of its in-process research and development intangible assets and reclassified $0.4 million as completed technology; (ii) an impairment charge of $0.5 million related to customer relationships, existing technology, and trade names intangible assets as a result of the decision to discontinue one of the Company's product lines and cease operations in its facility in North Carolina, and (iii) an impairment charge of $0.1 million and retired $5.3 million of fully amortized intangible assets related to customer relationships, existing technology, and trade names intangible assets as a result of the Company's periodic evaluation of its intangible assets.

There were no impairment charges recognized during the year ended December 31, 2018.

## 7. Inventories

As of December 31, 2019, and December 31, 2018, inventories consist of the following:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Finished goods | $ 5,561 | $ 6,936 |
| Work in process | 3,153 | 3,667 |
| Raw materials | 13,347 | 14,484 |
| Total | $ 22,061 | $ 25,087 |

## 8. Property, Plant and Equipment

As of December 31, 2019 and December 31, 2018, property, plant and equipment consist of the following:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Machinery and equipment | $ 7,198 | $ 9,678 |
| Computer equipment and software | 8,954 | 9,685 |
| Leasehold improvements | 2,151 | 2,468 |
| Furniture and fixtures | 1,321 | 1,390 |
| Automobiles | 92 | 115 |
| | 19,716 | 23,336 |
| Less: accumulated depreciation | (14,940) | (17,438) |
| Property, plant and equipment, net | $ 4,776 | $ 5,898 |

During the year ended December 31, 2019, the Company removed approximately $4.8 million of fully depreciated and disposed of property and equipment from its fixed asset records.

## 9. Restructuring and Other Exit Costs

During 2019, the Board of Directors of the Company approved a restructuring program designed to improve gross margins and operating margins while reinvesting in resources required to deliver sustained, profitable organic growth. The restructuring program will entail consolidating and downsizing several sites and includes headcount reductions in Europe and North America to improve operational efficiency and reduce costs.

The restructuring program is expected to be completed by the end of 2020, with the majority of activities completed in the first half of 2020. The Company expects to incur costs associated with headcount reductions, program management and other transition costs necessary to affect the site consolidations and other business improvements including the $1.4 million restructuring costs incurred during the year ended December 31, 2019. Substantially all of these costs are expected to result in future cash outlays.

The following table summarizes the activity for accrued restructuring liability for the year ended December 31, 2019:

| (in thousands) | Cost of Revenues | Severance Costs | Impairment | Other | Total |
|---|---|---|---|---|---|
| Restructuring charges | $ 235 | $ 530 | $ 460 | $ 129 | $ 1,354 |
| Non-cash charges | (235) | - | (460) | (10) | (705) |
| Cash payments | - | (166) | - | (115) | (281) |
| Balance at December 31, 2019 | $ - | $ 364 | $ - | $ 4 | $ 368 |

Of the $1.4 million restructuring costs incurred during the year ended December 31, 2019, $0.5 million has been recorded as impairment of intangible assets in the accompanying consolidated statements of operations, $0.2 million has been included in cost of revenues, and the remaining costs of $0.7 million have been included as a component of selling, general and administrative expenses. As of December 31, 2019, the Company had a restructuring liability of $0.4 million which is payable within the next twelve months and has been included in other current liabilities in the consolidated balance sheet.

## 10. Related Party Transactions

As part of the acquisitions of Multi Channel Systems MCS GmbH (MCS) and Triangle BioSystems, Inc. (TBSI) in 2014, the Company signed lease agreements with the former owners of these acquired companies. The principals of such former owners of MCS and TBSI became employees of the Company. Pursuant to these lease agreements, the Company made rent payments of approximately $0.3 million for each of the years ended December 31, 2019 and 2018.

## 11. Employee Benefit Plans

The Company sponsors profit sharing retirement plans for its U.S. employees, which includes employee savings plans established under Section 401(k) of the U.S. Internal Revenue Code (the “401(k) Plans”). The 401(k) Plans cover substantially all full-time employees who meet certain eligibility requirements. Contributions to the 401(k) Plans are at the discretion of management. For the years ended December 31, 2019 and 2018, the Company contributed approximately $0.4 million and $0.5 million, respectively, to the 401(k) Plans.

The Company’s subsidiary in the United Kingdom, Biochrom Limited maintains contributory, defined benefit or defined contribution pension plans for substantially all of its employees. In 2014, these defined benefit pension plans were closed to new employees, as well as closed to the future accrual of benefits for existing employees. The provisions of FASB ASC 715-20 require that the funded status of the Company’s pension plans be recognized in its balance sheet. FASB ASC 715-20 does not change the measurement or income statement recognition of these plans, although it does require that plan assets and benefit obligations be measured as of the balance sheet date. The Company has historically measured the plan assets and benefit obligations as of the balance sheet date.

The components of the Company's net period benefit cost were as follows:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Components of net periodic benefit cost: | | |
| Interest cost | 484 | 502 |
| Expected return on plan assets | (761) | (779) |
| Net amortization loss | 336 | 222 |
| Recognition of net gain/loss due to settlements | 228 | 110 |
| Net periodic benefit cost | $ 287 | $ 55 |

The measurement date is December 31 for these plans. The funded status of the Company's defined benefit pension plans and the amount recognized in the consolidated balance sheets at December 31, 2019 and 2018 is as follows:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Change in benefit obligation: | | |
| Balance at beginning of year | $ 18,701 | $ 21,126 |
| Service cost | - | 24 |
| Interest cost | 484 | 502 |
| Actuarial (gain) loss | 1,513 | (1,056) |
| Settlements due to transfers paid | (871) | (267) |
| Benefits paid | (447) | (521) |
| Currency translation adjustment | 647 | (1,107) |
| Balance at end of year | $ 20,027 | $ 18,701 |

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Change in fair value of plan assets: | | |
| Balance at beginning of year | $ 17,819 | $ 19,972 |
| Actual return on plan assets | 3,172 | (1,058) |
| Employer contributions | 831 | 741 |
| Settlement due to transfers paid | (931) | (263) |
| Benefits paid | (447) | (521) |
| Currency translation adjustment | 670 | (1,052) |
| Balance at end of year | $ 21,114 | $ 17,819 |

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Benefit obligation: | | |
| Funded status | $ 1,087 | $ (882) |
| Unrecognized net loss | N/A | N/A |
| Net asset (liability) recognized | $ 1,087 | $ (882) |

The amounts recognized in the consolidated balance sheets consist of:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Other long term assets (liabilities) | $ 1,087 | $ (882) |
| Deferred income tax assets | - | 150 |
| Net amount recognized | $ 1,087 | $ (732) |

The amounts recognized in accumulated other comprehensive loss, net of tax consist of:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Funded status of pension plans | $ 1,087 | $ (732) |
| Net amount recognized | $ 1,087 | $ (732) |

The weighted average assumptions used in determining the net pension cost for these plans follows:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| Discount rate | 2.02% | 2.65% |
| Expected return on assets | 3.84% | 4.68% |

The discount rate assumptions used for pension accounting reflect the prevailing rates available on high-quality, fixed-income debt instruments with terms that match the average expected duration of the Company's defined benefit pension plan obligations. The Company uses the iBoxx AA 15yr+ index, which matches the average duration of its pension plan liability of approximately 15 years.

The Company's mix of pension plan investments among asset classes also affects the long-term expected rate of return on plan assets. As of December 31, 2019, the Company's actual asset mix approximated its target mix. Differences between actual and expected returns are recognized in the calculation of net periodic pension (income)/cost over the average remaining expected future working lifetime, which is approximately 15 years, of active plan participants.

The fair value and asset allocations of the Company's pension benefits as of December 31, 2019 and 2018 measurement dates were as follows:

| | December 31, | | | |
|---|---|---|---|---|
| | 2019 | | 2018 | |
| | (in thousands) | | | |
| Asset category: | | | | |
| Equity securities | $ 11,534 | 55% | $ 9,134 | 51% |
| Debt securities | 3,919 | 19% | 3,274 | 18% |
| Liability driven investment funds | 3,615 | 17% | 4,341 | 24% |
| Cash and cash equivalents | 1,514 | 7% | 618 | 4% |
| Other | 532 | 3% | 452 | 3% |
| Total | $ 21,114 | 100% | $ 17,819 | 100% |

Financial reporting standards define a fair value hierarchy that consists of three levels. The fair values of the plan assets by fair value hierarchy level as of December 31, 2019 and 2018 is as follows:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Quoted Prices in Active Markets for Identical Assets (Level 1) | $ 1,514 | $ 618 |
| Significant Other Observable Inputs (Level 2) | 19,600 | 17,201 |
| Significant Other Unobservable Inputs (Level 3) | - | - |
| Total | $ 21,114 | $ 17,819 |

Level 1 assets consist of cash and cash equivalents held in the pension plans at December 31, 2019. The Level 2 assets primarily consist of investments in private investment funds that are valued using the net asset values provided by the trust or fund, including an insurance contract. Although these funds are not traded in an active market with quoted prices, the investments underlying the net asset value are based on quoted prices.

The Company expects to contribute at least $0.9 million to its pension plans during 2020. The benefits expected to be paid from the pension plans are $0.5 million in 2020, $0.5 million in 2021, $0.6 million in 2022, $0.7 million in 2023 and $0.8 million in 2024. The expected benefits to be paid in the five years from 2025—2029 are $4.2 million. The expected benefits are based on the same assumptions used to measure the Company's benefit obligation at December 31, 2019.

## 12. Leases

The Company has noncancelable operating leases for office, manufacturing facilities, warehouse space, automobiles and equipment expiring at various dates through 2024. As discussed in Footnote 1, the Company adopted ASC 842 as of January 1, 2019, using a current period adjustment method. In accordance with this method, the Company recognized a right of use asset of $9.4 million and an operating lease liability of $11.7 million as of January 1, 2019. As a result of using the current period adjustment method, the lease expense for the year ended December 31, 2019 and 2018 was recognized under ASC 842, and ASC 840, the previous standard, respectively.

The components of lease expense for the year ended December 31, 2019 are as follows:

| | Year Ended December 31, 2019 |
|---|---|
| | (in thousands) |
| Operating lease cost | $ 2,084 |
| Short term lease cost | 245 |
| Sublease income | (429) |
| Total lease cost | $ 1,900 |

Supplemental cash flow information related to the Company's operating leases was as follows:

| | Year Ended December 31, 2019 |
|---|---|
| | (in thousands) |
| Cash paid for amounts included in the measurement of lease liabilities: | $ 2,530 |
| Right-of-use assets obtained in exchange for lease obligations: | $ 177 |

Supplemental balance sheet information related to the Company's operating leases was as follows:

| | December 31, 2019 |
|---|---|
| | (in thousands) |
| Operating lease right-of use assets | $ 8,463 |
| | |
| Current portion, operating lease liabilities | $ 2,424 |
| Operating lease liabilities, long term | 8,224 |
| Total operating lease liabilities | $ 10,648 |
| | |
| Weighted average remaining lease term (in years) | 8.1 |
| Weighted average discount rate | 9.2% |

Since most of the Company's leases do not provide an implicit rate, the Company determines an incremental borrowing rate based on the information available at commencement date in determining the present value of lease payments.

Future minimum lease payments for operating leases, with initial or remaining terms in excess of one year at December 31, 2019, are as follows:

| | Operating Leases |
|---|---|
| | (in thousands) |
| 2020 | $ 2,426 |
| 2021 | 1,945 |
| 2022 | 1,862 |
| 2023 | 1,832 |
| 2024 | 1,587 |
| Thereafter | 5,889 |
| Total lease payments | 15,541 |
| Less interest | (4,893) |
| Total operating lease liabilities | $ 10,648 |

As presented in our 2018 Form 10-K, the future minimum lease payments for operating leases, with initial or remaining terms in excess of one year at December 31, 2018 were:

| | Operating Leases |
|---|---|
| | (in thousands) |
| 2019 | $ 2,250 |
| 2020 | 2,247 |
| 2021 | 1,987 |
| 2022 | 1,966 |
| 2023 | 1,990 |
| Thereafter | 7,559 |
| Net minimum lease payments | $ 17,999 |

Total rent expense was $3.2 million and $1.8 million for the year ended December 31, 2018 and 2017, respectively.

## 13. Capital Stock and Stock-Based Compensation

*Common Stock*

On February 5, 2008, the Company's Board of Directors adopted a Shareholder Rights Plan and declared a dividend distribution of one preferred stock purchase right for each outstanding share of the Company's common stock to shareholders of record as of the close of business on February 6, 2008. These rights were not initially exercisable and would trade with the shares of the Company's common stock. The rights would become exercisable under various conditions according to the terms of the plan. The Shareholder Rights Plan expired, with no rights having become exercisable, in accordance with its terms on the close of business on February 6, 2018.

*Preferred Stock*

The Company's Board of Directors has the authority to issue up to 5.0 million shares of preferred stock and to determine the price privileges and other terms of the shares. The Board of Directors may exercise this authority without any further approval of stockholders. As of December 31, 2019, the Company had no preferred stock issued or outstanding.

*Employee Stock Purchase Plan (as amended, the ESPP)*

In 2000, the Company approved the ESPP. Under this ESPP, participating employees can authorize the Company to withhold a portion of their base pay during consecutive six-month payment periods for the purchase of shares of the Company's common stock. At the conclusion of the period, participating employees can purchase shares of the Company's common stock at 85% of the lower of the fair market value of the Company's common stock at the beginning or end of the period. Shares are issued under the ESPP for the six-month periods ending June 30 and December 31. On May 16, 2019, the stockholders of the Company approved an increase of 350,000 shares of common stock in the number of shares available for issuance under the ESPP. Following such amendment, 1,400,000 shares of common stock are authorized for issuance, of which 1,081,404 shares were issued as of December 31, 2019. There were 190,642 and 89,308 shares issued under the ESPP during the years ended December 31, 2019 and 2018, respectively. As of December 31, 2019, there were 318,596 shares available for issuance under the plan.

*Third Amended and Restated 2000 Stock Option and Incentive Plan (as amended, the Third A&R Plan)*

On May 25, 2011, the stockholders of the company approved the Third A&R Plan, which such plan currently authorizes the grant of stock options and stock-based awards to officers, employees, non-employee directors and other key persons of the Company and its subsidiaries. The Third Amendment to the Third A&R Plan (the Amendment) was adopted by the Board of Directors on April 2, 2018. Such Amendment was approved by the stockholders at the Company's 2018 Annual Meeting of Stockholders. Pursuant to the Amendment, the aggregate number of shares authorized for issuance under the Third A&R Plan was increased by 3,400,000 shares to 20,908,929.

*Restricted Stock Units with a Market Condition (the Market Condition RSUs)*

On August 3, 2015, the Compensation Committee of the Board of Directors of the Company approved and granted deferred stock awards of Market Condition RSUs (the 2015 Market Condition RSUs) to certain members of the Company's management team under the Third A&R Plan. The vesting of these 2015 Market Condition RSUs was cliff-based and linked to the achievement of a relative total shareholder return of the Company's common stock from August 3, 2015 to the earlier of (i) August 3, 2018 or (ii) upon a change of control (measured relative to the Russell 3000 index and based on the 20-day trading average price before each such date). As of August 3, 2018, certain of the target total shareholder returns were achieved, and as a result, 69,667 of the 2015 Market Condition RSUs vested. The remaining 2015 Market Condition RSUs did not vest and were canceled.

In 2018, the Compensation Committee of the Board of Directors of the Company approved and granted deferred stock awards of Market Condition RSUs (the 2018 Market Condition RSUs) to certain members of the Company's management team under the Third A&R Plan. The vesting of the 2018 Market Condition RSUs is based on a graded-vesting schedule (one third at the end of each year for three years) and linked to the achievement of a relative total shareholder return of the Company's common stock from May 24, 2018 to the earlier of (i) May 24, 2019 or (ii) upon a change of control (measured relative to the NASDAQ Biotechnology index and based on the 20-day trading average price before each such date).

In 2019, the Compensation Committee of the Board of Directors of the Company approved and granted deferred stock awards of Market Condition RSUs (the 2019 Market Condition RSUs) to certain members of the Company's management team under the Third A&R Plan. The vesting of the 2019 Market Condition RSUs is based on a graded-vesting schedule (one third at the end of each year for three years) and linked to the achievement of a relative total shareholder return of the Company's common stock from the 2019 Market Condition RSUs grant date to the earlier of (i) the anniversary date of the grant or (ii) upon a change of control (measured relative to the NASDAQ Biotechnology index and based on the 20-day trading average price before each such date).

As of December 31, 2019, the target number of these restricted stock units that may be earned is 529,491 shares; the maximum amount is 150% of the target number.

*Stock-Based Payment Awards*

The Company accounts for stock-based payment awards in accordance with the provisions of FASB ASC 718, which requires it to recognize compensation expense for all stock-based payment awards made to employees and directors including stock options, restricted stock units, Market Condition RSUs and employee stock purchases related to the ESPP. The Company has elected as an accounting policy to account for forfeitures for service-based awards as they occur, with no adjustment for estimated forfeitures.

Stock option and restricted stock unit activity under the Company's Third A&R Plan for the years ended December 31, 2018 and 2019 were as follows:

| | Stock Options | | Restricted Stock Units | | Market Condition RSU's | |
|---|---|---|---|---|---|---|
| | Stock Options Outstanding | Weighted Average Exercise Price | Restricted Stock Units Outstanding | Grant Date Fair Value | Market Condition RSU's Outstanding | Grant Date Fair Value |
| Balance at December 31, 2017 | 3,780,244 | $ 3.95 | 1,796,927 | $ 2.69 | 164,127 | $ 4.81 |
| Granted | 104,585 | 4.48 | 639,126 | 4.31 | 156,944 | 4.19 |
| Exercised | (1,696,255) | 3.50 | - | - | - | - |
| Vested (RSUs) | - | - | (845,326) | 2.88 | (69,667) | 4.81 |
| Cancelled / forfeited | (231,842) | 4.96 | (356,965) | 2.84 | (134,460) | 4.63 |
| Balance at December 31, 2018 | 1,956,732 | 4.25 | 1,233,762 | 3.36 | 116,944 | 4.19 |
| Granted | 943,424 | 3.28 | 1,652,720 | 2.31 | 605,005 | 1.98 |
| Exercised | (3,750) | 2.98 | - | - | - | - |
| Vested (RSUs) | - | - | (813,762) | 3.29 | (3,778) | 4.19 |
| Cancelled / forfeited | (630,284) | 3.96 | (482,270) | 3.42 | (188,680) | 4.18 |
| Balance at December 31, 2019 | 2,266,122 | $ 3.93 | 1,590,450 | $ 2.27 | 529,491 | $ 1.67 |

*Earnings per share*

Basic earnings per share is based upon net income divided by the number of weighted average common shares outstanding during the period. The calculation of diluted earnings per share assumes conversion of stock options, restricted stock units and Market Condition RSUs into common stock using the treasury method. The weighted average number of shares used to compute basic and diluted earnings per share consists of the following:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| Basic | 37,813,580 | 36,453,126 |
| Dillutive effect of equity awards | - | - |
| Diluted | 37,813,580 | 36,453,126 |

Excluded from the shares used in calculating the diluted earnings per common share in the above table are options, restricted stock units and Market Condition RSUs of approximately 4,386,063 and 3,307,438 shares of common stock for the years ended December 31, 2019 and 2018, respectively, as the impact of these shares would be anti-dilutive.

The Company's policy is to issue stock available from its registered but unissued stock pool through its transfer agent to satisfy stock option exercises and vesting of the restricted stock units.

The following table summarizes information concerning currently outstanding and exercisable options as of December 31, 2019 (Aggregate Intrinsic Value, in thousands):

| | Options Outstanding | | | | Options Exercisable | | | |
|---|---|---|---|---|---|---|---|---|
| Range of Exercise Price | Number Outstanding at Dec. 31, 2019 | Weighted Average Remaining Contractual Life in Years | Weighted Average Exercise Price | Aggregate Intrinsic Value | Shares Exercisable at Dec. 31, 2019 | Weighted Average Remaining Contractual Life in Years | Weighted Average Exercise Price | Aggregate Intrinsic Value |
| $1.78 - 2.59 | 234,399 | 6.48 | $ 2.14 | $ 213 | 94,069 | 1.94 | $ 2.57 | $ 45 |
| 2.60 - 2.94 | 208,414 | 9.52 | 2.84 | 44 | 10,000 | 7.25 | 2.60 | 5 |
| 2.95 - 3.49 | 264,571 | 8.00 | 3.23 | - | 148,400 | 7.45 | 3.27 | - |
| 3.50 - 3.92 | 305,839 | 7.32 | 3.74 | - | 166,431 | 5.76 | 3.70 | - |
| 3.93 - 4.08 | 65,849 | 1.42 | 4.04 | - | 65,849 | 1.42 | 4.04 | - |
| 4.09 - 4.17 | 355,625 | 4.41 | 4.12 | - | 355,625 | 4.41 | 4.12 | - |
| 4.18 - 4.38 | 370,000 | 3.93 | 4.30 | - | 370,000 | 3.93 | 4.30 | - |
| 4.39 - 5.39 | 141,550 | 5.56 | 4.99 | - | 126,550 | 5.22 | 5.04 | - |
| 5.40 - 5.54 | 174,875 | 5.18 | 5.51 | - | 174,875 | 5.18 | 5.51 | - |
| 5.55 - 5.75 | 145,000 | 5.65 | 5.58 | - | 137,500 | 5.49 | 5.57 | - |
| **$1.78 - 5.78** | **2,266,122** | **5.95** | **$ 3.93** | **$ 257** | **1,649,299** | **4.70** | **$ 4.28** | **$ 50** |

The aggregate intrinsic value in the preceding table represents the total pre-tax intrinsic value, based on the Company's closing stock price of $3.05 as of December 31, 2019, which would have been received by the option holders had all option holders exercised their options as of that date. The aggregate intrinsic value of options exercised for the year ended December 31, 2019 was not material. The aggregated intrinsic value of options exercised for the year ended December 31, 2018 was approximately $2.6 million. The total number of in-the-money options that were exercisable as of December 31, 2019 was 189,069.

For the year ended December 31, 2019, the total compensation costs related to unvested awards not yet recognized is $3.7 million and the weighted average period over which it is expected to be recognized is approximately 2 years.

*Valuation and Expense Information under Stock-Based-Payment Accounting*

Stock-based compensation expense related to stock options, restricted stock units, Market Condition RSU's and the employee stock purchase plan for the years ended December 31, 2019 and 2018 was allocated as follows:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Cost of product revenues | $ 43 | $ 64 |
| Sales and marketing | 119 | 431 |
| General and administrative | 2,710 | 2,232 |
| Research and development | 162 | 167 |
| Discontinued operations | - | 150 |
| Total stock-based compensation | $ 3,034 | $ 3,044 |

The Company did not capitalize any stock-based compensation.

The weighted-average estimated fair value per share of stock options granted during 2019 and 2018 was $1.40 and $1.83, respectively, using the Black Scholes option-pricing model with the following weighted-average assumptions:

| | 2019 | 2018 |
|---|---|---|
| Volatility | 48.11% | 43.28% |
| Risk-free interest rate | 2.12% | 2.84% |
| Expected holding period (in years) | 4.7 | 4.8 |
| Dividend Yield | -% | -% |

The weighted average fair value of the 2019 Market Condition RSUs during the year ended December 31, 2019 was $1.98. The weighted average fair value of the 2018 Market Condition RSUs granted during the year ended December 31, 2018 was $4.19. The following assumptions were used to estimate the fair value, using a Monte-Carlo valuation simulation, of the Market Condition RSUs granted during the year ended December 31, 2018:

| | 2019 | 2018 |
|---|---|---|
| Volatility | 58.96% | 44.02% |
| Risk-free interest rate | 1.99% | 2.27% |
| Correlation coefficient | 23.59% | 0.07% |
| Dividend yield | -% | -% |

The Company used historical volatility to calculate the expected volatility as of December 31, 2019. Historical volatility was determined by calculating the mean reversion of the daily adjusted closing stock price. The risk-free interest rate assumption is based upon observed U.S. Treasury bill interest rates (risk-free) appropriate for the term of the Company's stock options. The expected holding period of stock options represents the period of time options are expected to be outstanding and were based on historical experience. The vesting period ranges from one to four years and the contractual life is ten years.

## 14. Long Term Debt

On January 22, 2018, in connection with the closing of the Denville Transaction, the Company terminated the Third Amended and Restated Credit Agreement (the Credit Agreement), among the Company, Brown Brothers Harriman & Co. and each of the other lenders party thereto, and Bank of America, as administrative agent. All outstanding amounts under the agreement were repaid in full using a portion of the proceeds of the Denville Transaction. At the time of repayment, there was approximately $11.9 million outstanding.

On January 31, 2018, the Company entered into a financing agreement by and among the Company and certain subsidiaries of the Company parties thereto, as borrowers (collectively, the Borrower), certain subsidiaries of the Company parties thereto, as guarantors, various lenders from time to time party thereto (the Lenders), and Cerberus Business Finance, LLC, as collateral agent and administrative agent for the Lenders (the Financing Agreement).

On August 16, 2018, the Company and Cerberus Business Finance, LLC entered into a First Amendment to the Financing Agreement, which such amendment modified certain provisions related to the borrowing base and reporting, among other things.

On November 4, 2019, the Company and Cerberus Business Finance, LLC entered into a Second Amendment to the Financing Agreement, which modified certain provisions effective as of September 30, 2019 related to the Company's quarterly leverage ratio financial covenant amongst other provisions.

The Financing Agreement provided for senior secured credit facilities (the Senior Secured Credit Facilities) comprised of a $64.0 million term loan and up to a $25.0 million revolving line of credit. The proceeds of the term loan and $4.8 million of advances under the revolving line of credit were used to fund a portion of the DSI acquisition, and to pay fees and expenses related thereto and the closing of the Senior Secured Credit Facilities. In addition, the revolving facility is available for use by the Company and its subsidiaries for general corporate and working capital needs, and other purposes to the extent permitted by the Financing Agreement. The Senior Secured Credit Facilities matures in 2023.

Commencing on March 31, 2018, the outstanding term loans began to amortize in equal quarterly installments equal to $0.4 million per quarter on such date and during each of the next three quarters thereafter, $0.6 million per quarter during the next four quarters thereafter and $0.8 million per quarter thereafter, with a balloon payment at maturity. Furthermore, within ten days of the Company's delivery of its audited annual financial statements each year, the term loans are permanently reduced pursuant to certain mandatory prepayment events including an annual "excess cash flow sweep" of 50% of the consolidated excess cash flow; provided that, in any fiscal year, any voluntary prepayments of the term loans shall be credited against the Company's "excess cash flow" prepayment obligations on a dollar-for-dollar basis for such fiscal year. During the year ended December 31, 2019, the Company made an excess cash flow payment of $4.0 million and a payment of $1.0 million in connection with the release of an escrow amount associated with the Denville Transaction discussed in Note 5 as required by the Financing Agreement.

The obligations of the Borrower under the Senior Secured Credit Facilities are unconditionally guaranteed by the Company and certain of the Company's existing and subsequently acquired or organized subsidiaries. The Senior Secured Credit Facilities and related guarantees are secured on a first-priority basis (subject to certain liens permitted under the Financing Agreement) by a lien on substantially all the tangible and intangible assets of the Borrower and the subsidiary guarantors, including all of the capital stock held by such obligors (subject to a 65% limitation on pledges of capital stock of foreign subsidiaries), subject to certain exceptions.

Interest on all loans under the Senior Secured Credit Facilities is paid monthly. Borrowings under the Financing Agreement accrue interest at a per annum rate equal to, at the Borrower's option, a base rate plus 4.75% or a London Interbank Offered Rate (LIBOR) rate plus 6.25%. The loans are also subject to a 1.25% interest rate floor for LIBOR loans and a 4.25% interest rate floor for base rate loans.

The Financing Agreement contains customary representations and warranties and affirmative covenants applicable to the Company and its subsidiaries and also contains certain restrictive covenants, including, among others, limitations on the incurrence of additional debt, liens on property, acquisitions and investments, loans and guarantees, mergers, consolidations, liquidations and dissolutions, asset sales, dividends and other payments in respect of the Company's capital stock, prepayments of certain debt, transactions with affiliates and modifications of organizational documents, material contracts, affiliated practice agreements and certain debt agreements. The Financing Agreement contains customary events of default and is subject to covenant and working capital borrowing restrictions. The Company had available borrowing capacity under the revolving line of credit of $8.7 million as of December 31, 2019.

As of December 31, 2019, the weighted effective interest rate, net of the impact of the Company's interest rate swap, on its borrowings was 8.48%. The carrying value of the debt approximates fair value because the interest rate under the obligation approximates market rates of interest available to the Company for similar instruments.

As of December 31, 2019, and December 31, 2018, the Company's borrowings were comprised of:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Long-term debt: | | |
| Term loan | $ 54,997 | 62,400 |
| Revolving line | - | - |
| Total unamortized deferred financing costs | (1,180) | (1,605) |
| Total debt | 53,817 | 60,795 |
| Less: current installments | (3,200) | (2,400) |
| Less: excess cash flow sweep | (4,093) | (3,983) |
| Current unamortized deferred financing costs | 393 | 401 |
| Long-term debt | $ 46,917 | $ 54,813 |

The aggregate amounts of debt maturing during the next five years are as follows:

| | (in thousands) |
|---|---|
| 2020 | $ 7,293 |
| 2021 | 3,200 |
| 2022 | 3,200 |
| 2023 | 41,304 |
| Total | $ 54,997 |

**15. Derivatives**

The Company uses interest-rate-related derivative instruments to manage its exposure related to changes in interest rates on its variable-rate debt instruments. The Company does not enter into derivative instruments for any purpose other than cash flow hedging. The Company does not speculate using derivative instruments.

By using derivative financial instruments to hedge exposures to changes in interest rates, the Company exposes itself to credit risk and market risk. Credit risk is the failure of the counterparty to perform under the terms of the derivative contract. When the fair value of a derivative contract is positive, the counterparty owes the Company, which creates credit risk for the Company. When the fair value of a derivative contract is negative, the Company owes the counterparty and, therefore, the Company is not exposed to the counterparty's credit risk in those circumstances. The Company minimizes counterparty credit risk in derivative instruments by entering into transactions with carefully selected major financial institutions based upon their credit profile.

Market risk is the adverse effect on the value of a derivative instrument that results from a change in interest rates. The market risk associated with interest-rate contracts is managed by establishing and monitoring parameters that limit the types and degree of market risk that may be undertaken.

The Company assesses interest rate risk by continually identifying and monitoring changes in interest rate exposures that may adversely impact expected future cash flows and by evaluating hedging opportunities. The Company maintains risk management control systems to monitor interest rate risk attributable to both the Company's outstanding and forecasted debt obligations as well as the Company's offsetting hedge positions. The risk management control systems involve the use of analytical techniques, including cash flow sensitivity analysis, to estimate the expected impact of changes in interest rates on the Company's future cash flows.

The Company uses variable-rate LIBOR debt to finance its operations. The debt obligations expose the Company to variability in interest payments due to changes in interest rates. Management believes that it is prudent to limit the variability of a portion of its interest payments. To meet this objective, management enters into LIBOR based interest rate swap agreements to manage fluctuations in cash flows resulting from changes in the benchmark interest rate of LIBOR. These swaps change the variable-rate cash flow exposure on the debt obligations to fixed cash flows. Under the terms of the interest rate swaps, the Company receives LIBOR based variable interest rate payments and makes fixed interest rate payments, thereby creating the equivalent of fixed-rate debt for the notional amount of its debt hedged.

As disclosed in Note 14, on January 31, 2018, the Company entered into a Financing Agreement comprised of a $64.0 million term loan and up to a $25.0 million revolving line of credit. Shortly after entering into this Financing Agreement, the Company entered into an interest rate swap contract with PNC Bank with a notional amount of $36.0 million and a termination date of January 1, 2023 in order to hedge the risk of changes in the effective benchmark interest rate (LIBOR) associated with the Company's Term Loan. The swap contract converted specific variable-rate debt into fixed-rate debt and fixed the LIBOR rate associated with a portion of the term loan under the Financing Agreement at 2.72%. The interest rate swap was designated as a cash flow hedge instrument in accordance with ASC 815 "Derivatives and Hedging".

The following table presents the notional amount and fair value of the Company's derivative instruments as of December 31, 2019 and December 31, 2018.

| | | December 31, 2019 | |
|---|---|---|---|
| | | Notional Amount | Fair Value (a) |
| **Derivatives instruments** | **Balance sheet classification** | (in thousands) | |
| Interest rate swaps | Other long term liabilities | $ 28,821 | $ (603) |

| | | December 31, 2018 | |
|---|---|---|---|
| | | Notional Amount | Fair Value (a) |
| **Derivatives instruments** | **Balance sheet classification** | (in thousands) | |
| Interest rate swaps | Other long term liabilities | $ 34,090 | $ (170) |

(a) See Note 16 for the fair value measurements related to these financial instruments.

All of the Company's derivative instruments are designated as hedging instruments. The Company has structured its interest rate swap agreements to be 100% effective and as a result, there was no impact to earnings resulting from hedge ineffectiveness. Changes in the fair value of interest rate swaps designated as hedging instruments that effectively offset the variability of cash flows associated with variable-rate, long-term debt obligations are reported in accumulated other comprehensive income (AOCI). These amounts subsequently are reclassified into interest expense as a yield adjustment of the hedged interest payments in the same period in which the related interest affects earnings. The Company's interest rate swap agreement was deemed to be fully effective in accordance with ASC 815, and, as such, unrealized gains and losses related to these derivatives were recorded as AOCI.

The following table summarizes the effect of derivatives designated as cash flow hedging instruments and their classification within comprehensive loss for the years ended December 31, 2019 and 2018:

| Derivatives in Hedging Relationships | Amount of gain (loss) recognized in OCI on derivative (effective portion) Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Interest rate swaps | $ (572) | $ (343) |

The following table summarizes the reclassifications out of accumulated other comprehensive loss for the year ended December 31, 2019 and 2018:

| Details about AOCI Components | Amount reclassified from AOCI into income (effective portion) Year Ended December 31, | | Location of amount reclassified into income (effective portion) |
|---|---|---|---|
| | 2019 | 2018 | |
| | (in thousands) | | |
| Interest rate swaps | $ 139 | $ 136 | Interest expense |

As of December 31, 2019, $0.3 million of deferred losses on derivative instruments accumulated in AOCI are expected to be reclassified to earnings during the next twelve months. Transactions and events expected to occur over the next twelve months that will necessitate reclassifying these derivatives' losses to earnings include the repricing of variable-rate debt.

## 16. Fair Value Measurements

Fair value measurement is defined as the price that would be received to sell an asset or paid to transfer a liability in the principal or most advantageous market for the asset or liability in an orderly transaction between market participants at the measurement date. A fair value hierarchy is established, which prioritizes the inputs used in measuring fair value into three broad levels as follows:

Level 1—Quoted prices in active markets for identical assets or liabilities.
Level 2—Inputs, other than the quoted prices in active markets, that are observable either directly or indirectly.
Level 3—Unobservable inputs based on the Company's own assumptions.

The following tables present the fair value hierarchy for those assets or liabilities measured at fair value on a recurring basis:

| | Fair Value as of December 31, 2019 | | | |
|---|---|---|---|---|
| (In thousands) | Level 1 | Level 2 | Level 3 | Total |
| Assets (Liabilities): | | | | |
| Interest rate swap agreements | $ - | $ (603) | $ - | $ (603) |

| | Fair Value as of December 31, 2018 | | | |
|---|---|---|---|---|
| (In thousands) | Level 1 | Level 2 | Level 3 | Total |
| Assets (Liabilities): | | | | |
| Interest rate swap agreements | $ - | $ (170) | $ - | $ (170) |

The Company uses the market approach technique to value its financial liabilities. The Company's financial assets and liabilities carried at fair value include derivative instruments used to hedge the Company's interest rate risks. The fair value of the Company's interest rate swap agreements was based on LIBOR yield curves at the reporting date.

**17. Other current liabilities**

Other current liabilities consist of:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Compensation and payroll | $ 2,554 | $ 2,899 |
| Professional fees | 395 | 536 |
| Warranty costs | 252 | 391 |
| Local taxes, including VAT | 345 | 423 |
| Customer related costs | 963 | 1,242 |
| Interest | 425 | 480 |
| Other | 1,157 | 1,379 |
| Total | $ 6,091 | $ 7,350 |

**18. Revenues**

The following table represents a disaggregation of revenue from contracts with customers. Revenue originating from the following geographic areas for the years ended December 31, 2019 and 2018 consist of:

| | Year Ended December 31, 2019 | | | | |
|---|---|---|---|---|---|
| | (in thousands) | | | | |
| | United States | United Kingdom | Germany | Rest of the world | Total |
| Instruments, equipment, software and accessories | $ 78,196 | $ 10,607 | $ 13,359 | $ 8,058 | $ 110,220 |
| Service, maintenance and warranty contracts | 4,742 | 819 | 313 | 82 | 5,956 |
| Total revenues | $ 82,938 | $ 11,426 | $ 13,672 | $ 8,140 | $ 116,176 |

| | Year Ended December 31, 2018 | | | | |
|---|---|---|---|---|---|
| | (in thousands) | | | | |
| | United States | United Kingdom | Germany | Rest of the world | Total |
| Instruments, equipment, software and accessories | $ 79,614 | $ 13,690 | $ 13,193 | $ 8,571 | $ 115,068 |
| Service, maintenance and warranty contracts | 4,438 | 832 | 366 | 70 | 5,706 |
| Total revenues | $ 84,052 | $ 14,522 | $ 13,559 | $ 8,641 | $ 120,774 |

***Deferred revenue***

The Company had approximately $3.9 million and $3.8 million in deferred revenue from service contracts and advance payments as of December 31, 2019 and 2018, respectively. Changes in deferred revenue from service contracts and advance payments from customers during the period were as follows:

| | Year Ended December 31, 2019 | | |
|---|---|---|---|
| | (in thousands) | | |
| | Service Contracts | Customer Advances | Total |
| Balance, beginning of period | $ 1,659 | $ 2,161 | $ 3,820 |
| Deferral of revenue | 2,152 | 1,095 | 3,247 |
| Recognition of deferred revenue | (2,233) | (894) | (3,127) |
| Effect of foreign currency translation | 9 | - | 9 |
| Balance, end of period | $ 1,587 | $ 2,362 | $ 3,949 |

| | Year Ended December 31, 2018 | | |
|---|---|---|---|
| | (in thousands) | | |
| | Service Contracts | Customer Advances | Total |
| Balance, beginning of period | $ 505 | $ - | $ 505 |
| Addition due to business combination | 848 | 2,128 | 2,976 |
| Deferral of revenue | 4,305 | 1,210 | 5,515 |
| Recognition of deferred revenue | (3,984) | (1,177) | (5,161) |
| Effect of foreign currency translation | (15) | - | (15) |
| Balance, end of period | $ 1,659 | $ 2,161 | $ 3,820 |

***Allowance for Doubtful Accounts***

Allowance for doubtful accounts is based on the Company's assessment of the collectability of customer accounts. A rollforward of allowance for doubtful accounts is as follows:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Balance, beginning of period | $ 332 | $ 193 |
| Addition due to business combination | - | 103 |
| Bad debt expense | 288 | 25 |
| Charge-offs and other recoveries | (293) | 12 |
| Effect of foreign currency translation | (2) | (1) |
| Balance, end of period | $ 325 | $ 332 |

***Concentrations***

No customer accounted for more than 10% of the revenues for the years ended December 31, 2019, and 2018. At December 31, 2019 and 2018, no customer accounted for more than 10% of net accounts receivable.

## 19. Warranties

Warranties are estimated and accrued at the time revenues are recorded. A rollforward of the Company's product warranty accrual is as follows:

| | Beginning Balance | Additions | (Charges)\ Credits | Ending Balance |
|---|---|---|---|---|
| | | (in thousands) | | |
| Year ended December 31, 2018 | $ 246 | 182 | (37) | $ 391 |
| Year ended December 31, 2019 | $ 391 | 10 | (149) | $ 252 |

**20. Income Tax**

Income tax from continuing operations was a benefit of approximately $0.8 million and $3.7 million for the years ended December 31, 2019 and 2018, respectively. The effective tax rate on continuing operations was 14.8% for the year ended December 31, 2019 compared with 46.1% for the same period in 2018. The difference between the Company's effective tax rate year over year was primarily attributable to changes in the mix of pre-tax income and losses at individual subsidiaries as well as the impact of stock compensation deductions and windfalls in 2018.

For the year ended December 31, 2019, there was no income tax expense or benefit recorded for discontinued operations. For the year ended December 31, 2018, income tax benefit for discontinued operations was $0.4 million.

Income tax expense attributable to income from continued operations for years ended December 31, 2019 and 2018 consisted of:

| | Year Ended December 31, | |
|---|---|---|
| | **2019** | **2018** |
| | (in thousands) | |
| Current income tax (benefit) expense: | | |
| Federal and state | $ (707) | $ (191) |
| Foreign | 290 | 279 |
| | (417) | 88 |
| Deferred income tax (benefit) expense: | | |
| Federal and state | (281) | (3,552) |
| Foreign | (117) | (212) |
| | (398) | (3,764) |
| Total income tax benefit from continuing operations | $ (815) | $ (3,676) |

The total benefit from income taxes included in the statement of operations is as follows:

| | Year Ended December 31, | |
|---|---|---|
| | **2019** | **2018** |
| | (in thousands) | |
| Continuing operations | $ (815) | $ (3,676) |
| Discontinued operations | - | (441) |
| Total income tax benefit | $ (815) | $ (4,117) |

Income tax benefit for the years ended December 31, 2019 and 2018 differed from the amount computed by applying the U.S. federal income tax rate of 21% to pre-tax continuing operations income as a result of the following:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Computed "expected" income tax benefit | $ (1,161) | $ (1,674) |
| Increase (decrease) in income taxes resulting from: | | |
| Permanent differences, net | 241 | (117) |
| Foreign tax rate differential | 42 | (11) |
| State income taxes, net of federal income tax benefit | (74) | (121) |
| Non-deductible stock compensation expense | 205 | (329) |
| Acquisition costs | 3 | 438 |
| Tax credits | 220 | (242) |
| Change in reserve for uncertain tax position | (111) | 203 |
| Impact of change to prior year tax accruals | 314 | 100 |
| Change in valuation allowance allocated to income tax benefit | (578) | (1,850) |
| Other | 84 | (73) |
| Total income tax benefit | $ (815) | $ (3,676) |

The Company’s policy is to account for Global Intangible Low-Taxed income (GILTI) as a period cost.

Income tax (benefit) expense is based on the following pre-tax income from continuing operations for the years ended December 31, 2019 and 2018:

| | Year Ended December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Domestic | $ (5,616) | $ (9,034) |
| Foreign | 114 | 1,059 |
| Total | $ (5,502) | $ (7,975) |

The tax effects of temporary differences that give rise to significant components of the deferred tax assets and deferred tax liabilities at December 31, 2019 and 2018 are as follows :

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Deferred income tax assets: | | |
| Inventory | $ 1,079 | $ 1,147 |
| Operating loss and credit carryforwards | 18,802 | 20,095 |
| Accrued expenses | 654 | 1,037 |
| Deferred interest expense | 1,475 | 655 |
| Stock compensation | 1,011 | 999 |
| Lease liability | 2,081 | - |
| Other assets | 223 | 339 |
| Total gross deferred assets | 25,325 | 24,272 |
| Less: valuation allowance | (13,745) | (13,899) |
| Deferred tax assets | $ 11,580 | $ 10,373 |
| | | |
| Deferred income tax liabilities: | | |
| Indefinite-lived intangible assets | $ 2,048 | $ 1,975 |
| Definite-lived intangible assets | 9,168 | 10,221 |
| Right-of-use asset | 1,580 | - |
| Other liabilities | 507 | 267 |
| Total deferred tax liabilities | 13,303 | 12,463 |
| Deferred income tax liability, net | $ (1,723) | $ (2,090) |

Certain prior year amounts in the above table have been reclassified for consistency with the current year presentation. These reclassifications had no effect on the Company's consolidated financial statements.

Deferred income tax assets and liabilities by classification on the consolidated balance sheets were as follows:

| | December 31, | |
|---|---|---|
| | 2019 | 2018 |
| | (in thousands) | |
| Deferred income tax assets (included in other long-term assets) | $ 251 | $ 211 |
| Deferred income tax liabilities | (1,974) | (2,301) |
| Deferred income tax liability, net | $ (1,723) | $ (2,090) |

As of December 31, 2019 and 2018, the Company maintained a total valuation allowance of $13.7 million and $13.9 million, respectively, which relates to foreign, federal, and state deferred tax assets in both years. The valuation allowance is based on estimates of taxable income in each of the jurisdictions in which we operate and the period over which our deferred tax assets will be recoverable. The net change in total valuation allowance for each of the years ended December 31, 2019 and December 31, 2018 was a decrease of $(0.2) million and an increase of $2.5 million, respectively. The movement in the valuation allowance in 2019 is primarily due to a change in estimate of the realizability of certain U.S. deferred tax assets offset by changes in UK pension asset and the expiration of U.S. state credits with full valuation allowances. The movement in the valuation allowance in 2018 is primarily due to the finalization of purchase accounting for the DSI acquisition and its impact on the valuation allowance related to certain U.S. deferred tax assets.

At December 31, 2019, the Company had U.S. federal net operating loss carryforwards of $27.2 million, a portion of which ($21.9 million) expires between 2020 and 2037; the remainder have an unlimited carryforward period. The Company's state net operating loss carryforwards of $17.8 million expire between 2020 and 2037. The Company has net operating loss carryforwards of $5.5 million in certain foreign jurisdictions, partially offset by valuation allowances, as well as $0.3 million non-U.S. research and development credits. The Company has foreign tax credits of $0.2 million which begin to expire in 2020, as well as $8.7 million of research and development tax credit carryforwards which begin to expire in 2020. Approximately $1.0 million of the research and development tax credit carryforwards are offset by a reserve for uncertain tax positions. The Company had $0.8 million of alternative minimum tax credit carryforwards which are not subject to expiration and become refundable under the 2017 Tax Cuts and Jobs Act beginning in 2021. In addition, the Company had a total of $3.2 million of state investment tax credit carryforwards, research and development tax credit carryforwards, and EZ credit carryforwards, which begin to expire in 2020. The Internal Revenue Code (IRC) limits the amounts of net operating loss carryforwards or credits that a company may use in any one year in the event of a change in ownership under IRC Sections 382 or 383. As a result of the DSI acquisition as well as other acquisitions in prior years, certain losses and credit carryforwards are subject to these limitations. The Company has provided a full or partial valuation allowance for the portion of state NOLs and federal and state credit carryforwards the Company expects will expire before use.

As of December 31, 2019 and December 31, 2018, cash and cash equivalents held by the Company's foreign subsidiaries was $3.5 million and $3.2 million, respectively. As of December 31, 2019, the Company maintained its indefinite reinvestment assertion, providing that all foreign cash balances above the level required for local operating expenses would be repatriated to the U.S. As a result of the 2017 Tax Cuts and Jobs Act, post-2017 dividends from qualifying Controlled Foreign Corporations are no longer taxed in the U.S. However, any dividends to the U.S., as well as dividends between foreign subsidiaries, must still be assessed for withholding tax liability as well as foreign and state income tax liability. As a result of the Company's assertion, the Company has determined the potential income tax liability related to available cash balances at foreign subsidiaries to be immaterial in 2019 and 2018. An accrued withholding tax liability of $55 thousand and $38 thousand was recorded as of December 31, 2019 and December 31, 2018, respectively, related to amounts determined to be available for repatriation.

At December 31, 2019 and 2018 the amount of unrecognized tax benefits that would affect the Company's effective tax rate are shown in the table below:

| | (in thousands) |
|---|---|
| Balance at December 31, 2017 | $ 323 |
| Release due to expiration of statute of limitations positions of prior years | (94) |
| Additions based on tax positions of prior years | 242 |
| Additions based on tax positions of acquired entities | 1,389 |
| Balance at December 31, 2018 | 1,860 |
| Additions based on tax positions of prior years | 68 |
| Decreases based on tax positions of prior years | (133) |
| Additions based on tax position of current year | 21 |
| Settlements | (398) |
| Decreases based on tax positions of acquired entities | (65) |
| Balance at December 31, 2019 | $ 1,353 |

In 2018, the Company recorded a reserve of $0.2 million related to upcoming audits. Additionally, reserves of $1.4 million were recorded to purchase accounting based on tax positions of acquired entities, including $0.8 million for credits and $0.5 million related to state income tax issues. In 2019, a foreign income tax audit was closed without payment and a reserve for $0.1 million was reversed, and the Company settled U.S. state income tax liabilities of $0.4 million. In addition, the Company reduced the reserve on tax positions of acquired entities by $0.1 million and recorded a reserve of $0.1 million related to upcoming audits.

The Company anticipates that the total unrecognized tax benefits will be reduced within the next 12 months by approximately $32 thousand due to the expected settlement of certain positions of acquired entities. The Company classifies interest and penalties related to unrecognized tax benefits as a component of income tax expense. At December 31, 2019 and at December 31, 2018, the Company had accrued interest and penalties of $0.1 million and $0.1 million respectively. During 2019 and 2018, the Company recognized a net expense of $26 thousand and $31 thousand, respectively, for interest and penalties in its total tax provision.

The Company or one of its subsidiaries files income tax returns in the U.S. federal jurisdiction, and various states and foreign jurisdictions. With few exceptions, the Company is no longer subject to income tax examinations by tax authorities in foreign jurisdictions for years before 2015. In the U.S., the Company's net operating loss and tax credit carryforward amounts remain subject to federal and state examination for tax years starting in 2000 as a result of tax losses incurred in prior years. There are currently no pending federal or state tax examinations. The Company is subject to audits by various foreign taxing jurisdictions. At December 31, 2019, the Company anticipates an income tax examination to begin in 2020 at a foreign subsidiary for which reserves have been recorded.

## 21. Commitments and Contingent Liabilities

On April 14, 2017, representatives for the estate of an individual plaintiff filed a wrongful death complaint with the Suffolk Superior Court, in the County of Suffolk, Massachusetts, against the Company and other defendants, including Biostage, Inc. (f/k/a Harvard Apparatus Regenerative Technology, Inc.), our former subsidiary that was spun off in 2013, as well as another third party. The complaint seeks payment for an unspecified amount of damages and alleges that the plaintiff sustained terminal injuries allegedly caused by products, including synthetic trachea scaffolds and bioreactors, provided by certain of the named defendants and utilized in connection with surgeries performed by third parties in 2012 and 2013. The litigation is at an early stage and the Company intends to vigorously defend this case and has contacted its liability insurance carrier to request defense and indemnification of any losses incurred in connection with this lawsuit. While the Company believes that such claim is without merit, the Company is unable to predict the ultimate outcome of this litigation.

We are involved in various other claims and legal proceedings arising in the ordinary course of business. In our opinion after consultation with legal counsel, the ultimate disposition of such proceedings is not likely to have a material adverse effect on our business, financial condition, results of operations or cash flows. We have not accrued for loss contingencies relating to any such matters because we believe that, although unfavorable outcomes in the proceedings are possible, they are not considered by management to be probable and reasonably estimable. If one or more of these matters are resolved in a manner adverse to our company, the impact on our business, financial condition, results of operations and cash flows could be material.

**22. Segment and Related Information**

Operating segments are determined by products and services provided by each segment, internal organization structure, the manner in which operations are managed, criteria used by the Chief Operating Decision Maker, or CODM, to assess the segment performance, as well as resource allocation and the availability of discrete financial information. The Company has one operating segment and therefore segment results and consolidated results are the same.

Refer to footnote 18 for a summary of revenue by geographic area of origin.

The following tables summarize additional selected financial information of the Company's continuing operations by geographic location:

Long-lived assets by geographic area consist of the following:

| | December 31, | |
|---|---|---|
| | **2019** | **2018** |
| | (in thousands) | |
| United States | $ 35,409 | $ 42,222 |
| Germany | 4,142 | 5,022 |
| United Kingdom | 320 | 585 |
| Rest of the world | 2,176 | 2,601 |
| Total long-lived assets (a) | $ 42,047 | $ 50,430 |

Net assets by geographic area consist of the following:

| | December 31, | |
|---|---|---|
| | **2019** | **2018** |
| | (in thousands) | |
| United States | $ 37,726 | $ 38,921 |
| Germany | 17,340 | 17,261 |
| United Kingdom | 11,254 | 10,473 |
| Rest of the world | 15,374 | 16,069 |
| Total net assets | $ 81,694 | $ 82,724 |

(a) Total long-lived assets consist of property, plant and equipment, net and amortizable intangible assets, net.

**23. Quarterly Financial Information (unaudited)**

**Statement of Operations Data:**

| 2019 | First Quarter | Second Quarter | Third Quarter | Fourth Quarter | Fiscal Year |
|---|---|---|---|---|---|
| | (in thousands, except per share data) | | | | |
| Revenues | $ 28,202 | $ 29,584 | $ 27,418 | $ 30,972 | $ 116,176 |
| Cost of revenues | 12,048 | 13,629 | 12,439 | 13,738 | 51,854 |
| Gross profit | 16,154 | 15,955 | 14,979 | 17,234 | 64,322 |
| Total operating expenses | 16,273 | 15,727 | 16,344 | 15,601 | 63,945 |
| Operating (loss) income | (119) | 228 | (1,365) | 1,633 | 377 |
| Other expense, net | (1,675) | (1,360) | (1,309) | (1,535) | (5,879) |
| (Loss) income before income taxes | (1,794) | (1,132) | (2,674) | 98 | (5,502) |
| Income tax expense (benefit) | 576 | (885) | (54) | (452) | (815) |
| Net (loss) income | $ (2,370) | $ (247) | $ (2,620) | $ 550 | $ (4,687) |
| | | | | | |
| (Loss) earnings per share: | | | | | |
| Basic (loss) earnings per common share | $ (0.06) | $ (0.01) | $ (0.07) | $ 0.02 | $ (0.12) |
| | | | | | |
| Diluted (loss) earnings per common share | $ (0.06) | $ (0.01) | $ (0.07) | $ 0.02 | $ (0.12) |

The fourth quarter includes certain true ups in income tax due to the reassessment of valuation allowances in association with certain tax assets.

**Statement of Operations Data:**

| 2018 | First Quarter | Second Quarter | Third Quarter | Fourth Quarter | Fiscal Year |
|---|---|---|---|---|---|
| | (in thousands, except per share data) | | | | |
| Revenues | $ 26,759 | $ 31,522 | $ 28,635 | $ 33,858 | $ 120,774 |
| Cost of revenues | 13,490 | 16,167 | 12,818 | 15,118 | 57,593 |
| Gross profit | 13,269 | 15,355 | 15,817 | 18,740 | 63,181 |
| Total operating expenses | 14,535 | 15,737 | 14,927 | 16,998 | 62,197 |
| Operating (loss) income | (1,266) | (382) | 890 | 1,742 | 984 |
| Other expense, net | (3,979) | (1,485) | (1,798) | (1,697) | (8,959) |
| (Loss) income from continuing operations before income taxes | (5,245) | (1,867) | (908) | 45 | (7,975) |
| Income tax expense (benefit) | 605 | (369) | (652) | (3,260) | (3,676) |
| Net (loss) income from continuing operations | (5,850) | (1,498) | (256) | 3,305 | (4,299) |
| Income (loss) from discontinued operations, net of tax | 1,786 | 34 | - | (443) | 1,377 |
| Net (loss) income | $ (4,064) | $ (1,464) | $ (256) | $ 2,862 | $ (2,922) |
| | | | | | |
| (Loss) earnings per share: | | | | | |
| Basic (loss) earnings per common share from continuing operations | $ (0.16) | $ (0.04) | $ (0.01) | $ 0.09 | $ (0.12) |
| Basic earnings (loss) per common share from discontinued operations | 0.05 | - | - | (0.01) | 0.04 |
| Basic (loss) earnings per common share | $ (0.11) | $ (0.04) | $ (0.01) | $ 0.08 | $ (0.08) |
| | | | | | |
| Diluted (loss) earnings per common share from continuing operations | $ (0.16) | $ (0.04) | $ (0.01) | $ 0.09 | $ (0.12) |
| Diluted earnings (loss) per common share from discontinued operations | 0.05 | - | - | (0.01) | 0.04 |
| Diluted (loss) earnings per common share | $ (0.11) | $ (0.04) | $ (0.01) | $ 0.08 | $ (0.08) |

The fourth quarter includes certain true ups in income tax due to the reassessment of valuation allowances in association with certain tax assets and in combination with deferred tax attributes of the DSI acquisition.

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**SIGNATURES**

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by undersigned thereunto duly authorized.

HARVARD BIOSCIENCE, INC.

Date: March 16, 2020

By: /s/ JAMES GREEN
James Green
Chief Executive Officer

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated:

| Signature | Title | Date |
|---|---|---|
| /s/ JAMES GREEN<br>**James Green** | Chief Executive Officer and Director<br>(Principal Executive Officer) | March 16, 2020 |
| /s/ MICHAEL A. ROSSI<br>**Michael A. Rossi** | Chief Financial Officer<br>(Principal Financial Officer and Principal Accounting Officer) | March 16, 2020 |
| /s/ KATHERINE A. EADE<br>**Katherine A. Eade** | Director | March 16, 2020 |
| /s/ ALAN EDRICK<br>**Alan Edrick** | Director | March 16, 2020 |
| /s/ JOHN F. KENNEDY<br>**John F. Kennedy** | Director | March 16, 2020 |
| /s/ THOMAS W. LOEWALD<br>**Thomas W. Loewald** | Director | March 16, 2020 |
| /s/ BERTRAND LOY<br>**Bertrand Loy** | Director | March 16, 2020 |

**EXHIBIT INDEX**

The following exhibits are filed as part of this Annual Report on Form 10-K. Where such filing is made by incorporation by reference to a previously filed document, such document is identified.

| Exhibit Number | Description | Method of Filing |
|---|---|---|
| 2.1§ | Separation and Distribution Agreement between Harvard Bioscience, Inc. and Biostage, Inc. (f/k/a Harvard Apparatus Regenerative Technology, Inc.) dated as of October 31, 2013. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed November 6, 2013) and incorporated by reference thereto. |
| 2.2§ | Purchase Agreement, dated as of January 22, 2018, between Harvard Bioscience, Inc., Denville Scientific, Inc. and Thomas Scientific, LLC. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 26, 2018) and incorporated by reference thereto. |
| 3(i) | Second Amended and Restated Certificate of Incorporation of Harvard Bioscience, Inc. | Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto. |
| 3(ii) | Amended and Restated By-laws of Harvard Bioscience, Inc. | Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto. |
| 3.1 | Amendment No. 1 to Amended and Restated Bylaws of Harvard Bioscience, Inc. (as adopted October 30, 2007). | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed on November 1, 2007) and incorporated by reference thereto. |
| 3.2 | Certificate of Designations, Preferences and Rights of a Series of Preferred Stock of Harvard Bioscience, Inc. classifying and designating the Series A Junior Participating Cumulative Preferred Stock. | Previously filed as an exhibit to the Company's Registration Statement on Form 8-A (filed February 8, 2008) and incorporated by reference thereto. |
| 3.3 | Certificate of Elimination of Series A Junior Participating Cumulative Preferred Stock, dated as of February 27, 2018. | Previously filed as an exhibit to the Company's Registration Statement on Form 8-A/A (filed March 2, 2018) and incorporated by reference thereto. |
| 4.1 | Specimen certificate for shares of Common Stock, $0.01 par value, of Harvard Bioscience, Inc. | Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto. |
| 4.2 | Description of Securities | Filed with this report |

| | | |
|---|---|---|
| 10.1 # | Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan, as amended | Previously disclosed as Appendix A to the Company's Proxy Statement on Schedule 14A (filed April 6, 2018) and incorporated by reference thereto |
| 10.2 | Harvard Bioscience, Inc. Employee Stock Purchase Plan, as amended | Previously disclosed as Appendix A to the Company's Proxy Statement on Schedule 14A (filed April 5, 2019) and incorporated by reference thereto |
| 10.3 | Form of Director Indemnification Agreement | Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on October 25, 2000) and incorporated by reference thereto |
| 10.4 + | Trademark License Agreement, dated December 19, 2002, by and between Harvard Bioscience, Inc. and President and Fellows of Harvard College. | Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed May 15, 2003) and incorporated by reference thereto |
| 10.5 | Lease Agreement Between Seven October Hill, LLC and Harvard Bioscience, Inc. dated December 30, 2005. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 4, 2006) and incorporated by reference thereto |
| 10.6 # | Form of Incentive Stock Option Agreement (Executive Officers). | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto |
| 10.7 # | Form of Non-Qualified Stock Option Agreement (Executive Officers). | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto |
| 10.8 # | Form of Non-Qualified Stock Option Agreement (Non-Employee Directors). | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto |
| 10.9 | Amendment No. 2, dated as of May 22, 2010, to Lease Agreement, as subsequently amended, between Seven October Hill LLC and Harvard Bioscience, Inc. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed June 3, 2010) and incorporated by reference thereto |
| 10.10 # | Form of Deferred Stock Award Agreement under the Harvard Bioscience, Inc. Second Amended and Restated 2000 Stock Option And Incentive Plan, as amended | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2011) and incorporated by reference thereto |
| 10.11 | Amendment No. 3, dated as of May 30, 2014, to Lease Agreement, as subsequently amended, between Seven October Hill LLC and Harvard Bioscience, Inc. | Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed August 7, 2014) and incorporated by reference thereto |
| 10.12 # | Form of Market Condition Deferred Stock Award Agreement under the Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option And Incentive Plan, as amended | Filed with this report |

| | | |
|---|---|---|
| 10.13 | Lease Agreement, dated as of August 15, 2008, between AX US L.P. (as assigned to it by New Brighton 14 th Street LLC), Ryan Companies US, Inc. and Data Sciences International, Inc. (as assigned to it by Transoma Medical, Inc.) | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2018) and incorporated by reference thereto |
| 10.14 | First Amendment to Lease Agreement, dated as of February 26, 2008, between AX US L.P. (as assigned to it by New Brighton 14 th Street LLC), Ryan Companies US, Inc. and Data Sciences International, Inc. (as assigned to it by Transoma Medical, Inc.) | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2018) and incorporated by reference thereto |
| 10.15 | Second Amendment to Lease Agreement, dated as of August 4, 2008, between AX US L.P. (as assigned to it by New Brighton 14 th Street LLC), Ryan Companies US, Inc. and Data Sciences International, Inc. (as assigned to it by Transoma Medical, Inc.) | Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2018) and incorporated by reference thereto |
| 10.16 | Financing Agreement, dated as of January 31, 2018, between Harvard Bioscience, Inc., each of the borrowers named therein, the lenders from time to time party thereto, and Cerberus Business Finance, LLC | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed February 2, 2018) and incorporated by reference thereto. |
| 10.17 | First Amendment to Financing Agreement, dated as of August 16, 2018, between Harvard Bioscience, Inc., each of the borrowers named therein, the lenders from time to time party thereto, and Cerberus Business Finance, LLC. | Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed November 1, 2018) and incorporated by reference thereto. |
| 10.18 | Third Amendment to Lease Agreement, entered into as of November 1, 2018, with an effective date as of October 25, 2018, between Data Sciences International, Inc. and AX US L.P. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed November 7, 2018) and incorporated by reference thereto. |
| 10.19# | Employment Agreement between Harvard Bioscience, Inc. and James Green. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 8, 2019) and incorporated by reference thereto. |
| 10.20# | Employment Agreement between Harvard Bioscience, Inc. and Michael Rossi. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 19, 2019) and incorporated by reference thereto. |
| 10.21# | Employment Agreement between Harvard Bioscience, Inc. and Yash Singh. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed November 1, 2019) and incorporated by reference thereto. |
| 10.22 | Second Amendment to Financing Agreement, dated November 5, 2019, between Harvard Bioscience, Inc., each of the other borrowers named therein, the lenders party thereto, and Cerberus Business Finance, LLC. | Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed November 5, 2019) and incorporated by reference thereto |

| | | |
|---|---|---|
| 21.1 | Subsidiaries of the Registrant | Filed with this report |
| 23.1 | Consent of Grant Thornton LLP | Filed with this report |
| 31.1 | Certification of Chief Financial Officer of Harvard Bioscience, Inc., pursuant to Rules 13a-15(e) and 15d-15(e), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 | Filed with this report |
| 31.2 | Certification of Chief Executive Officer of Harvard Bioscience, Inc., pursuant to Rules 13a-15(e) and 15d-15(e), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002 | Filed with this report |
| 32.1 | Certification of Chief Financial Officer of Harvard Bioscience, Inc., pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 | * |
| 32.2 | Certification of Chief Executive Officer of Harvard Bioscience, Inc., pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002 | * |

| | | |
|---|---|---|
| 101.INS | XBRL Instance Document | Filed with this report |
| 101.SCH | XBRL Taxonomy Extension Schema Document | Filed with this report |
| 101.CAL | XBRL Taxonomy Extension Calculation Linkbase Document | Filed with this report |
| 101.DEF | XBRL Taxonomy Extension Definition Linkbase Document | Filed with this report |
| 101.LAB | XBRL Taxonomy Extension Label Linkbase Document | Filed with this report |
| 101.PRE | XBRL Taxonomy Extension Presentation Linkbase Document | Filed with this report |

+ Certain portions of this document have been granted confidential treatment by the Securities and Exchange Commission (the Commission).

* This certification shall not be deemed “filed” for purposes of Section 18 of the Securities Exchange Act of 1934, or otherwise subject to the liability of that section, nor shall it be deemed to be incorporated by reference into any filing under the Securities Act of 1933 or the Securities Exchange Act of 1934

# Management contract or compensatory plan or arrangement.

§ The schedules and exhibits have been omitted. A copy of any omitted schedule or exhibit will be furnished to the SEC supplementally upon request.

The Company will furnish to stockholders a copy of any exhibit without charge upon written request.

**EXHIBIT 4.2**

**DESCRIPTION OF THE REGISTRANT'S SECURITIES REGISTERED PURSUANT TO SECTION 12 OF THE SECURITIES EXCHANGE ACT OF 1934**

As of December 31, 2019, Harvard Bioscience, Inc. had one class of securities registered under Section 12 of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), being our common stock, $0.01 par value. The following description of our common stock is a summary and does not purport to be complete. It is subject to and qualified in its entirety by reference to our Second Amended and Restated Certificate of Incorporation (as amended, the "Charter") and our Amended and Restated By-laws (as amended, the "Bylaws"), each of which are incorporated by reference as an exhibit to the Annual Report on Form 10-K of which this Exhibit 4.2 is a part. We encourage you to read our Charter, our Bylaws and the applicable provisions of Delaware law for additional information.

**Authorized Capital Stock**

Our authorized capital stock consists of 80,000,000 shares of common stock, par value $0.01 per share, and 5,000,000 shares of undesignated preferred stock, par value $0.01 per share.

**Common Stock**

*Voting Rights*. Holders of our common stock are entitled to one vote for each share held of record on all matters submitted to a vote of shareholders; provided, that, except as otherwise required by law, holders of common stock are not entitled to vote on any amendment to the Charter that changes the powers, preferences, rights or other terms of one or more series of undesignated preferred stock if the holders of the affected series are entitled to vote, separately or together, with the holders of one or more other such series, on such amendment pursuant to the Charter or Delaware General Corporation Law.

*Classified Board of Directors*. Our Charter provides that our Board of Directors (the "Board") shall be divided into three classes, each consisting as nearly as reasonably may be possible of one-third of the total number of directors constituting the entire Board, with each class's term expiring on a staggered basis. Newly-created directorships and vacancies on our Board may only be filled by a majority of the members of the incumbent board then in office, though less than a quorum, and not by our stockholders. Directors may be removed from office only for cause by the affirmative vote of the holders of at least seventy-five percent (75%) of the outstanding shares entitled to be cast on the election of directors by the then-outstanding shares of all classes and series of capital stock, voting together as a single class.

*Liquidation*. In the event of our liquidation, dissolution or winding up, after the satisfaction in full of the liquidation preferences of holders of any preferred stock, holders of common stock are entitled to ratable distribution of the remaining assets available for distribution to stockholders.

*Dividend Rights*. Holders of common stock are entitled to receive proportionately any such dividends declared by our Board, out of legally available funds for dividends, subject to any preferences that may be applicable to any shares of preferred stock that may be outstanding at that time.

*Rights and Preferences*. Holders of common stock have no preemptive, redemption or conversion rights and are not subject to future calls or assessments. No sinking fund provisions apply to our common stock. The rights, preferences and privileges of holders of common stock are subject to, and may be adversely affected by, the rights of the holders of shares of any series of preferred stock that we may designate and issue in the future.

*Fully Paid and Nonassessable*. All outstanding shares are fully-paid and non-assessable.

**Listing**

Our common stock is listed on the NASDAQ Global Market under the symbol "HBIO."

**Anti-takeover Effects of Our Certificate of Incorporation and Bylaws and Delaware Law**

***Provisions of our Certificate of Incorporation and Bylaws***

Certain provisions of the Delaware General Corporation Law and of our Charter and Bylaws could have the effect of delaying, deferring or discouraging another party from acquiring control of us. These provisions, which are summarized below, are expected to discourage certain types of coercive takeover practices and inadequate takeover bids and, as a consequence, they might also inhibit temporary fluctuations in the market price of our common stock that often result from actual or rumored hostile takeover attempts. These provisions are also designed in part to encourage anyone seeking to acquire control of us to first negotiate with our Board. These provisions might also have the effect of preventing changes in our management. It is possible that these provisions could make it more difficult to accomplish transactions that stockholders might otherwise deem to be in their best interests. However, we believe that the advantages gained by protecting our ability to negotiate with any unsolicited and potentially unfriendly acquirer outweigh the disadvantages of discouraging such proposals, including those priced above the then-current market value of our common stock, because, among other reasons, the negotiation of such proposals could improve their terms.

Our Charter, our Bylaws and Delaware law contain provisions that could discourage, delay or prevent a third party from acquiring us, even if doing so may be beneficial to our stockholders. In addition, these provisions could limit the price investors would be willing to pay in the future for shares of our common stock. The following are examples of such provisions in our Charter and Bylaws:

- only our Board, pursuant to a resolution adopted by a majority of our directors, may call special meetings of our stockholders;
- stockholders may not act by written consent and stockholder action must take place at the annual or special meeting of our stockholders;
- stockholder proposals and nominations of candidates for election as directors other than nominations made by or at the direction of our Board or a committee of our Board to be brought before any meeting of our stockholders must comply with advance notice procedures;
- our Board is classified into three classes, each consisting as nearly as reasonably may be possible of one-third of the total number of directors constituting the entire Board;
- our Board will fix the exact number of directors to comprise our Board;
- subject to any rights that holders of any series of our undesignated preferred stock may have to elect directors and to fill vacancies on our Board, newly-created directorships and vacancies on our Board may only be filled by a majority of the members of the incumbent board then in office, even if less than a quorum is present, and not by our stockholders;
- a director may be removed from office only for cause by the affirmative vote of holders of shares representing at least seventy-five percent (75%) of the votes entitled to be cast on such matter by the then-outstanding shares of all classes and series of our capital stock, voting together as a single class;
- our Charter and Bylaws do not provide for cumulative voting in the election of directors;
- our Bylaws may be further amended by either (i) the affirmative vote of at least a majority of our entire Board or (ii) the affirmative vote of the holders of at least seventy-five percent (75%) of the combined voting power of the outstanding shares of all classes and series of our capital stock entitled to vote on such amendment, voting together as a single class; and
- our Board is authorized to issue, without further action by our stockholders, up to 5,000,000 shares of undesignated preferred stock with rights and preferences, including voting rights, designated from time to time by our Board.

Additionally, as required by the Delaware General Corporation Law, any amendment of our Charter must first be approved by a majority of our Board and, as required by our Charter, thereafter be approved by a majority of the outstanding shares entitled to vote on the amendment, and a majority of the outstanding shares of each class entitled to vote thereon, voting together as a single class, except that the amendment of the provisions relating to stockholder action, directors, limitation of liability, the amendment of our Bylaws and Charter and forum must be approved by not less than seventy-five percent (75%) of the outstanding shares entitled to vote on the amendment, and not less than seventy-five percent (75%) of the outstanding shares of each class entitled to vote thereon as a class. Our Bylaws may be amended by either (i) a vote of at least a majority of our entire Board or (ii) a vote of the holders of at least seventy-five percent (75%) of the combined voting power of the outstanding shares of all classes and series of our capital stock entitled to vote on such amendment, voting together as a single class.

***Delaware Anti-Takeover Law***

We are subject to the provisions of Section 203 of the Delaware General Corporation Law. In general, Section 203 prohibits a publicly-held Delaware corporation from engaging in a "business combination" with an "interested stockholder" for a three-year period following the time that this stockholder becomes an interested stockholder, unless the business combination is approved in a prescribed manner. A "business combination" includes, among other things, a merger, asset or stock sale or other transaction resulting in a financial benefit to the interested stockholder. An "interested stockholder" is a person who, together with affiliates and associates, owns, or did own within three years prior to the determination of interested stockholder status, fifteen percent (15%) or more of the corporation's voting stock. Under Section 203, a business combination between a corporation and an interested stockholder is prohibited unless it satisfies one of the following conditions:

- before the stockholder became interested, the Board approved either the business combination or the transaction which resulted in the stockholder becoming an interested stockholder;

- upon consummation of the transaction which resulted in the stockholder becoming an interested stockholder, the interested stockholder owned at least eight-five percent (85%) of the voting stock of the corporation outstanding at the time the transaction commenced, excluding for purposes of determining the voting stock outstanding, shares owned by persons who are directors and also officers, and employee stock plans, in some instances; or

- at or after the time the stockholder became interested, the business combination was approved by the Board of the corporation and authorized at an annual or special meeting of the stockholders by the affirmative vote of at least two-thirds of the outstanding voting stock which is not owned by the interested stockholder.

**DEFERRED STOCK AWARD AGREEMENT**
**UNDER THE HARVARD BIOSCIENCE, INC. THIRD AMENDED AND RESTATED 2000**
**STOCK OPTION AND INCENTIVE PLAN, AS AMENDED**

Name of Grantee: _____ (the "**Grantee**")

Grant Date: _____ (the "**Grant Date**")

Pursuant to the Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan (as amended, the "**Plan**"), Harvard Bioscience, Inc. (the "**Company**") hereby grants a number of Restricted Stock Units ("**RSUs**") to be determined in accordance herewith to the Grantee named above (the "**Award**"), subject to the terms of the Plan and this Deferred Stock Award Agreement (the "**Agreement**"). The Award represents a promise to pay to the Grantee certain shares of Common Stock, par value $0.01 per share (the "**Stock**") of the Company in an amount determined based on the attainment of performance goals related to total shareholder return ("**TSR**") and continued employment, subject to the restrictions and conditions set forth herein and in the Plan.

1. Grant and Restrictions.

(a) Grant. The Company hereby awards to the Grantee a target award of _____ RSUs (hereinafter, as adjusted in accordance with Section 8, the "**Target Award**"), subject to the vesting and other conditions set forth herein and in the Plan, with the final amount of the Award to be the Final RSUs as determined in accordance with Section 2 below.

(b) No Voting Rights and Dividends. Until such time as the RSUs are paid to the Grantee in shares of Stock, the Grantee shall have no voting rights and no rights to any dividends or other distributions with respect to the RSUs.

(c) Restrictions on Transfer. The RSUs granted pursuant to this Agreement may not be sold, assigned, transferred, pledged or otherwise encumbered or disposed of prior to vesting.

2. Vesting of Restricted Stock Units.

(a) General Vesting Terms. Except as set forth in Paragraphs 2(b) and 2(c) below, to the extent the achieved Performance Factor is greater than 0% as of the end of the Performance Period (as defined below), the Grantee shall vest in a number of RSUs (the "**Final RSUs**") based on the attainment of the TSR performance goals described on Schedule A as of the end of the Performance Period (as defined below), such vesting to be as follows: (i) 1/3 of the aggregate amount of the Final RSUs shall vest on the last day of the Performance Period (the "**Initial Vesting Date**"), (ii) 1/3 of the aggregate amount of the Final RSUs shall vest on the first anniversary of the Initial Vesting Date, and (iii) the remaining 1/3 of the aggregate amount of the Final RSUs shall vest on the second anniversary of the Initial Vesting Date, provided that with respect to each such 1/3 tranche, the Grantee remains employed by the Company or any Subsidiaries through the respective vesting date (i.e., with respect to the initial 1/3, the Grantee must remain so employed on the Initial Vesting Date). The Performance Period is the one year period beginning on the Grant Date (the "**Performance Period**"). Your Final RSUs will be determined by multiplying the Target Award by the percentage (from zero to 150%) (the "**Performance Factor**") which is based on the Company's Total Shareholder Return during the Performance Period compared to the Index Constituent Companies, determined according to Schedule A of this Agreement. Except as specifically provided below in this Section 2, no RSUs will vest for any reason prior to the Initial Vesting Date. Except as provided in Paragraphs 2(b) and 2(c) below, if the TSR performance goals are not attained at the end of the Performance Period, the RSUs will be immediately forfeited. Upon vesting in accordance herewith or Paragraph 2(c), the restrictions and conditions in Paragraph 1 of this Agreement with respect to such RSU shall lapse and such RSU shall become payable to the Grantee in shares of Stock on the relevant vesting date in the amount of the vested RSUs in accordance with this Paragraph (a) and Schedule A. Any fractional RSU resulting from the vesting of the RSUs in accordance with this Agreement shall be rounded down to the nearest whole number.

(b) Except as noted in Paragraph 2(c) below, and notwithstanding any provision of any other agreement or arrangement between the Grantee and the Company that provides accelerated vesting of RSUs or all equity awards in general in the event of certain types of termination, the Grantee's rights to all RSUs granted herein and not yet vested in accordance with the provisions of Paragraphs 2(a) or 2(c), and Schedule A, shall automatically terminate upon the Grantee's termination of employment, voluntarily or involuntarily, with the Company and its Subsidiaries for any reason (including death).

(c) Notwithstanding anything to the contrary in this Agreement, if a Change of Control occurs during the Performance Period, the date of such Change of Control shall be deemed the last day of the Performance Period, and the Performance Factor will be calculated as if the date of the Change of Control is the last day of the Performance Period. In such event, (i) your Final RSUs will be determined by multiplying the Target Award by the calculated Performance Factor and (ii) to the extent the achieved Performance Factor is greater than 0% as of the end of such reduced Performance Period, your Final RSUs shall vest in full as of the date of such Change of Control.

3. Receipt of Stock Upon Vesting. Upon the vesting of the RSUs as provided in Paragraph 2, the Grantee shall receive one share of Stock for each RSU vested. Shares of Stock acquired pursuant to this Award shall be issued and delivered to the Grantee either in actual stock certificates or by electronic book entry, subject to tax withholding as provided in Paragraph 6 below.

4. Incorporation of Plan. Notwithstanding anything herein to the contrary, this Agreement shall be subject to and governed by all the terms and conditions of the Plan, including the powers of the Administrator set forth in the Plan. Capitalized terms in this Agreement shall have the meaning specified in the Plan, unless a different meaning is specified herein.

5. Transferability. This Agreement is personal to the Grantee, is non-assignable and is not transferable in any manner, by operation of law or otherwise, other than by will or the laws of descent and distribution.

6. Tax Withholding. Unless the Grantee elects to satisfy the tax withholding obligation in a timely manner by making the payments or related arrangements in accordance with Section 14(a) of the Plan (including, without limitation, payments made from such Grantee's compensation or other cash payments otherwise due him or her from the Company or by paying the Company directly by a separate check), the tax withholding obligation shall be satisfied by the Company withholding, from shares of Stock to be issued to the Grantee hereunder, such number of the Grantee's shares having an aggregate fair market value equal to the required minimum amount of the tax withholding then due with respect to such Grantee.

7. No Obligation to Continue Employment. Neither the Company nor any Subsidiary is obligated by or as a result of the Plan or this Agreement to continue the Grantee in employment and neither the Plan nor this Agreement shall interfere in any way with the right of the Company or any Subsidiary to terminate the employment of the Grantee at any time.

8. Certain Corporate Changes. If any change is made to the Common Stock (whether by reason of merger, consolidation, reorganization, recapitalization, stock dividend, stock split, combination of shares, or exchange of shares or any other change in capital structure made without receipt of consideration), then unless such event or change results in the termination of all the RSUs granted under this Agreement, the Administrator shall adjust, as provided in the Plan, the number and class of shares underlying the RSUs held by the Grantee, the maximum number of shares for which the RSUs may vest, and the share price or class of Common Stock for purposes of the TSR performance goals, as appropriate, to reflect the effect of such event or change in the Company's capital structure in such a way as to preserve the value of the RSUs. Any adjustment that occurs under the terms of this Section 8 or the Plan will not change the timing or form of payment with respect to any RSUs except in accordance with section 409A of the Code.

9. Notices. Notices hereunder shall be mailed or delivered to the Company at its principal place of business and shall be mailed or delivered to the Grantee at the address on file with the Company or, in either case, at such other address as one party may subsequently furnish to the other party in writing.

HARVARD BIOSCIENCE, INC.

By: _____

Name:
Title:

The foregoing Agreement is hereby accepted and the terms and conditions thereof hereby agreed to by the undersigned.

Dated:

Grantee's Signature

Grantee's name and address:

**Schedule A**

**Determination of Performance Factor**

The Performance Factor shall be determined according to the following table:

| **Relative TSR Percentile Rank*** | **Performance Factor**** |
|---|---|
| 20th percentile or lower | 0% |
| 21st to 32nd percentile | for each 1 percentile in range above 20th percentile, 4% |
| 33rd percentile | 50% |
| 34th to 49th percentile | 50%, plus for each 1 percentile in range above 33rd percentile, an additional 3% |
| 50th percentile | 100% |
| 51st to 74th percentile | 100%, plus for each 1 percentile in range above 50th percentile, an additional 2% |
| 75th percentile or higher | 150% |
| ***Examples***: If the Company's Relative TSR Percentile Rank falls into the 43rd percentile (i.e., ten percentiles above the 33rd percentile), the Performance Factor will be 80% (calculated by multiplying eight by 3% and adding it to 50%). If the Company's Relative TSR Percentile Rank falls into the 65th percentile (i.e., fifteen percentiles above the 50th percentile), the Performance Factor will be 130% (calculated by multiplying fifteen by 2% and adding it to 100%), provided that if the Total Shareholder Return for the Company is negative, the Performance Factor in such instance would be 100%. | |

*Total Shareholder Return for the Company shall be based on the percentage increase/decrease from the Initial Price to the Final Price, and shall reflect the reinvestment of dividends paid (if any) to shareholders of Common Stock during the Measurement Period.
** If the Total Shareholder Return is negative for the Performance Period, the Performance Factor is subject to a cap of 100%.

For purposes of the foregoing calculation:

1. "**Total Shareholder Return**" mean the quotient (expressed as a percentage) obtained by dividing (i)(A) the Final Price, plus (B) the aggregate amount of dividends paid in respect of a share of Common Stock during the Measurement Period (assuming reinvestment of the dividends), minus (C) the Initial Price, by (ii) the Initial Price.

2. "**Initial Price**" means the average closing price of Common Stock over the twenty trading day period ending on the trading day immediately preceding the first day of the Performance Period.

3. "**Final Price**" means the average closing price of Common Stock over the twenty trading day period ending on the last day of the Measurement Period, provided that in connection with a Change of Control, the Final Price shall be the per share purchase price in the Change of Control.

4. "**Measurement Period**" means the Performance Period; provided that in the event of a Change of Control, Total Shareholder Return shall be calculated through the date of the Change of Control as provided in the Agreement.

5. "**Relative TSR Percentile Rank**" means the percentile within the Index Constituent Companies (as defined below) that the Company's Total Shareholder Return would have for the Measurement Period.

6. If the Company's Relative TSR Percentile Rank falls between the measuring points, the Company's Relative TSR Percentile Rank will be rounded to the nearest whole percentage point. With respect to the Index Constituent Companies, such Initial Price and Final Price shall be determined on a component basis (assuming dividend reinvestment) during the applicable twenty (20) trading day periods using an open approach).

7. The companies included from the NASDAQ Biotechnology Index for purposes of the Relative TSR Percentile Rank calculation (the "**Index Constituent Companies**") will be determined on the first day of the Measurement Period and will be changed only in accordance with the following and no company shall be added during the Measurement Period for purposes of the Relative TSR Percentile Rank calculation. The Index Constituent Companies for purposes of the Relative TSR Percentile Rank calculation will be subject to change as follows:

(i) In the event of a merger, acquisition or business combination transaction of a company in the Index Constituent Companies in which the company in the Index Constituent Companies is the surviving entity and remains publicly traded, the surviving entity shall remain a company in the Index Constituent Companies. Any entity involved in the transaction that is not the surviving company shall no longer be a company in the Index Constituent Companies.

(ii) In the event of a merger, acquisition or business combination transaction of a company in the Index Constituent Companies, a "going private" transaction or other event involving a company in the Index Constituent Companies or the liquidation of a company in the Index Constituent Companies, in each case where the company in the Index Constituent Companies is not the surviving entity or is no longer publicly traded, the company shall no longer be a company in the Index Constituent Companies.

(iii) Notwithstanding the foregoing, in the event of a bankruptcy of a company in the Index Constituent Companies where the company in the Index Constituent Companies is not publicly traded at the end of the Measurement Period, such company shall remain a company in the Index Constituent Companies but shall be deemed to have a Total Shareholder Return of negative 100% (-100%).

**Exhibit 21.1**

**Subsidiaries of the Registrant**

AHN Acquisition GmbH (Germany)
Asys Hitech GmbH (Austria)
Biochrom Limited (United Kingdom)
Biochrom US, Inc. (Delaware, United States)
BioDrop Ltd. (United Kingdom)
Cartesian Technologies, Inc. (Delaware, United States)
CMA Microdialysis AB (Sweden)
Coulbourn Instruments, LLC (Delaware, United States)
Data Sciences International, Inc. (Delaware, United States)
Data Sciences (UK) MN, Ltd. (United Kingdom)
Data Sciences EURL (France)
Data Sciences GmbH (Germany)
DSI (Shanghai) Trading Co Ltd. (China)
Ealing Scientific Limited (doing business as Harvard Apparatus, Canada) (Canada)
FKA GSI US, Inc. (formerly Genomic Solutions, Inc.) (Delaware, United States)
FKAUBI, Inc. (formerly Union Biometrica, Inc.) (Delaware, United States)
Genomic Solutions Canada, Inc. (Delaware, United States)
Harvard Apparatus, S.A.R.L. (France)
Harvard Bioscience (Shanghai) Co. Ltd.
Harvard Distribution Oldco, Inc. (formerly Denville Scientific, Inc.) (Delaware, United States)
HEKA Electronics Incorporated (Canada)
HEKA Electronik GmbH (Germany)
HEKA Instruments Incorporated (New York, United States)
Hoefer, Inc. (Delaware, United States)
Hugo Sachs Elektronik - Harvard Apparatus GmbH (Germany)
KD Scientific, Inc. (Massachusetts, United States)
MultiChannel Systems MCS GmbH (Germany)
Panlab S.L. (Spain)
Scie-Plas Ltd. (United Kingdom)
Triangle BioSystems, Inc. (Delaware, United States)
Walden Precision Apparatus Ltd. (United Kingdom)
Warner Instruments LLC (Delaware, United States)

**EXHIBIT 23.1**

**CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM**

We have issued our reports dated March 16, 2020, with respect to the consolidated financial statements and internal control over financial reporting included in the Annual Report of Harvard Bioscience, Inc. on Form 10-K for the year ended December 31, 2019. We consent to the incorporation by reference of the said reports in the Registration Statements of Harvard Bioscience, Inc. on Form S-3 (File No. 333-224535) and Forms S-8 (File No. 333-53848, File No. 333-104544, File No. 333-135418, File No. 333-151003, File No. 333-174476, File No. 333-189175, File No. 333-204760, File No. 333-218497, File No. 333-225365 and File No. 333-231825).

/s/ GRANT THORNTON LLP

Boston, Massachusetts
March 16, 2020

**EXHIBIT 31.1**

**Certification**

I, Michael A. Rossi, certify that:

1. I have reviewed this annual report on Form 10-K of Harvard Bioscience, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

    a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

    b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

    c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

    d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

    a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

    b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 16, 2020

/s/ MICHAEL A. ROSSI
Michael A. Rossi
Chief Financial Officer

**EXHIBIT 31.2**

**Certification**

I, James Green, certify that:

1. I have reviewed this annual report on Form 10-K of Harvard Bioscience, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

    a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

    b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

    c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

    d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

    a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonable likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

    b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 16, 2020

/s/ JAMES GREEN
James Green
Chief Executive Officer

**EXHIBIT 32.1**

**CERTIFICATION OF PERIODIC FINANCIAL REPORT**
**PURSUANT TO 18 U.S.C. SECTION 1350**

The undersigned officer of Harvard Bioscience, Inc. (the "Company") hereby certifies to her knowledge that the Company's annual report on Form 10-K for the year ended December 31, 2019 to which this certification is being furnished as an exhibit (the "Report"), as filed with the Securities and Exchange Commission on the date hereof, fully complies with the requirements of Section 13(a) or 15(d), as applicable, of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), and that the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company. This certification is provided solely pursuant to 18 U.S.C. Section 1350 and Item 601(b)(32) of Regulation S-K ("Item 601(b)(32)") promulgated under the Securities Act of 1933, as amended (the "Securities Act"), and the Exchange Act. In accordance with clause (ii) of Item 601(b)(32), this certification (A) shall not be deemed "filed" for purposes of Section 18 of the Exchange Act, or otherwise subject to the liability of that section, and (B) shall not be deemed to be incorporated by reference into any filing under the Securities Act or the Exchange Act, except to the extent that the Company specifically incorporates it by reference.

Date: March 16, 2020

/s/ MICHAEL A. ROSSI
Name: Michael A. Rossi
Title: Chief Financial Officer

**EXHIBIT 32.2**

**CERTIFICATION OF PERIODIC FINANCIAL REPORT**
**PURSUANT TO 18 U.S.C. SECTION 1350**

The undersigned officer of Harvard Bioscience, Inc. (the "Company") hereby certifies to his knowledge that the Company's annual report on Form 10-K for the year ended December 31, 2019 to which this certification is being furnished as an exhibit (the "Report"), as filed with the Securities and Exchange Commission on the date hereof, fully complies with the requirements of Section 13(a) or 15(d), as applicable, of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), and that the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company. This certification is provided solely pursuant to 18 U.S.C. Section 1350 and Item 601(b)(32) of Regulation S-K ("Item 601(b)(32)") promulgated under the Securities Act of 1933, as amended (the "Securities Act"), and the Exchange Act. In accordance with clause (ii) of Item 601(b)(32), this certification (A) shall not be deemed "filed" for purposes of Section 18 of the Exchange Act, or otherwise subject to the liability of that section, and (B) shall not be deemed to be incorporated by reference into any filing under the Securities Act or the Exchange Act, except to the extent that the Company specifically incorporates it by reference.

Date: March 16, 2020

/s/ JAMES GREEN
Name: James Green
Title: Chief Executive Officer