2018 ANNUAL REPORT

Revolutionizing Physiologic Monitoring

Cardiovascular Neuroscience Immuno Oncology Diabetes

Harvard Bioscience

Solutions to Advance Life Science

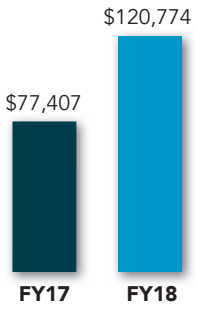
Financial Highlights

Jeff Duchemin

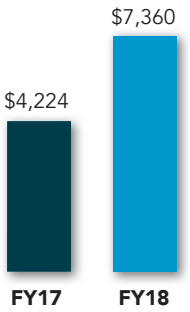
Jeffrey A. Duchemin was appointed Chief Executive Officer on August 26, 2013. He assumed the additional roles of President on November 1, 2013 and Director on October 29, 2013. Prior to joining Harvard Bioscience, Mr. Duchemin spent 16 years with Becton Dickinson (BD) in progressive sales, marketing and executive leadership positions across BD's three business segments; BD Medical Systems, BD Diagnostic Systems, and BD Biosciences.

Mr. Duchemin earned an M.B.A. from Southern New Hampshire University and a B.S. in accounting from the University of Massachusetts Dartmouth.

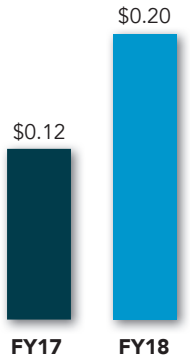
Revenues
($ U.S. in thousands)



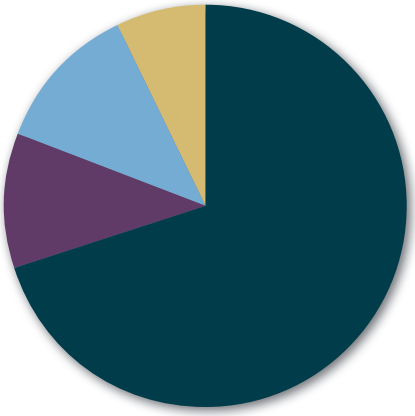
Non-GAAP Adjusted Net Income
($ U.S. in thousands)



Non-GAAP Adjusted Diluted EPS
($ U.S.)

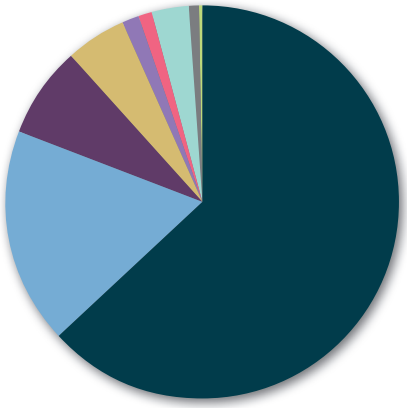


2018 Revenues by Region
(Revenues originating from region)



70% United States
12% United Kingdom
11% Germany
7% Rest of the World

Employees by Country
(As of December 31, 2018)



63% United States
18% Germany
7% United Kingdom
6% Spain
3% China
1% Sweden
1% Canada
1% France
<1% Italy

In this annual report, we have included non-GAAP financial information including adjusted net income and adjusted earnings per diluted share. We believe that this non-GAAP financial information provides investors with an enhanced understanding of the underlying operations of the business. This non-GAAP financial information approximates information used by our management to internally evaluate our results. In particular, we believe that the presentation of non-GAAP adjusted net income, including a number of adjusted line items, provides investors with a clearer understanding of the full effect of the adjustments that we make to our GAAP income and earnings per diluted share in order to derive our non-GAAP adjusted net income and earnings per diluted share. A tabular reconciliation of these non-GAAP adjusted results can be found at Exhibit 1 and 2.

Financial Performance

Selected Financial Data

	For the Year Ended December 31, 2018	2017
Statement of Operations Data:		
Revenues	$120,774	$ 77,407
Cost of revenues	57,593	38,237
Gross profit	63,181	39,170
Operating expenses	62,197	39,805
Operating income (loss)	984	(635)
Other expense, net	(8,959)	(1,986)
Loss from continuing operations before income taxes	(7,975)	(2,621)
Income tax benefit	(3,676)	(605)
Loss from continuing operations	(4,299)	(2,016)
Discontinued operations:		
Income from discontinued operations, net of tax	1,377	1,151
Net loss	$(2,922)	$ (865)
(Loss) earnings per share:		
Basic loss per common share from continuing operations	$(0.12)	$ (0.06)
Discontinued operations	0.04	0.03
Basic loss per common share	$(0.08)	$ (0.02)
Diluted loss per common share from continuing operations	$(0.12)	$ (0.06)
Discontinued operations	0.04	0.03
Diluted loss per common share	$(0.08)	$ (0.02)
Weighted average common shares:		
Basic	36,453	34,753
Diluted	36,453	34,753

	As of December 31, 2018	2017
Balance Sheet Data:		
Cash and cash equivalents	$8,173	$5,192
Working capital	36,326	33,494
Total assets	168,613	109,354
Long-term debt, net of current portion	58,796	8,983
Stockholders' equity	82,724	80,900

Kam Unninayar

Kam Unninayar was appointed Chief Financial Officer on November 26, 2018. Prior to joining the company she was recently CFO at Tetraphase, Inc. (NASDAQ:TTPH), a clinical stage biopharmaceutical company. Prior to this, she spent more than eleven years at Thermo Fisher Scientific, across multiple roles leading financial operations, corporate financial planning and analysis, finance for business strategy, and acquisitions and integrations. During her tenure there, she was Vice President of Finance for the Customer Channels group, Laboratory Products and Services segment, and other businesses with revenues that ranged from $200 million to $4 billion. Ms. Unninayar earned an Master of Science in Administration from Wichita State University, as well as a Master of Finance and Control and Bachelor of Commerce from the University of Delhi, India.

Dear Fellow Shareholders

Telemetry

Data Sciences International (DSI) provides a complete preclinical platform to assess physiological data for research ranging from basic, to drug discovery, and drug development.

DSI is best known as the company who pioneered the manufacturing of implantable telemetry devices for the wireless collection of physiologic signals in freely-moving, unstressed subjects.

Today, implantable telemetry is considered the gold standard for researchers in academia, pharmaceutical companies, contract research organizations, and government institutions. Physiologic endpoints collected include blood pressure, blood glucose, ocular pressure, ECG, EEG, EMG, intracranial pressure, tumor pressure, and many more.

2018 was a really important year in the history of Harvard Bioscience. The hard work and dedication of our team to transform Harvard Bioscience, which we began five years ago, paid off in January of 2018 when we announced the sale of Denville Scientific and the acquisition of Data Sciences International.

The sale of Denville and acquisition of DSI transformed Harvard Bioscience into a pure play life science company with competitive advantages across our portfolio. Sitting here today, having completed a banner year for the company, we are a larger organization, less susceptible to fluctuations in academic research funding, with improved profitability. Our 2018 results indicate just that. Among the highlights:

- **2018 adjusted revenue increased 20% to approximately $122 million.**
- **2018 adjusted gross margin percentage increased 890 basis points to approximately 56% as compared to 2017.**
- **2018 adjusted operating margin percentage increased 540 basis points to approximately 12% as compared to 2017.**
- **2018 adjusted earnings per share increased 65% to $0.20 per share.**
- **As most of you know, Harvard Bioscience has historically been heavily weighted in academia. DSI's revenue from academic customers is almost an inverse of Harvard Bioscience's customer mix. Our 2018 customer mix was closer to 60% revenue from academic customers and 40% from biopharma, contract research organizations, and government.This diversification has made our organization less susceptible to fluctuations in academic research funding, as well as created tremendous cross selling opportunity of DSI products into more academic labs and our legacy brands into the biopharma and CRO markets.**
- **When we announced the acquisition early last year, we spoke about approximately $2.5 million to $3.5 million in combined revenue and cost synergies in the first year, post-acquisition. As of today, I am happy to say we met our expectations and have realized synergies within that range over the first twelve months of ownership. As we move into 2019 and beyond, we continue to expect that topline and bottomline synergies will drive organic revenue growth and earnings expansion.**

Other 2018 Highlights

We closed 2018 with several other key highlights and developments that, in addition to the transformation of the business with the acquisition of DSI and divestiture of Denville, further creates a foundation of long term success.

Topline growth in China continued a strong trend in 2018. When I started with Harvard Bioscience five years ago, we had one dedicated channel manager selling our products in China. Today, in combination of the commercial team at DSI, our company has sixteen channel managers that are focused exclusively on China, Japan, and the rest of the Asian life science markets. We have grown our topline in China by more than four times in that five year span. The dedication and execution of our teams in China has made China and the Asian region, as a whole, an important growth driver for our company.

2018 was also a great year for innovation with product launches and product line extensions in telemetry, electrophysiology, and electroporation, expanding our applications in key life

science research markets in order to better serve our customers. Product development continues to be an important element of our strategy.

We have spent a lot of time during my tenure consolidating our manufacturing footprint in order to contain costs and expand margins. Our future expansion in gross margins and operating margins will continue to be driven by prudent cost containment measures, as well as improvement from two recent, small site consolidations. In the U.S., we moved our Hoefer brand from its previous facility in California to our Holliston, Massachusetts corporate headquarters. In Germany, we moved our HEKA Electronik manufacturing site to our MCS facility. Both of these moves took place in Q4 of 2018 and will positively impact our financial results in 2019 and beyond.

Finally, we hired our new Chief Financial Officer, Kam Unninayar, in late 2018. Kam brought a deep knowledge of our industry, having held financial leadership positions for various business segments at Thermo Fisher Scientific for more than 11 years, as well as most recently as CFO for Tetraphase Pharmaceuticals, a Nasdaq-listed company. She also held financial roles at other global public companies, and is well-versed and experienced in the operations of a global organization. Kam's proven skills align very well with our strategic initiatives of commercial excellence, operational efficiencies, product development, and acquisitions.

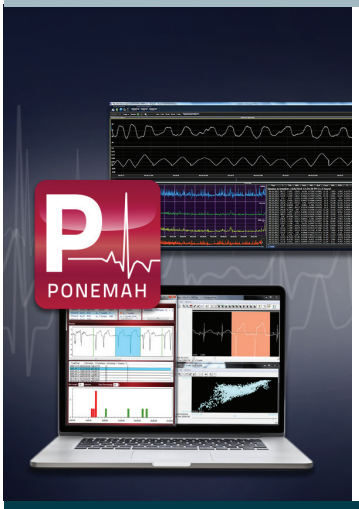
Looking Ahead…

In reflecting on the last five years at Harvard Bioscience, I am struck by what we've been able to accomplish. Our primary focus has been on our corporate initiatives – commercial excellence, operational efficiency, product development, and acquisitions. In that time we can point to successes in each area of our corporate initiatives, including this year – a true inflection point in the history of our organization. I am extremely proud of the global team we have assembled and the dedication they have shown to the success of our company. With the foundation strengthened, today we are more confident than ever of our position to achieve our growth goals in the years ahead.

We appreciate the commitment and continued support and look forward to sharing the future success of Harvard Bioscience with you all.

Sincerely,

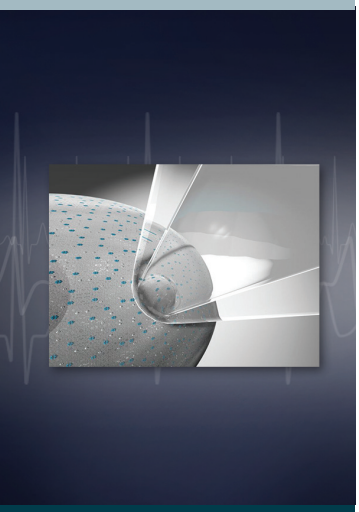
Jeffrey A. Duchemin
President & Chief Executive Officer



Ponemah, FinePointe and Neuroscore software

DSI offers three unique software platforms for the acquisition and analysis of physiological data. DSI's Ponemah software is a robust, yet flexible software platform. Ponemah is the leading choice for researchers seeking a comprehensive set of software tools designed for use with telemetry in a GLP environment. FinePointe software is used for collecting, analyzing, and reporting respiratory data from DSI's Buxco respiratory hardware. NeuroScore is the leading software choice for scientists involved with central nervous system monitoring.

Corporate Information



Patch Clamp

Developed by Nobel Prize winners Erwin Neher and Bert Sakmann, this trusted technique is used in electro-physiological studies of ion channels in tissue sections, individual living cells or patches of cell membrane.

Voltage clamp or current clamp technique is performed in any type of excitable cells, mostly neurons, cardiomyocytes, pancreatic beta cells or muscle fibers. Experiments include slice-recordings, single-cell-layer-recordings, in vivo-recordings, whole-cell-recordings, and single-channel-recordings.

Our Company

Harvard Bioscience, Inc., a Delaware corporation, is a global developer, manufacturer, marketer and provider of a broad range of scientific instruments, systems, software and services used to advance life science for basic research, drug discovery, physiologic monitoring, clinical and environmental testing. Our products and services are sold to thousands of researchers in over 100 countries through our global sales organization, websites, catalogs, and through distributors including Thermo Fisher Scientific Inc., VWR and other specialized distributors. We have sales and manufacturing operations in the United States, the United Kingdom, Germany, Sweden, Spain, France, Canada, Italy and China. Our vision is to be a world-leading life science company that excels in meeting the needs of our customers by providing a wide breadth of innovative products and solutions, while providing exemplary customer service.

Board of Directors

Jeffrey A. Duchemin
Our President &
Chief Executive Officer

Katherine A. Eade
Deputy General Counsel
La-Z-Boy, Inc.

James W. Green
General Partner
Grantchester Group

John F. Kennedy
Formerly President & CFO
Nova Ventures Corporation

Thomas W. Loewald
Division President
ProAmpac

Bertrand Loy
President & CEO
Entegris, Inc.

Price Range of Common Stock

Year Ended December 31, 2018

Quarter	High	Low
First	$ 5.15	$ 3.30
Second	$ 5.95	$ 4.20
Third	$ 6.65	$ 5.00
Fourth	$ 5.00	$ 3.03
FY 2018 average		$ 4.79
FY 2018 closing		$ 3.18

Year Ended December 31, 2017

Quarter	High	Low
First	$ 3.25	$ 2.55
Second	$ 2.75	$ 2.30
Third	$ 3.75	$ 2.35
Fourth	$ 3.80	$ 3.08
FY 2017 average		$ 2.92
FY 2017 closing		$ 3.30

Management

Jeffrey A. Duchemin
President &
Chief Executive Officer

Kam Unninayar
Chief Financial Officer

Stock Profile

Since the Company's initial public offering on December 7, 2000, shares of Harvard Bioscience, Inc. have been quoted on the Nasdaq Global Market, and currently trade under the symbol "HBIO".

As of March 7, 2019, the Company had 109 stockholders of record. The Company believes that the number of beneficial owners of our common stock at that date was substantially greater.

Corporate Address

Harvard Bioscience, Inc.
84 October Hill Road
Holliston, Massachusetts 01746
www.harvardbioscience.com

Independent Registered Public Accounting Firm

Grant Thorton LLP
75 State Street
Boston, Massachusetts 02109
www.grantthornton.com

General Counsel

Burns & Levinson LLP
125 Summer Street
Boston, Massachusetts 02110

Transfer Agent & Registrar

Computershare Limited
250 Royall Street
Canton, MA 02021

Annual Meeting of Stockholders

The Annual Meeting of Stockholders of Harvard Bioscience, Inc. will be held on Thursday, May 16, 2019 at 11:00 a.m. local time, at the offices of Burns & Levinson LLP, 125 Summer Street, Boston, MA 02110.

Investor Relations

To obtain copies of this annual report or other financial information, please write or call:

Investor Relations
Harvard Bioscience, Inc.
84 October Hill Road
Holliston, Massachusetts 01746
508-893-8066

Dividends

Harvard Bioscience, Inc. has never declared or paid cash dividends on its common stock and currently has no plans to do so in the foreseeable future.

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

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, 2018
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

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	**Name of each exchange on which registered**
Common Stock, $0.01 par value	**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 and posted on its corporate web site, if any, every Interactive Data File required to be submitted and posted pursuant to Rule 405 of Regulation S-T during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). ☒ YES ☐ NO

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

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 ☐		Accelerated filer ☒
Non-accelerated filer ☐	(Do not check if a smaller reporting company)	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 28,753,642 shares of voting common equity held by non-affiliates of the registrant as of June 30, 2018 was approximately $153,831,985 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 7, 2019, there were 37,667,783 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 2019 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.

HARVARD BIOSCIENCE, INC.
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For the Year Ended December 31, 2018
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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 global developer, manufacturer, marketer and provider of a broad range of scientific instruments, systems, software and services used to advance life science for basic research, drug discovery, physiologic monitoring, clinical and environmental testing. Our products and services are sold to thousands of researchers in over 100 countries through our global sales organization, websites, catalogs, and through distributors including Thermo Fisher Scientific Inc., VWR and other specialized distributors. We have sales and manufacturing operations in the United States, the United Kingdom, Germany, Sweden, Spain, France, Canada, Italy and China.

Our History

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 complimentary 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.

We are pursuing a strategy to grow the business organically as well as through strategic, accretive acquisitions, including five acquisitions since the fourth quarter of 2014. 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.

We have also conducted a multi-year restructuring program to reduce costs, align global functions and consolidate facilities to optimize our global footprint, divest non-core businesses and to reinvest in key areas such as sales and marketing

and new product development through research and 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) for approximately $20.0 million, which included a $3.0 million earn-out provision. Denville was a laboratory products supplier that was no longer core to our vision.

We have also developed many new product lines including: new generation Harvard Apparatus laboratory syringe pumps, Hoefer Gel Electrophoresis systems, Biochrom spectrophotometers and amino acid analysis products, Warner Instruments micro-incubation and perfusion products, CMA Microdialysis probes and guides, Panlab behavioral research products, Harvard Apparatus touch screen ventilators, HEKA PatchMaster data acquisition system, Harvard Apparatus physiological monitoring system, Warner valve control system, BTX electroporation generators, TBSI wireless in vivo telemetry implants and MCS beta screen for diabetic research. Additionally, in 2018, following the DSI acquisition, we introduced into the marketplace, the PhysioTel miniature telemetry devices and Buxco inhalation exposure systems.

Our Strategy

Our vision is to be a world leading life science company that excels in meeting the needs of our customers by providing a wide breath of innovative products and solutions, while providing exemplary customer service. Our business strategy is to grow our top-line and bottom-line, and build shareholder value through a commitment to:

- commercial excellence;
- organic growth;
- operational efficiencies;
- new product development; and
- strategic acquisitions.

Our Products

Our broad core product range is currently organized into three commercial product families: Physiology, Cell, Molecular Instruments (PCMI), Data Sciences International (DSI), and Electrophysiology (Ephys). We primarily sell our products under brand names, including Harvard Apparatus, DSI, Ponemah, Buxco, KD Scientific, Hoefer, Biochrom, BTX, Warner Instruments, MCS, HEKA, Hugo Sachs Elektronik, Panlab, Coulbourn Instruments, TBSI, and CMA Microdialysis.

Our products consist of instruments, consumables, systems and software. Our products include 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. 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. We manufacture our products at our locations in the United States, Germany, Sweden and Spain.

In addition to our proprietary manufactured products, we sell many products that are made by other manufacturers. These distributed products accounted for approximately 15% of our revenues for the year ended December 31, 2018. 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.

Physiology, Cell and Molecular Instruments Product Family

Our PCMI product family includes our traditional 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, microdialysis instruments, behavior research systems, and isolated organ and tissue bath systems. Our product offerings are marketed through our Harvard Apparatus, CMA Microdialysis, Panlab, Coulbourn, Hugo Sachs brands and entities. We sell these products through our global sales force, technical service team and our global distribution channel.

The PCMI product family also includes spectrophotometers, microplate readers, amino acid analyzers, gel electrophoresis equipment, sample preparation plates and columns, electroporation and electrofusion instruments. We market them under the names Biochrom, BioDrop, Hoefer, Scie-plas, QuikPrep, and BTX. We sell them primarily through our distribution arrangements with various distributors.

Our PCMI product family made up approximately 47.3% of our global revenues for the year ended December 31, 2018.

Data Sciences International Family

Data Sciences International (DSI) provides a complete preclinical platform to assess physiological data for research ranging from basic research, to drug discovery, and drug development services. The Data Sciences International family consists of the DSI and Buxco brands.

DSI develops and manufactures 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 DSI family made up approximately 35.2% of our global revenues for the year ended December 31, 2018.

Electrophysiology Family

The Electrophysiology product family includes the brands Multi-Channel Systems, HEKA, TBSI and Warner Instruments.

Multi-Channel Systems focuses on the development and manufacture of 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.

HEKA also develops, designs and manufactures precision electrophysiology equipment specializing in Patch Clamp Amplifiers and both manual and automated Patch Clamp Systems along with the associated software. The brand also specializes in instrumentation and equipment for Electrochemistry.

Warner Instruments manufactures specialized tools for Electrophysiology and Cell Biology research including cell chambers, perfusion controllers, temperature controllers, microincubation systems and bio-sensing systems.

TBSI designs and develops in vivo neural interface systems research to aid neuroscience research, especially in the fields of electrophysiology, psychology, neurology and pharmacology. This includes both wireless and tethered systems for both stimulation and recording.

Our Electrophysiology product family made up approximately 17.5% of our global revenues for the year ended December 31, 2018.

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 tens of thousands of customers worldwide and no customer accounted for more than 10% of our revenues in 2018.

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, 2018, revenues from direct sales to end-users represented approximately 59% of our revenues; and revenues from sales of our products through distributors represented approximately 41% 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 $11.0 million, and $5.6 million for the years ended December 31, 2018 and 2017, 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.

Manufacturing Activity	Manufacturing Facility
syringe pumps, ventilators, cell injectors, molecular sample preparation products, electroporation products, electrophysiology products, spectrophotometers, amino acid analysis systems, low-volume, high-throughput liquid dispensers, plate readers, behavioral research products, electrophoresis products and microdialysis products	Holliston, Massachusetts
physiological monitoring products and systems	New Brighton, Minnesota
electrophysiology products	Hamden, Connecticut
electrophysiology products	Reutlingen, Germany
complete organ testing systems	March-Hugstetten, Germany
behavioral research products	Barcelona, Spain
behavioral research products	Durham, North Carolina
microdialysis products	Kista, Sweden

Going forward we will continue to evaluate our manufacturing facilities and operations in order to achieve an optimal manufacturing footprint.

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, 2018, we employed 547 employees, of which 519 are full-time and 28 are part-time. As of December 31, 2017, we employed 434 employees, of which 413 were full-time and 21 were part-time. The increase in the number of employees was primarily due to our acquisition of DSI in 2018, partially offset by the disposition of Denville during 2018.

Geographical residence information for these employees is summarized in the table below:

	As of December 31, 2018
United States	346
Germany	97
United Kingdom	41
Spain	28
China	16
Canada	7
Sweden	6
France	5
Italy	1
Total	547

Geographic Area

Financial information regarding geographic areas in which we operate is provided in Note 22 of the "Notes to Consolidated Financial Statements," which are included elsewhere in this report.

Executive Officers of the Registrant

The following table shows information about our executive officers as of December 31, 2018.

Name	Age	Position
Jeffrey Duchemin	53	Chief Executive Officer, President and Director
Kam Uninayar	51	Chief Financial Officer
Yong Sun*.....	55	Vice President and General Manager, PCMI

*Resigned effective as of January 4, 2019.

Jeffrey A. Duchemin was appointed Chief Executive Officer on August 26, 2013. He assumed the additional roles of President on November 1, 2013 and Director on October 29, 2013. Prior to joining Harvard Bioscience, Mr. Duchemin spent 16 years with Becton Dickinson ("BD") in progressive sales, marketing and executive leadership positions across BD's three business segments; BD Medical Systems, BD Diagnostic Systems, and BD Biosciences. In October 2012, BD Biosciences Discovery Labware was acquired by Corning Life Sciences. Mr. Duchemin was a Global Business Director for Corning Life Sciences until his departure to Harvard Bioscience. Mr. Duchemin is a transformational leader with demonstrated business results. The depth of his experience spans across a broad range of life science research and medical device products resulting in growth on a global basis. Mr. Duchemin earned an M.B.A. from Southern New Hampshire University and a B.S. in accounting from the University of Massachusetts Dartmouth.

Kam Unninayar was appointed Chief Financial Officer on November 26, 2018. Prior to joining the company she was recently Chief Financial Officer at Tetraphase, Inc. (NASDAQ:TTPH), a clinical stage biopharmaceutical company. Prior to this, she spent more than eleven years at Thermo Fisher Scientific, a global leader in serving science, across multiple roles leading financial operations, corporate financial planning and analysis, finance for business strategy, and acquisitions and integrations. During her tenure there, she was Vice President of Finance for the Customer Channels group, Laboratory Products and Services segment, and other businesses with revenues that ranged from $200 million to $4 billion. Earlier in her career, Ms. Unninayar held finance roles with increasing responsibilities at Fortune 500 consumer companies. Ms. Unninayar earned an M.B.A. from Wichita State University, as well as a Master of Finance and Control and Bachelor of Commerce from the University of Delhi, India.

Yong Sun resigned as Vice President and General Manager of our PCMI product family, effective as of January 4, 2019. Previously Mr. Sun held the positions of Vice President, Commercial Operations since October 28, 2015, Vice President, Strategic Marketing and Business Development since October 28, 2013 and Vice President, R&D since March 10, 2014. Prior to joining Harvard Bioscience, he served as Vice President of Global Marketing and Americas Sales at Beaver-Visitec International, a company combining former ophthalmic business units from BD and Medtronic; in this role he led global marketing to develop and implement strategic marketing plans in target surgical markets. Prior to this, he served in progressive positions at BD, including Director of Global Marketing & United States Sales. Earlier, he served as Marketing Manager, Global Life Sciences Market & Greater China Region at Eli Lilly & Company's eLilly Unit (now InnoCentive, Inc.). Mr. Sun, holds an M.B.A. from the MIT Sloan School of Management, a M.S. in environmental science & engineering from Northeastern University and a B.S. in biochemistry from Peking University.

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. With respect to these recent acquisitions or 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 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, 2018, we had borrowings of $62.4 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.

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 PCMI, Ephys and Data Sciences 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 are 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; 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; and potential unfavorable tax consequences as a result of our operations in China.

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 are 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.

In June 2016, the United Kingdom (the U.K.) held a referendum in which voters approved an exit from the European Union (E.U.), commonly referred to as Brexit. On March 29, 2017, the U.K. formally notified the E.U. of its intention to withdraw pursuant to the Treaty on European Union. The withdrawal of the U.K. from the E.U. will take effect either when agreed upon or, in the absence of such an agreement, two years after the U.K. provided its notice of withdrawal. It appears likely that this withdrawal will involve a process of lengthy negotiations between the U.K. and the E.U. member states to determine the terms of the withdrawal as well as the U.K.'s relationship with the E.U. going forward. 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 announcement of Brexit and the likely withdrawal of the U.K. from the E.U. may also create global economic uncertainty, including an uncertain funding environment for U.K. customers receiving funding from the E.U, which may cause our customers to closely monitor their costs and 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 a transitional period or more permanently. Since a significant proportion of the regulatory framework in the U.K. is derived from E.U. directives and regulations, the referendum 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.

Further, Brexit could adversely affect European and worldwide economic or market conditions and could contribute to instability in global financial markets. 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.

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. The litigation is at an early stage and 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, 2018, we had goodwill and intangible assets of $103.1 million, or 61%, of our total assets and we concluded that none of our goodwill or other intangible assets was impaired.

If our accounting estimates are not correct, our financial results could be adversely affected.

Management judgment and estimates are required in the application of our Critical Accounting Policies. We discuss these estimates in the subsection entitled critical accounting policies beginning on page 28 in Item 7, Management's Discussion and Analysis of Financial Condition and Results of Operations in this Annual Report. If our estimates are incorrect, our future financial operating results and financial condition could be adversely affected.

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, Jeffrey A. Duchemin; the Chief Financial Officer, Kam Unninayar; 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 metropolitan area, 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, our presently 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.

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.

An active trading market for our common stock may not be sustained.

Although our common stock is quoted on the NASDAQ Global Market, an active trading market for the shares may not be sustained. This could negatively affect the price for our common stock, including investors' ability to buy or sell our common stock and the listing thereof.

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 twelve principal facilities incorporate manufacturing, research and development, sales and marketing, and administration functions. Our facilities consist of:

- a leased 95,529 square foot facility in New Brighton, Minnesota;
- a leased 83,123 square foot facility in Holliston, Massachusetts, which includes our corporate headquarters;
- a leased 22,449 square foot facility in Reutlingen, Germany;
- a leased 20,853 square foot facility in Barcelona, Spain;
- a leased 12,031 square foot facility in March-Hugstetten, Germany.

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.***

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 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 we believe that such claim is without merit, we are unable to predict the ultimate outcome of such litigation.

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.***

Price Range of Common Stock

Our common stock has been quoted on the NASDAQ Global Market since our initial public offering on December 7, 2000, and currently trades under the symbol "HBIO." The following table sets forth the range of the high and low sales prices per share of our common stock as reported on the NASDAQ Global Market for the quarterly periods indicated.

Fiscal Year Ended December 31, 2018	**High**	**Low**
First Quarter	$ 5.15	$ 3.30
Second Quarter	$ 5.95	$ 4.20
Third Quarter	$ 6.65	$ 5.00
Fourth Quarter	$ 5.00	$ 3.03

Fiscal Year Ended December 31, 2017	**High**	**Low**
First Quarter	$ 3.25	$ 2.55
Second Quarter	$ 2.75	$ 2.30
Third Quarter	$ 3.75	$ 2.35
Fourth Quarter	$ 3.80	$ 3.08

On March 7, 2019, the closing sale price of our common stock on the NASDAQ Global Market was $3.79 per share. There were 109 holders of record of our common stock as of March 7, 2019. 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 global developer, manufacturer, marketer and provider of a broad range of scientific instruments, systems, software and services used to advance life science for basic research, drug discovery, physiologic monitoring, clinical and environmental testing. Our products and services are sold to thousands of researchers in over 100 countries through our global sales organization, websites, catalogs, and through distributors including

Thermo Fisher Scientific Inc., VWR and other specialized distributors. We have sales and manufacturing operations in the United States, the United Kingdom, Germany, Sweden, Spain, France, Canada, Italy and China.

We are pursuing a strategy to grow the business organically as well as through strategic, accretive acquisitions, including five acquisitions since the fourth quarter of 2014. 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.

We have also conducted a multi-year restructuring program to reduce costs, align global functions and consolidate facilities to optimize our global footprint, divest non-core businesses and to reinvest in key areas such as sales and marketing and new product development through R&D. 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) for approximately $20.0 million, which included a $3.0 million earn-out provision. Denville was a laboratory products supplier that was no longer core to our vision.

Our Strategy

Our vision is to be a world leading life science company that excels in meeting the needs of our customers by providing a wide breadth of innovative products and solutions, while providing exemplary customer service. Our business strategy is to grow our top-line and bottom-line, and build shareholder value through a commitment to:

- commercial excellence;
- organic growth;
- operational efficiencies;
- new product development; and
- strategic acquisitions.

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

	2018	% of Revenues	2017	% of Revenues
	(dollars in thousands)			
Revenues	$ 120,774		$ 77,407	
Cost of revenues	57,593	47.7%	38,237	49.4%
Sales and marketing expenses	24,443	20.2%	15,082	19.5%
General and administrative expenses	21,382	17.7%	17,525	22.6%
Research and development expenses	10,988	9.1%	5,645	7.3%
Amortization of intangible assets	5,384	4.5%	1,553	2.0%
Other expense, net	8,959	7.4%	1,986	2.6%
Income from discontinued operations	1,377	1.1%	1,151	1.5%

Components of Operating Income

As previously described above, 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 years ended December 31, 2018 and 2017 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. Our websites and catalogs serve as the primary sales tools for our various product lines. 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 59% and 55% of our revenues for the years ended December 31, 2018 and 2017, 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. Following the acquisition of DSI, 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, 2018 and 2017, approximately 41% and 45% of our total revenues from continuing operations, respectively, were derived from sales to distributors.

For the years ended December 31, 2018 and 2017, approximately 85% and 82% of our revenues from continuing operations, respectively, were derived from products we manufacture and approximately 15% and 18%, 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, 2018 and 2017, approximately 30% and 46% of our revenues from continuing operations, respectively, were derived from sales made by our non-United States operations. As discussed later under "Selected Results of Operations", the increase in revenues is primarily attributable to the acquisition of DSI and the effect of currency translation.

Changes in the relative proportion of our revenue sources between direct sales and distribution sales, and the proportion of U.S. and non-U.S sales are primarily the result of the acquisition of DSI.

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 expense consists primarily of salaries and related expenses for personnel and spending to develop and enhance our products. Other research and development expense includes 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.

Stock-based compensation expenses. Stock-based compensation expense for the years ended December 31, 2018 and 2017 was $3.0 million and $3.5 million, respectively. Included in stock-based compensation expense for the years ended December 31, 2018 and 2017 was stock-based compensation related to discontinued operations of $0.2 million and $0.1 million, respectively. The stock-based compensation expense related to stock options, restricted stock units, restricted stock units with a market condition and the employee stock purchase plan was recorded as a component of cost of revenues, sales and marketing expenses, general and administrative expenses, research and development expenses, and income from discontinued operations.

Selected Results of Operations

Year ended December 31, 2018 compared to year ended December 31, 2017

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, 2018 were $120.8 million, an increase of 56.0%, or $43.4 million, compared to revenues of $77.4 million for the same period in 2017.

The increase in revenues reflects the addition of revenues from DSI in the year ended December 31, 2018 of approximately $42.6 million, while the impact of currency translation positively impacted revenues in the period by approximately $1.3 million. The favorability in currency translation for the year was primarily from the strengthening of the euro and British pound against the U.S. dollar.

Reconciliation of Changes In Revenues Compared to the Same Period of the Prior Year

	For the Year Ended December 31, 2018
Organic and DSI change	54.3%
Foreign exchange effect	1.7%
Total revenue change	56.0%

Each reporting period, we face currency exposure that arises from translating the results of our worldwide operations to the United States dollar at exchange rates that fluctuate from the beginning of such period. We evaluate our results of operations on both a reported and a foreign currency-neutral basis, which excludes the impact of fluctuations in foreign currency exchange rates. We believe that disclosing this non-GAAP financial information provides investors with an enhanced understanding of the underlying operations of the business. This non-GAAP financial information approximates information used by our management to internally evaluate our operating results. The non-GAAP financial information provided in the table above should be considered in addition to, not as a substitute for, the financial information provided and presented in accordance with accounting principles generally accepted in the United States, or GAAP.

Cost of revenues

Cost of revenues increased $19.4 million, or 50.6%, to $57.6 million for the year ended December 31, 2018 compared with $38.2 million for the year ended December 31, 2017. The increase in cost of revenues was primarily due to the effect on cost of revenues of the acquisition of DSI which was approximately $18.5 million. Gross profit margin as a percentage of revenues increased to 52.3% for the year ended December 31, 2018 compared with 50.6% for 2017. The increase in gross profit margin is primarily attributable to the effect of higher margin products following the acquisition of DSI. The increase in gross profit margin was offset by the effect of a $3.8 million charge recognized in cost of revenues during the year ended December 31, 2018 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 approximately six months.

Sales and marketing expenses

Sales and marketing expenses increased $9.3 million, or 62.1%, to $24.4 million for the year ended December 31, 2018 compared with $15.1 million for the year ended December 31, 2017. The increase in sales and marketing expenses was primarily due to the impact of the acquisition of DSI, as well as to a lesser extent, increases in employee, consulting, and travel costs.

General and administrative expenses

General and administrative expenses increased $3.9 million, or 22.0%, to $21.4 million for the year ended December 31, 2018 compared with $17.5 million for the year ended December 31, 2017. The increase was primarily attributable to the impact of the acquisition of DSI, as well as an increase in accrued bonus compensation. This increase was partially offset by a decrease in stock-based compensation expense and employee costs.

Research and development expenses

Research and development expenses were $11.0 million for the year ended December 31, 2018, an increase of $5.4 million, or 94.7%, compared with $5.6 million for the year ended December 31, 2017. The increase was primarily due to the impact of the acquisition of DSI.

Amortization of intangible assets

Amortization of intangible asset expenses was $5.4 million and $1.6 million for the years ended December 31, 2018 and 2017, respectively. The increase in amortization expense was primarily due to the addition of definite-lived intangible assets as a result of the DSI acquisition.

Other expense, net

Other expense, net, was $9.0 million and $2.0 million for the years ended December 31, 2018 and 2017, respectively. The increase in other expense, net was primarily due to an increase in interest expense, net as a result of higher debt balances during the current period compared to the same period last year as well as transaction costs incurred in 2018 of approximately $3.4 million, related to the acquisition of DSI and divestiture of Denville. These increases were offset by a decrease in foreign currency losses as compared to the prior period. Interest expense was $5.4 million and $0.7 million for the years ended December 31, 2018 and 2017, respectively. Currency exchange rate fluctuations included as a component of net loss resulted in approximately $0.1 million of currency gains and $0.5 million in currency losses during the years ended December 31, 2018 and 2017, respectively.

Income taxes

Income tax from continuing operations was a benefit of $3.7 million and $0.6 million for the years ended December 31, 2018 and 2017, respectively. The effective income tax rate was 46.1% for the year ended December 31, 2018, compared with 23.1% for the same period in 2017. The difference in our effective tax rate year over year was primarily attributable to lower pre-tax income at certain individual subsidiaries in 2018 versus the impact of certain provisions of U.S. tax reform in 2017.

On December 22, 2017, tax reform legislation known as the Tax Cuts and Jobs Act (the Tax Act) was signed into law. A majority of the provisions of the Tax Act are effective January 1, 2018. The Tax Act makes broad and complex changes to the U.S. Internal Revenue Code which include, but are not limited to: (1) the reduction of the corporate income tax rate from 35% to 21%; (2) the implementation of a modified territorial tax system with a one-time transition tax on previously unremitted earnings of foreign subsidiaries; (3) a new provision designed to tax global intangible low-taxed income (GILTI); (4) the deduction for foreign-derived intangible income (FDII); (5) a new limitation on deductible interest expense; and (6) limitations on the deductibility of certain executive compensation. The impacts of the Tax Act have been recorded in expense from continuing operations and the details are discussed more fully in Note 20, *Income Taxes*, in the Notes to Consolidated Financial Statements.

Income from discontinued operations

Discontinued operations resulted in income of $1.4 million and $1.2 million for the years ended December 31, 2018 and 2017, respectively. On January 22, 2018, we sold substantially all the assets of Denville, for approximately $20.0 million, which included a $3.0 million earn-out provision. The results of Denville were presented in discontinued operations for both the years ended December 31, 2018 and 2017. Income from discontinued operations for the year ended December 31, 2018 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 a 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, 2018, we held cash and cash equivalents from continuing operations of $8.2 million, compared with $5.2 million at December 31, 2017. As of December 31, 2018 and December 31, 2017, we had $60.8 million and $11.7 million of borrowings outstanding under our credit facility, net of deferred financing costs, respectively. Total debt, net of cash and cash equivalents was $52.6 million at December 31, 2018, compared to $6.5 million at December 31, 2017. In addition, we had an underfunded United Kingdom pension liability of approximately $0.9 million and $1.2 million at December 31, 2018 and December 31, 2017, respectively.

As of December 31, 2018 and December 31, 2017, cash and cash equivalents held by our foreign subsidiaries was $3.2 million and $4.8 million, respectively. As of December 31, 2017, we changed our indefinite reinvestment assertion to provide that all foreign cash balances above the level required for local operating expenses would be repatriated to the U.S. in tax years after 2017. We maintain this modified assertion at December 31, 2018. 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 2018 and 2017, and we had an accrued withholding tax liability of $38 thousand as of both December 31, 2018 and December 31, 2017, related to amounts determined to be available for repatriation.

Condensed Cash Flow Statements
(unaudited)

	Year Ended December 31,	
	2018	**2017**
	(in thousands)	
Cash flows from operations:		
Net loss	$ (2,922)	$ (865)
Other adjustments to operating cash flows	7,481	5,733
Changes in assets and liabilities	(1,675)	(3,811)
Net cash provided by operating activities	2,884	1,057
Investing activities:		
Additions to property, plant and equipment	(986)	(890)
Acquisition, net of cash acquired	(68,548)	-
Disposition, net of cash sold	15,754	-
Other investing activities	(16)	(27)
Net cash used in investing activities	(53,796)	(917)
Financing activities:		
Net proceeds from issuance of debt	50,502	(1,952)
Other financing activities	2,551	160
Net cash provided by (used in) financing activities	53,053	(1,792)
Effect of exchange rate changes on cash	299	1,789
Increase in cash and cash equivalents	$ 2,440	$ 137

Our operating activities provided cash of $2.9 million and $1.1 million for the year ended December 31, 2018 and 2017, respectively. The decrease in net cash flow from operations was primarily due to the increase in net loss as well as the effect of changes in working capital period over period.

Our investing activities used cash of $53.8 million and $0.9 million for the year ended December 31, 2018 and 2017, respectively. 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. Investing activities during the year ended December 31, 2017 primarily included cash used for purchases of property, plant and equipment. We spent $1.0 million and $0.9 million on capital expenditures during the year ended December 31, 2018 and 2017, 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, 2018, financing activities provided cash of $53.1 million, compared with $1.8 million of cash used by financing activities for the year ended December 31, 2017. During the year ended December 31, 2018, we borrowed $70.7 million, repaid $20.2 million of debt and ended the year with $60.8 million of borrowings, net of deferred financing costs of $1.6 million. During the year ended December 31, 2017, we borrowed $2.8 million under our credit facility, repaid $4.7 million of debt under our credit facility and term loans and ended the year with $11.7 million of borrowings, net of deferred financing costs of $0.2 million. Net cash proceeds from the issuance of common stock for the years ended December 31, 2018 and 2017 was $4.6 million and $0.2 million, respectively.

Borrowing Arrangements

On January 22, 2018, in connection with the closing of the sale of Denville, we terminated the Third Amended and Restated Credit Agreement (the Credit Agreement), dated as of May 1, 2017, among us, 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 sale. At the time of repayment, there was approximately $11.9 million of borrowings outstanding.

On January 31, 2018, we entered into a financing agreement by and among us and certain of our subsidiaries, as borrowers (collectively, the Borrower), certain of our subsidiaries 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, we and Cerberus Business Finance, LLC entered into a First Amendment to the Financing Agreement, which such amendment modified certain provisions relating to the borrowing base and reporting, among other things.

The Financing Agreement provides 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 us and our subsidiaries for general corporate and working capital needs, and other purposes to the extent permitted by the Financing Agreement. The Senior Secured Credit Facilities have a maturity of five years. At the closing date of the Financing Agreement, we had approximately $14.5 million of available borrowing capacity under the revolving line of credit.

Commencing on March 31, 2018, the outstanding term loans 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.

The obligations under the Senior Secured Credit Facilities are unconditionally guaranteed by us and certain of our 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 Company and its 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 a 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. As further described under Item 7A, we have hedged a portion of the Financing Agreement using an interest rate swap.

The Financing Agreement contains customary representations and warranties and affirmative covenants applicable to us and our 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 our 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 also contains customary events of default.

As of December 31, 2018 and December 31, 2017, we had borrowings net of debt issuance costs of $60.8 million and $11.7 million respectively, outstanding. The carrying value of the debt approximates fair value because the interest rate under the obligation approximates market rates of interest available to us for similar instruments. As of December 31, 2018, we were in compliance with all financial covenants contained in the Financing Agreement, were subject to covenant and working capital borrowing restrictions and had available borrowing capacity under our Financing Agreement of $9.8 million.

As of December 31, 2018, the weighted effective interest rate, net of the impact of our interest rate swap, on our Term Loan was 8.88%.

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. Based on our current operations and current operating plans, we expect that our available cash, cash generated from current operations and debt capacity will be sufficient to finance current operations, fund our pension obligations, and finance capital expenditures for the next 12 months and beyond. We may however need to incur additional debt or raise equity capital for our business. Additional capital raising activities will dilute the ownership interests of existing stockholders to the extent we raise capital by issuing equity securities and we cannot guarantee that we will be successful in raising additional capital on favorable terms or at all.

Critical Accounting Policies

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, 2018, we have a valuation allowance of $13.9 million, of which $13.0 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, 2018, amortizable intangible assets include existing technology, trade names, distribution agreements, in-process research and development, 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, 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 in the fourth quarter of fiscal year 2018. The determination of the fair value of the reporting unit requires us to make a significant estimate on control premiums appropriate of industries in which we compete. We compared our carrying value to our overall market capitalization.

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. We also concluded that the fair value of the unamortized intangible assets significantly exceeds the carrying amounts.

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 adopted ASU 2016-09 as of January 1, 2017. As a result of this adoption, we have elected as an accounting policy to 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 are 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, especially the British pound, the euro, the Canadian dollar and the Swedish krona.

During the year ended December 31, 2018, changes in foreign currency exchange rates resulted in a favorable translation effect on our consolidated revenues and a favorable effect on our consolidated net loss. Changes in foreign currency exchange rates resulted in a favorable effect on revenues of approximately $1.3 million and an unfavorable effect on expenses of approximately $1.0 million.

The loss associated with the translation of foreign equity into U.S. dollars included as a component of comprehensive (loss) gain during the year ended December 31, 2018, was approximately $2.9 million, compared to a gain of $4.4 million for the year ended December 31, 2017.

Currency exchange rate fluctuations included as a component of net loss resulted in approximately $0.1 million in currency gains and $0.5 million in currency losses during the year ended December 31, 2018 and 2017, respectively.

Recently Issued Accounting Pronouncements

In February 2016, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) 2016-02, *Leases*, which is intended to improve financial reporting about leasing transactions. The update requires a lessee to record on the 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. We expect to utilize a practical expedient in our method of adoption of the standard. Under this expedient, which is a "current-period adjustment method," we would apply ASC 842 as of January 2019 and record a cumulative-effect adjustment to retained earnings as of that date.

We have made substantial progress in our assessment over the impact of the standard and determined that only material leases that we hold are our building leases. Upon adoption of the standard, we preliminarily expect to record a right of use asset in the range of approximately $9 to $11 million and a lease liability in the range of approximately $10 to $12 million on our consolidated balance sheet. The finalization of our assessment may result in changes to our estimates that may impact our preliminary estimate of the cumulative effect.

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 ASU is effective for public entities for fiscal years beginning after December 15, 2019, with early adoption permitted. In November 2018, the FASB issued ASU No. 2018-19, *Codification Improvements to Topic 326, Financial Instruments—Credit Losses*, which provided additional implementation guidance on the previously issued ASU. We have not yet completed our assessment of the impact of the new standard on our consolidated financial statements. Currently, we believe that the most notable impact of this ASU will relate to our processes around the assessment of the adequacy of our allowance for doubtful accounts on trade accounts receivable and the recognition of credit losses.

In August 2017, the FASB issued ASU 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. Early adoption is permitted, including adoption in any interim period. We are evaluating the requirements of this guidance and have not yet determined the impact of the adoption on our 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. We have not yet completed our assessment of the impact of the new standard on our consolidated financial statements.

Recently Adopted Accounting Pronouncements

In May 2014, the FASB issued ASU 2014-09, *Revenue from Contracts with Customers,* a new accounting standard that provides for a comprehensive model to use in the accounting for revenue arising from contracts with customers that will replace most existing revenue recognition guidance within generally accepted accounting principles in the United States. Under this standard, revenue will be recognized to depict the transfer of promised goods or services to customers in an amount that reflects the consideration to which we expect to be entitled in exchange for those goods or services.

We adopted this standard as of January 1, 2018 using the modified retrospective approach. As part of the implementation of the standard, we identified our significant revenue streams, which currently consist primarily of product revenue transactions, and service, maintenance and extended warranty transactions on certain product sales. The timing of recognizing revenues for these revenue streams did not materially change. Additionally, there were no material changes to business processes, systems and controls. Our updated revenue recognition policy and additional disclosures are presented in Note 17.

In May 2017, the FASB issued ASU 2017-09, Stock compensation (Topic 718): Scope of modification accounting which amends the scope of modification accounting for share-based payment arrangements. The ASU provides guidance on the types of changes to the terms or conditions of share-based payment awards to which an entity would be required to apply modification accounting under ASC 718. Specifically, an entity would not apply modification accounting if the fair value, vesting conditions, and classification of the awards are the same immediately before and after the modification. The ASU is effective for annual reporting periods, including interim periods within those annual reporting periods, beginning after December 15, 2017. We adopted this guidance on January 1, 2018, and the new standard did not have a material impact on our consolidated financial position, results of operations and cash flows.

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, 2018, we had $60.8 million outstanding under our Financing Agreement, net of deferred financing costs.

As noted above under the heading "Borrowing Arrangements", on January 22, 2018, we terminated the Credit Agreement, and on January 31, 2018, entered into the Financing Agreement. As a result of terminating the Credit Agreement, we unwound our previously existing swap agreement and received an immaterial amount of proceeds. On February 16, 2018, we entered into a new 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 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, 2018, the weighted effective interest rates, net of the impact of our interest rate swaps, on our Term Loan was 8.88%. 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, 2018 is quantified and summarized as follows:

If compared to the rate as of December 31, 2018	**Interest expense increase**
	(in thousands)
Interest rates increase by 1%	$ 283
Interest rates increase by 2%	$ 566

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

The information required by this item is contained in the consolidated financial statements filed as part of this Annual Report on Form 10-K and is listed under Item 15 of Part IV below.

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, 2018, 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, 2018.

The Company closed the acquisition of DSI on January 31, 2018. DSI's total assets and revenue constituted 47.6% and 35.2%, respectively, of the Company's consolidated total assets and revenue as shown on our consolidated financial statements as of and for the year ended December 31, 2018. As the acquisition occurred in the first quarter of fiscal 2018, the Company excluded DSI's internal control over financial reporting from the scope of the assessment of the effectiveness of the Company's disclosure controls and procedures. This exclusion is in accordance with the general guidance issued by the Staff of the Securities and Exchange Commission that an assessment of a recently-acquired business may be omitted from the scope in the year of acquisition, if specified conditions are satisfied.

The effectiveness of our internal control over financial reporting as of December 31, 2018 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, 2018, 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

The 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, 2018, 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, 2018, 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, 2018, and our report dated March 18, 2019 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.

Our audit of, and opinion on, the Company's internal control over financial reporting does not include the internal control over financial reporting of Data Sciences International, Inc. (DSI), a wholly-owned subsidiary, whose financial statements reflect total assets and revenues constituting 47.6 and 35.2 percent, respectively, of the related consolidated financial statement amounts as of and for the year ended December 31, 2018. As indicated in Management's Report, DSI was acquired during 2018. Management's assertion on the effectiveness of the Company's internal control over financial reporting excluded internal control over financial reporting of DSI.

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 18, 2019

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 2019 Annual Meeting of Stockholders. Information concerning executive officers of our Company is included in Part I of this Annual Report on Form 10-K as Item 1. Business- Executive Officers of the Registrant and incorporated herein by reference.

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 2019 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 2019 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 2019 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 2019 Annual Meeting of Stockholders.

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

(a) Documents Filed. The following documents are filed as part of this Annual Report on Form 10-K or incorporated by reference as indicated:

1 Financial Statements. The consolidated financial statements of Harvard Bioscience, Inc. and its subsidiaries filed under this Item 15:

2 Exhibits and Exhibit Index. See the Exhibit Index included as the last part of this Annual Report on Form 10-K, which is incorporated herein by reference.

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

HARVARD BIOSCIENCE, INC.

Report of Independent Registered Public Accounting Firm

The 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, 2018 and 2017, 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, 2018, 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, 2018 and 2017, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2018, 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, 2018, 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 18, 2019 expressed an unqualified opinion.

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 18, 2019

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

	December 31, 2018	December 31, 2017
Assets		
Current assets:		
Cash and cash equivalents	$ 8,173	$ 5,192
Accounts receivable, net of allowance for doubtful accounts of $332 and $193, respectively	21,463	13,382
Inventories	25,087	16,848
Other receivables and other assets	3,109	3,709
Current assets held for sale	-	8,404
Total current assets	57,832	47,535
Property, plant and equipment, net	5,898	3,743
Deferred income tax assets	211	182
Amortizable intangible assets, net	44,532	10,030
Goodwill	57,304	36,336
Indefinite lived intangible assets	1,232	1,244
Other assets	1,604	324
Long term assets held for sale	-	9,960
Total assets	$ 168,613	$ 109,354
Liabilities and Stockholders' Equity		
Current liabilities:		
Current portion, long-term debt	$ 1,999	$ 2,765
Accounts payable	7,359	4,410
Deferred revenue	3,820	505
Accrued income taxes	978	395
Accrued expenses	5,762	3,816
Other liabilities – current	1,588	293
Current liabilities held for sale	-	1,857
Total current liabilities	21,506	14,041
Long-term debt, less current installments	58,796	8,983
Deferred income tax liabilities - non-current	2,301	2,653
Other long term liabilities	3,286	1,466
Long term liabilities held for sale	-	1,311
Total liabilities	85,889	28,454
Commitments and contingencies		
Stockholders' equity:		
Preferred stock, par value $0 per share, 5,000,000 shares authorized	-	-
Common stock, par value $0 per share, 80,000,000 shares authorized; 45,124,309 and 42,763,985 shares issued and 37,378,802 and 35,018,478 shares outstanding, respectively	436	419
Additional paid-in-capital	226,377	218,792
Accumulated deficit	(119,889)	(116,967)
Accumulated other comprehensive loss	(13,532)	(10,676)
Treasury stock at cost, 7,745,507 common shares	(10,668)	(10,668)
Total stockholders' equity	82,724	80,900
Total liabilities and stockholders' equity	$ 168,613	$ 109,354

See accompanying notes to consolidated financial statements.

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

	Year Ended December 31,	
	2018	**2017**
Revenues	$ 120,774	$ 77,407
Cost of revenues (exclusive of items shown separately below)	57,593	38,237
Gross profit	63,181	39,170
Sales and marketing expenses	24,443	15,082
General and administrative expenses	21,382	17,525
Research and development expenses	10,988	5,645
Amortization of intangible assets	5,384	1,553
Total operating expenses, net	62,197	39,805
Operating income (loss)	984	(635)
Other income (expense):		
Foreign exchange	148	(534)
Interest expense, net	(5,367)	(713)
Other expense, net	(3,740)	(739)
Other expense, net	(8,959)	(1,986)
Loss from continuing operations before income taxes	(7,975)	(2,621)
Income tax benefit	(3,676)	(605)
Loss from continuing operations	(4,299)	(2,016)
Discontinued operations:		
Income from discontinued operations before income taxes	936	534
Income tax benefit	(441)	(617)
Income from discontinued operations, net of tax	1,377	1,151
Net loss	$ (2,922)	$ (865)
(Loss) earnings per share:		
Basic loss per common share from continuing operations	$ (0.12)	$ (0.06)
Discontinued operations	0.04	0.03
Basic loss per common share	$ (0.08)	$ (0.02)
Diluted loss per common share from continuing operations	$ (0.12)	$ (0.06)
Discontinued operations	0.04	0.03
Diluted loss per common share	$ (0.08)	$ (0.02)
Weighted average common shares:		
Basic	36,453	34,753
Diluted	36,453	34,753

See accompanying notes to consolidated financial statements.

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

	Year Ended December 31,	
	2018	**2017**
Net loss	$ (2,922)	$ (865)
Other comprehensive (loss) income:		
Foreign currency translation adjustments	(2,875)	4,445
Derivatives qualifying as hedges, net of tax:		
Loss on derivative instruments designated and qualifying as cash flow hedges	(343)	(24)
Amounts reclassified from accumulated other comprehensive (loss) income to net (loss) income	136	61
Derivatives qualifying as hedges, net of tax	(207)	37
Defined benefit pension plans, net of tax:		
Amortization of net losses included in net periodic pension costs, net of tax expense of $56 and $62 in 2018 and 2017, respectively	275	300
Net (loss) gain, net of tax benefit of $10 and $246 in 2018 and 2017, respectively	(49)	1,200
Defined benefit pension plans, net of tax	226	1,500
Other comprehensive (loss) income	(2,856)	5,982
Comprehensive (loss) income	$ (5,778)	$ 5,117

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 Income (Loss)	Treasury Stock	Total Stockholders' Equity
Balance at December 31, 2016	42,187	418	215,134	(116,030)	(16,658)	(10,668)	72,196
Share based payment change in accounting principle	-	-	72	(72)	-	-	-
Stock option exercises	143	2	188	-	-	-	190
Stock purchase plan, net	76	-	140	-	-	-	140
Vesting of restricted stock units	489	-	-	-	-	-	-
Shares withheld for taxes	(131)	(1)	(242)	-	-	-	(243)
Stock compensation expense	-	-	3,500	-	-	-	3,500
Net income	-	-	-	(865)	-	-	(865)
Other comprehensive loss	-	-	-	-	5,982	-	5,982
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
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

See accompanying notes to consolidated financial statements.

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

	Year Ended December 31,	
	2018	**2017**
Cash flows from operating activities:		
Net loss	$ (2,922)	$ (865)
Adjustments to reconcile net loss to net cash provided by operating activities:		
Stock compensation expense	3,044	3,500
Depreciation	2,423	1,317
Gain on sale of Denville	(1,251)	-
Gain on disposal of fixed assets, net	(3)	(12)
Loss on sale of AHN	-	93
Amortization of catalog costs	28	42
Provision for (recovery of) allowance for doubtful accounts	25	(109)
Amortization of intangible assets	5,431	2,442
Amortization of deferred financing costs	645	44
Deferred income taxes	(2,861)	(1,584)
Changes in operating assets and liabilities:		
(Increase) decrease in accounts receivable	(2,792)	196
Decrease (increase) in inventories	2,554	(548)
Increase in other receivables and other assets	(124)	(102)
Increase (decrease) in trade accounts payable	1,593	(918)
Increase in accrued income taxes	612	212
Decrease in accrued expenses	(3,149)	(736)
Increase in deferred revenue	2,492	95
Decrease in other liabilities	(2,861)	(2,010)
Net cash provided by operating activities	2,884	1,057
Cash flows used in investing activities:		
Additions to property, plant and equipment	(986)	(890)
Additions to catalog costs	(20)	(39)
Proceeds from sales of property, plant and equipment	4	12
Acquisition, net of cash acquired	(68,548)	-
Disposition, net of cash sold	15,754	-
Net cash used in investing activities	(53,796)	(917)
Cash flow provided by (used in) financing activities:		
Proceeds from issuance of debt	70,700	2,750
Repayments of debt	(20,198)	(4,702)
Payments of debt issuance costs	(2,006)	-
Net proceeds from issuance of common stock	4,557	160
Net cash provided by (used in) financing activities	53,053	(1,792)
Effect of exchange rate changes on cash	299	1,789
Increase in cash and cash equivalents	2,440	137
Cash and cash equivalents at the beginning of period, including cash included in assets held for sale	5,733	5,596
Cash and cash equivalents at the end of period, including cash included in assets held for sale	$ 8,173	$ 5,733
Supplemental disclosures of cash flow information:		
Cash paid for interest	$ 4,987	$ 686
Cash refunded for income taxes	$ 98	$ 13

See accompanying notes to consolidated financial statements.

1. Organization

Harvard Bioscience, Inc., a Delaware corporation, is a global developer, manufacturer, marketer and provider of a broad range of scientific instruments, systems, software and services used to advance life science for basic research, drug discovery, physiologic monitoring, clinical and environmental testing. The Company's products and services are sold to thousands of researchers in over 100 countries through its global sales organization, websites, catalogs, and through distributors including Thermo Fisher Scientific Inc., VWR and other specialized distributors. The Company has sales and manufacturing operations in the United States, the United Kingdom, Germany, Sweden, Spain, France, Italy, Canada and China.

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

For purposes of the consolidated balance sheets and statements of cash flows, 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:

Buildings	40 years
Machinery and equipment	3 – 10 years
Computer equipment and software	3 – 7 years
Furniture and fixtures	5 – 10 years
Automobiles	3 – 6 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) Catalog Costs

Significant costs of product catalog design, development and production are capitalized and amortized over the expected useful life of the catalog (usually one to three years).

(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 19 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, 2018, amortizable intangible assets include existing technology, trade names, distribution agreements, in-process research and development, 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, 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 2018. 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, 2018, 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. At December 31, 2018, the Company concluded that none of its indefinite-lived intangible assets were impaired.

(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, 2018, 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 and has been reduced for estimated forfeitures. 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 are based on the market price of the Company's 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 with the Company.

Stock-based compensation expense recognized under FASB ASC 718 for the years ended December 31, 2018 and 2017 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 14 for further details.

(s) Recently Issued Accounting Pronouncements

In February 2016, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) 2016-02, *Leases*, which is intended to improve financial reporting about leasing transactions. The update requires a lessee to record on the 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 expects to utilize a practical expedient in its method of adoption of the standard. Under this expedient, which is a "current-period adjustment method," the Company would apply ASC 842 as of January 2019 and record a cumulative-effect adjustment to retained earnings as of that date.

The Company has made substantial progress in its assessment over the impact of the standard and determined that the only material leases that it holds are building leases. Upon adoption of the standard, the Company preliminarily expects to record a right of use asset in the range of approximately $9 to $11 million and a lease liability in the range of approximately $10 to $12 million on its consolidated balance sheet. The finalization of the Company's assessment may result in changes to the Company's estimates that may impact its preliminary estimate of the cumulative effect. The Company's future commitments under lease obligations are summarized in Note 13.

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 ASU is effective for public entities for fiscal years beginning after December 15, 2019, with early adoption permitted. In November 2018, the FASB issued ASU No. 2018-19, Codification Improvements to Topic 326, Financial Instruments—Credit Losses, which provided additional implementation guidance on the previously issued ASU. Management has not yet completed its assessment of the impact of the new standard on the Company's Consolidated Financial Statements. Currently, the Company believes that the most notable impact of this ASU will relate to its processes around the assessment of the adequacy of its allowance for doubtful accounts on trade accounts receivable and the recognition of credit losses.

In August 2017, the FASB issued ASU 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. Early adoption is permitted, including adoption in any interim period. The Company is evaluating the requirements of this guidance and has not yet determined the impact of the adoption 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.

Recently Adopted Accounting Pronouncements

In May 2014, the FASB issued ASU 2014-09, *Revenue from Contracts with Customers,* a new accounting standard that provides for a comprehensive model to use in the accounting for revenue arising from contracts with customers that will replace most existing revenue recognition guidance within generally accepted accounting principles in the United States. Under this standard, revenue will be recognized to depict the transfer of promised goods or services to customers in an amount that reflects the consideration to which the Company expects to be entitled in exchange for those goods or services.

The Company adopted this standard as of January 1, 2018 using the modified retrospective approach, and applied the guidance to contracts that were not completed at the date of adoption. The Company's significant revenue streams currently consist primarily of product revenue transactions, service, maintenance and extended warranty transactions on certain product sales. The timing of recognizing revenues for these revenue streams did not materially change. Additionally, the adoption of ASU 2014-09 did not have a material impact on the Company's financial position, results of operations, equity or cash flows as of the adoption date or for the year ended December 31, 2018. The Company's updated revenue recognition policy is described in Note 2 and disaggregated revenue disclosures required under ASC 2014-09 are presented in Note 19.

In May 2017, the FASB issued ASU 2017-09, *Stock compensation* (Topic 718): Scope of modification accounting which amends the scope of modification accounting for share-based payment arrangements. The ASU provides guidance on the types of changes to the terms or conditions of share-based payment awards to which an entity would be required to apply modification accounting under ASC 718. Specifically, an entity would not apply modification accounting if the fair value, vesting conditions, and classification of the awards are the same immediately before and after the modification. The ASU is effective for annual reporting periods, including interim periods within those annual reporting periods, beginning after December 15, 2017. The Company adopted this guidance on January 1, 2018, and the new standard did not have a material impact on its consolidated financial position, results of operations and cash flows

(t) Reclassifications

As disclosed in Note 6, 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 years ended December 31, 2018 and 2017 have been presented in discontinued operations in the consolidated statements of operations. Additionally, the assets and liabilities of Denville as of December 31, 2017 have been recast in the consolidated balance sheet and presented as held for sale. These reclassifications and 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.

3. Concentrations

No customer accounted for more than 10% of the revenues for the years ended December 31, 2018, and 2017. At December 31, 2018 and 2017, no customer accounted for more than 10% of net accounts receivable.

4. 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, 2016	$ (14,200)	$ -	$ (2,458)	$ (16,658)
Other comprehensive income (loss) before reclassifications	4,445	(24)	1,200	5,621
Amounts reclassified from AOCI	-	61	300	361
Net other comprehensive income	4,445	37	1,500	5,982
Balance at December 31, 2017	$ (9,755)	$ 37	$ (958)	$ (10,676)
Other comprehensive 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)

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, 2018	2017
Amounts Reclassified From AOCI			
Derivatives qualifying as hedges			
Realized loss on derivatives qualifying as hedges	Interest expense, net	$ 136	$ 61
Income tax	Income tax (benefit) expense	-	-
		136	61
Defined benefit pension plans			
Amortization of net losses included in net periodic pension costs	General and administrative expenses	331	362
Income tax	Income tax (benefit) expense	(56)	(62)
		275	300
Total reclassifications		$ 411	$ 361

5. 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 6, and proceeds from the Financing Agreement discussed in Note 15.

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 aggregate purchase price for this acquisition was allocated to tangible and intangible net assets acquired as follows:

	(in thousands)
Tangible assets	$ 34,010
Liabilities assumed	(11,949)
Net assets	22,061
Goodwill and intangible assets:	
Goodwill	21,865
Amortizable intangible assets:	
Trade name	3,524
Developed technology	25,570
Customer relationships	9,837
In-process research and development	1,387
Total amortizable intangible assets	40,318
Deferred tax liabilities, net	(13,120)
Total goodwill and intangible assets, net of tax	49,063
Acquisition purchase price	$ 71,124

Tangible assets and liabilities assumed, as referenced above, consist of the following:

Cash acquired	$	2,576
Accounts receivable, net		5,069
Inventories		11,512
Other current assets		810
Property, plant and equipment, net		3,574
Deferred income tax assets, net		10,469
Tangible assets	$	34,010
Accounts payable and accrued liabilities	$	6,001
Deferred revenue including customer advances		2,976
Other long term liabilities		2,972
Liabilities assumed	$	11,949

The allocation of the purchase price for DSI was based on estimates of the fair value of the net assets acquired and was subject to adjustment upon finalization of the valuation of the acquired intangible assets and the related deferred taxes. Measurements of these items inherently require significant estimates and assumptions. During the year ended December 31, 2018, the Company made adjustments to the preliminary allocation of the purchase price that was presented in the March 31, 2018 Form 10-Q. The adjustments consisted of an increase of $4.5 million to deferred tax liabilities; an increase of $3.1 million to goodwill; a decrease of $1.6 million to other long term liabilities; an increase of $1.5 million to property, plant and equipment, net; an increase of $0.6 million in accounts payable and accrued liabilities; and an increase of $0.6 million to the purchase price related to a net working capital adjustment. As of December 31, 2018, the Company has finalized the purchase price allocation for DSI.

The weighted-average amortization periods for definite-lived intangible assets acquired are 9.4 years for tradenames, 8.2 years for developed technology, 12.4 years for customer relationships and 7.4 years for in-process research and development assets. The weighted average amortization period for all definite-lived intangible assets acquired is 9.3 years.

Goodwill recorded as a result of the acquisition of DSI is not deductible for tax purposes.

The results of operations for DSI have been included in the Company's consolidated financial statements from the date of acquisition. The revenues of DSI included in the Company's consolidated statement of operations from the date of acquisition were approximately $42.6 million for the eleven-month period ended December 31, 2018. The net income of DSI included in the Company's consolidated statement of operations for the same period was approximately $1.8 million. Included in DSI's net income 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 five and a half months. Also included in net income of DSI is $4.0 million of intangible asset amortization expense and $0.6 million of additional depreciation related to a step up of fair value of property, plant and equipment, net.

The following consolidated pro forma information is based on the assumption that the acquisition of DSI occurred on January 1, 2017. 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	**2017**
	(in thousands)	
Pro Forma		
Revenues	$ 124,319	$ 121,104
Income (loss) from continuing operations	3,614	(8,454)

Direct acquisition costs recorded in other expense, net in the Company's consolidated statements of operations were $3.4 million and $0 for the year ended December 31, 2018 and 2017, respectively.

6. 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 includes a $3.0 million earn-out provision (the Denville Transaction). Upon the closing of the transaction, the Company received $15.7 million. The $3.0 million earn-out provision represents consideration that is contingent on Denville achieving certain performance metrics over a period of two years.

The following table is a reconciliation of the carrying amounts of major assets and liabilities of Denville classified as held for sale in the Company's consolidated balance sheet as of December 31, 2017.

	December 31, 2017
	(in thousands)
Carrying amounts of major classes of assets	
Cash	$ 541
Accounts receivable, net	2,854
Inventories	4,505
Other receivables and other assets	504
Current assets held for sale	8,404
Property, plant and equipment	397
Amortizable intangible assets	5,930
Allocation of goodwill	3,633
Long term assets held for sale	9,960
Total assets of the disposal group classified as held for sale in the consolidated balance sheet	$ 18,364
Carrying amounts of major classes of liabilities	
Accounts payable and accrued expenses	$ 1,736
Other current liabilities	121
Current liabilities held for sale	1,857
Deferred income tax liabilities	1,311
Long term liabilities held for sale	1,311
Total liabilities of the disposal group classified as held for sale in the consolidated balance sheet	$ 3,168

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 and 2017.

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Revenues	$ 893	$ 24,475
Cost of revenues	(534)	(16,048)
Operating and other expenses	(674)	(7,893)
Gain on disposal of discontinued operations	1,251	-
Income from discontinued operations before income taxes	$ 936	$ 534
Income tax benefit	(441)	(617)
Income from discontinued operations	1,377	1,151

Included within the adjustments to reconcile net loss to net cash provided by operating activities in the Company's consolidated statements of cash flows for the year ended December 31, 2018 and 2017, was amortization of intangible assets for Denville of $47 thousand and $0.9 million, respectively. Depreciation and capital expenditures for Denville were immaterial for both periods presented.

7. Goodwill and Other Intangible Assets

Intangible assets consist of the following:

	December 31, 2018		December 31, 2017		Weighted Average Life	(a)
	(in thousands)					
Amortizable intangible assets:	Gross	Accumulated Amortization	Gross	Accumulated Amortization		
Existing technology	$ 41,268	$ (16,215)	$ 16,173	$ (13,179)	7.1	Years
Trade names	7,828	(2,861)	4,443	(2,280)	7.7	Years
Distribution agreements/customer relationships	22,657	(9,509)	13,197	(8,373)	10.6	Years
In-process research and development	1,387	(30)	-	-	7.3	Years
Patents	211	(204)	223	(174)	0.2	Years
Total amortizable intangible assets	73,351	$ (28,819)	34,036	$ (24,006)		
Indefinite-lived intangible assets:						
Goodwill	57,304		36,336			
Other indefinite-lived intangible assets	1,232		1,244			
Total goodwill and other indefinite-lived intangible assets	58,536		37,580			
Total intangible assets, gross	$ 131,887		$ 71,616			

(a) Weighted average life as of December 31, 2018.

The balances presented in the tables above and below exclude intangible assets and allocated goodwill of Denville as of December 31, 2017. Both the intangible assets and the allocated goodwill balances are reported as long term assets held for sale as of December 31, 2017. Refer to Note 6 for further details.

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

	(in thousands)
Balance at December 31, 2016	$ 38,032
Effect of change in currency translation	1,937
Reclassification of goodwill as held for sale	(3,633)
Balance at December 31, 2017	$ 36,336
Goodwill arising from business combination	21,865
Effect of change in currency translation	(897)
Balance at December 31, 2018	$ 57,304

Amortization of intangible assets

Intangible asset amortization expense from continuing operations was $5.4 million and $1.6 million for the years ended December 31, 2018 and 2017, respectively. Amortization expense of existing amortizable intangible assets is currently estimated to be $5.7 million for the year ending December 31, 2019, $5.6 million for the year ending December 31, 2020, $5.6 million for the year ending December 31, 2021, $5.6 million for the year ending December 31, 2022, and $5.4 million for the year ending December 31, 2023.

8. Inventories

Inventories consist of the following:

	December 31, 2018	December 31, 2017
	(in thousands)	
Finished goods	$ 6,936	$ 5,779
Work in process	3,667	1,042
Raw materials	14,484	10,027
Total	$ 25,087	$ 16,848

9. Property, Plant and Equipment

As of December 31, 2018 and December 31, 2017, property, plant and equipment consist of the following:

	December 31, 2018	December 31, 2017
	(in thousands)	
Land, buildings and leasehold improvements	$ 2,468	$ 2,197
Machinery and equipment	9,678	7,022
Computer equipment and software	9,685	8,819
Furniture and fixtures	1,390	1,139
Automobiles	115	120
	23,336	19,297
Less: accumulated depreciation	(17,438)	(15,554)
Property, plant and equipment, net	$ 5,898	$ 3,743

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 the acquired companies. The principals of such former owners of MCS and TBSI were employees of the Company as of December 31, 2018 and 2017. Pursuant to a lease agreement, the Company made rent payments of approximately $0.3 million and $0.2 million to the former owners of MCS during the years ended December 31, 2018 and 2017, respectively. The Company made rent payments of approximately $44 thousand and $42 thousand to the former owner of TBSI during the years ended December 31, 2018 and 2017, respectively.

11. 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	(Payments)\ Credits	Additions	Ending Balance
		(in thousands)		
Year ended December 31, 2017	$ 193	(7)	60	$ 246
Year ended December 31, 2018	$ 246	(37)	182	$ 391

12. 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, 2018 and 2017, the Company contributed approximately $0.5 million and $0.6 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 defined benefit pension expense were as follows:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Components of net periodic benefit cost:		
Interest cost	502	524
Expected return on plan assets	(779)	(663)
Net amortization loss	222	362
Recognition of net gain/loss due to settlements	110	-
Net periodic benefit cost	$ 55	$ 223

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, 2018 and 2017 is as follows:

	December 31,	
	2018	2017
	(in thousands)	
Change in benefit obligation:		
Balance at beginning of year	$ 21,126	$ 19,214
Service cost	24	-
Interest cost	502	524
Actuarial (gain) loss	(1,056)	26
Settlements due to transfers paid	(267)	-
Benefits paid	(521)	(514)
Currency translation adjustment	(1,107)	1,876
Balance at end of year	$ 18,701	$ 21,126

	December 31,	
	2018	2017
	(in thousands)	
Change in fair value of plan assets:		
Balance at beginning of year	$ 19,972	$ 16,252
Actual return on plan assets	(1,058)	1,871
Employer contributions	741	689
Settlement due to transfers paid	(263)	-
Benefits paid	(521)	(514)
Currency translation adjustment	(1,052)	1,674
Balance at end of year	$ 17,819	$ 19,972

	December 31,	
	2018	2017
	(in thousands)	
Change in benefit obligation:		
Funded status	$ (882)	$ (1,154)
Unrecognized net loss	N/A	N/A
Net amount recognized	$ (882)	$ (1,154)

The accumulated benefit obligation for all defined benefit pension plans was $18.7 million and $21.1 million at December 31, 2018 and 2017, respectively.

The amounts recognized in the consolidated balance sheets consist of:

	December 31,	
	2018	2017
	(in thousands)	
Deferred income tax assets	$ 150	$ 196
Other long term liabilities	(882)	(1,154)
Net amount recognized	$ (732)	$ (958)

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

	December 31,	
	2018	2017
	(in thousands)	
Underfunded status of pension plans	$ (732)	$ (958)
Net amount recognized	$ (732)	$ (958)

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

	Year Ended December 31,	
	2018	2017
Discount rate	2.65%	2.43%
Expected return on assets	4.68%	3.86%

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. With the current base of assets in the pension plans, a one percent increase/decrease in the discount rate assumption would decrease/increase annual pension expense by approximately $9,000.

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, 2018, 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. With the current base of assets, a one percent increase/decrease in the asset return assumption would decrease/increase annual pension expense by approximately $178,000.

The fair value and asset allocations of the Company's pension benefits as of December 31, 2018 and 2017 measurement dates were as follows:

	December 31,			
	2018		2017	
	(in thousands)			
Asset category:				
Equity securities	$ 9,134	51%	$ 10,774	54%
Debt securities	3,274	18%	3,204	16%
Liability driven investment funds	4,341	24%	4,685	23%
Cash and cash equivalents	618	4%	856	4%
Other	452	3%	453	3%
Total	$ 17,819	100%	$ 19,972	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, 2018 and 2017 is as follows:

	December 31,	
	2018	2017
	(in thousands)	
Quoted Prices in Active Markets for Identical Assets (Level 1)	$ 618	$ 856
Significant Other Observable Inputs (Level 2)	17,201	19,116
Significant Other Unobservable Inputs (Level 3)	-	-
Total	$ 17,819	$ 19,972

Level 1 assets consist of cash and cash equivalents held in the pension plans at December 31, 2018. 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 $0.7 million to its pension plans during 2019. These contributions are expected to increase in 2019 and beyond by an immaterial amount in order to accelerate the deficit recovery period.

The benefits expected to be paid from the pension plans are $0.6 million in 2019, $0.5 million in 2020, $0.5 million in 2021, $0.6 million in 2022 and $0.7 million in 2023. The expected benefits to be paid in the five years from 2024—2028 are $4.0 million. The expected benefits are based on the same assumptions used to measure the Company's benefit obligation at December 31, 2018.

13. Leases

The Company has noncancelable operating leases for office and warehouse space expiring at various dates through 2023 and thereafter. Rent payments for continuing operations were approximately $3.2 million and $1.8 million for the year ended December 31, 2018 and 2017, respectively.

Future minimum lease payments for operating leases, with initial or remaining terms in excess of one year at December 31, 2018, are as follows:

	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

14. Capital Stock

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, 2018, 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 18, 2017, the stockholders of the Company approved an increase of 300,000 shares of common stock in the number of shares available for issuance under the ESPP. Following such amendment, 1,050,000 shares of common stock are authorized for issuance, of which 890,762 shares were issued as of December 31, 2018. There were 89,308 and 76,215 shares issued under the ESPP during the years ended December 31, 2018 and 2017, respectively.

Stock Option and Equity Incentive Plans

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

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.

On May 24, 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). As of December 31, 2018, the target number of these restricted stock units that may be earned is 116,944 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 adopted ASU 2016-09 as of January 1, 2017. As a result of this adoption, 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. The Company recognized as of January 1, 2017, a cumulative effect adjustment of $0.1 million to reduce retained earnings as required under the modified retrospective approach.

Stock option and restricted stock unit activity under the Company's Third A&R Plan for the years ended December 31, 2017 and 2018 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, 2016	4,096,818	3.94	1,072,653	3.15	182,150	4.81
Granted	237,700	3.24	1,298,371	2.49	-	-
Exercised	(143,391)	2.48	-	-	-	-
Vested (RSUs)	-	-	(488,570)	3.08	-	-
Cancelled / forfeited	(410,883)	3.93	(85,527)	3.05	(18,023)	4.81
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

The Company did not capitalize any stock-based compensation.

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,	
	2018	2017
Basic	36,453,126	34,753,325
Effect of assumed conversion of employee and director stock options, restricted stock units and Market Condition RSUs	-	-
Diluted	36,453,126	34,753,325

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 3,307,438 and 5,741,298 shares of common stock for the years ended December 31, 2018 and 2017, 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, 2018 (Aggregate Intrinsic Value, in thousands):

	Options Outstanding				Options Exercisable			
Range of Exercise Price	Shares Outstanding at Dec. 31, 2018	Weighted Average Remaining Contractual Life in Years	Weighted Average Exercise Price	Aggregate Intrinsic Value	Shares Exercisable at Dec. 31, 2018	Weighted Average Remaining Contractual Life in Years	Weighted Average Exercise Price	Aggregate Intrinsic Value
$2.28 - 3.29	204,476	4.74	$ 2.71	$ 96	160,851	3.89	$ 2.66	$ 84
3.30 - 3.49	175,200	8.83	3.33	-	58,400	8.83	3.33	-
3.50 - 3.92	159,037	5.95	3.68	-	114,452	4.41	3.64	-
3.93 - 4.08	79,019	2.42	4.04	-	79,019	2.42	4.04	-
4.09 - 4.17	402,325	5.41	4.12	-	402,325	5.41	4.12	-
4.18 - 4.26	49,000	5.75	4.21	-	49,000	5.75	4.21	-
4.27 - 4.38	350,000	4.88	4.31	-	350,000	4.88	4.31	-
4.39 - 5.39	146,550	6.65	4.95	-	121,550	6.09	5.05	-
5.40 - 5.54	203,625	6.18	5.51	-	144,375	6.18	5.51	-
5.55 - 5.75	187,500	6.77	5.58	-	125,625	6.43	5.56	-
$2.28 - 5.75	**1,956,732**	**5.79**	**$ 4.25**	$ 96	**1,605,597**	**5.26**	**$ 4.26**	**$ 84**

The aggregate intrinsic value in the preceding table represents the total pre-tax intrinsic value, based on the Company's closing stock price of $3.18 as of December 31, 2018, 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 years ended December 31, 2018 and 2017 was approximately $2.6 million and $0.1 million, respectively. The total number of in-the-money options that were exercisable as of December 31, 2018 was 160,851.

For the year ended December 31, 2018, the total compensation costs related to unvested awards not yet recognized is $3.2 million and the weighted average period over which it is expected to be recognized is 2.12 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, 2018 and 2017 was allocated as follows:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Cost of revenues	$ 64	$ 61
Sales and marketing	431	488
General and administrative	2,232	2,695
Research and development	167	139
Discontinued operations	150	117
Total stock-based compensation	$ 3,044	$ 3,500

The Company did not capitalize any stock-based compensation.

The weighted-average estimated fair value per share of stock options granted during 2018 and 2017 was $1.83 and $1.32, respectively, using the Black Scholes option-pricing model with the following weighted-average assumptions:

	Year Ended December 31,	
	2018	2017
Volatility	43.28 %	41.63 %
Risk-free interest rate	2.84 %	2.03 %
Expected holding period (in years)	4.83 years	5.41 years
Dividend yield	- %	- %

The weighted average fair value of the 2018 Market Condition RSUs which were granted under the Third A&R Plan during the year ended December 31, 2018 was $4.19. There were no Market Condition RSUs granted during the year ended December 31, 2017. 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:

	Year Ended December 31,
	2018
Volatility	44.02%
Risk-free interest rate	2.27%
Correlation coefficient	0.07%
Dividend yield	-%

The Company used historical volatility to calculate the expected volatility as of December 31, 2018. 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.

Stock-based compensation expense recognized in the consolidated statements of operations for the years ended December 31, 2018 and 2017 is recognized on awards as they vest and following the adoption of ASU 2016-09 in January 2017, is not reduced for annualized estimated forfeitures.

15. 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.

The Financing Agreement provides 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 have a maturity of five years.

Commencing on March 31, 2018, the outstanding term loans amortized in equal quarterly installments equal to $0.4 million per quarter on such date and during each of the next three quarters thereafter. Beginning the quarter ending March 31, 2019, the term loans amortize in installments of $0.6 million per quarter, continuing for the next three quarters thereafter and $0.8 million per quarter thereafter, with a balloon payment at maturity.

The obligations 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 Company and its 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 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 also contains customary events of default. As of December 31, 2018, the Company was in compliance with all financial covenants contained in the Financing Agreement, was subject to covenant and working capital borrowing restrictions and had available borrowing capacity under its Financing Agreement of $9.8 million.

As of December 31, 2018 and December 31, 2017, the Company had borrowings net of debt issuance costs of $60.8 million and $11.7 million respectively, outstanding. 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, 2018, the weighted effective interest rate, net of the impact of the Company's interest rate swap, on its term loan was 8.88%.

As of December 31, 2018 and December 31, 2017, the Company's borrowings were comprised of:

	December 31, 2018	December 31, 2017
	(in thousands)	
Long-term debt:		
Term loan	$ 62,400	$ 11,899
Total unamortized deferred financing costs	(1,605)	(151)
Total debt	60,795	11,748
Less: current installments	(2,400)	(2,800)
Current unamortized deferred financing costs	401	35
Long-term debt	$ 58,796	$ 8,983

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

	(in thousands)
2019	$ 2,400
2020	3,200
2021	3,200
2022	3,200
2023	50,400
Total	$ 62,400

16. 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 or 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 15, 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 notional amount of the Company's derivative instruments as of December 31, 2018 was $34.1 million.

The following table presents the notional amount and fair value of the Company's derivative instruments as of December 31, 2018 and December 31, 2017.

		December 31, 2018	
		Notional Amount	Fair Value (a)
Derivatives designated as hedging instruments under ASC 815	**Balance sheet classification**	(in thousands)	
Interest rate swaps	Other assets (long term liabilities)	$ 34,090	$ (170)

		December 31, 2017	
		Notional Amount	Fair Value (a)
Derivatives designated as hedging instruments under ASC 815	**Balance sheet classification**	(in thousands)	
Interest rate swaps	Other assets (long term liabilities)	$ 11,900	$ 37

(a) See Note 17 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, 2018 and 2017:

Derivatives in Hedging Relationships	**Amount of loss recognized in OCI on derivative (effective portion) Year Ended December 31,**	
	2018	**2017**
Interest rate swaps	$ (343)	$ (24)

The following table summarizes the reclassifications out of accumulated other comprehensive loss for the year ended December 31, 2018 and 2017:

Details about AOCI Components	**Amount reclassified from AOCI into income (effective portion) Year Ended December 31,**		**Location of amount reclassified from AOCI into income (effective portion)**
	2018	**2017**	
Interest rate swaps	$ 136	$ 61	Interest expense, net

As of December 31, 2018, $61 thousand 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. As a result of terminating the Credit Agreement, as discussed in Note 15, the Company unwound its previous May 2017 interest rate swap contract and received $0.1 million in proceeds.

17. 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, 2018			
(In thousands)	Level 1	Level 2	Level 3	Total
Assets (Liabilities):				
Interest rate swap agreements	$ -	$ (170)	$ -	$ (170)

	Fair Value as of December 31, 2017			
(In thousands)	Level 1	Level 2	Level 3	Total
Assets (Liabilities):				
Interest rate swap agreements	$ -	$ 37	$ -	$ 37

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.

18. Accrued Expenses

Accrued expenses consist of:

	December 31,	
	2018	2017
	(in thousands)	
Compensation and payroll	$ 2,896	$ 1,540
Professional fees	536	579
Warranty costs	391	246
Local taxes, including VAT	423	376
Customer credits	372	310
Interest	480	33
Rent	255	388
Other	409	344
Total	$ 5,762	$ 3,816

19. Revenues

The following table represents a disaggregation of revenue from contracts with customers. Revenue from continuing operations originating from the following geographic areas for the years ended December 31, 2018 and 2017 consist of:

	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

	Year Ended December 31, 2017				
	(in thousands)				
	United States	United Kingdom	Germany	Rest of the world	Total
Instruments, equipment, software and accessories	$ 40,240	$ 14,224	$ 10,766	$ 9,392	$ 74,622
Service, maintenance and warranty contracts	1,481	819	396	89	2,785
Total revenues	$ 41,721	$ 15,043	$ 11,162	$ 9,481	$ 77,407

Deferred revenue

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

	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

Acquisition of DSI

As discussed in Note 5, the Company acquired DSI, a previously privately held company on January 31, 2018. The Company has adopted ASC 606 with respect to DSI as of January 31, 2018. The tables, revenue recognition policies applied, and product descriptions noted above are thus inclusive of, and reflect revenues of DSI for the periods from the acquisition date.

20. Income Tax

Income tax from continuing operations was a benefit of approximately $3.7 million and $0.6 million for the years ended December 31, 2018 and 2017, respectively. The effective tax rate on continuing operations was 46.1% for the year ended December 31, 2018 compared with 23.1% for the same period in 2017. The difference between the Company's effective tax rate year over year was primarily attributable to lower pre-tax income at certain individual subsidiaries in 2018 versus the impact of certain provisions of U.S tax reform in 2017.

On December 22, 2017, tax reform legislation known as the Tax Cuts and Jobs Act (the Tax Act) was signed into law. A majority of the provisions of the Tax Act are effective January 1, 2018. The Tax Act makes broad and complex changes to the U.S. Internal Revenue Code which include, but are not limited to: (1) the reduction of the corporate income tax rate from 35% to 21%; (2) the implementation of a modified territorial tax system with a one-time transition tax on previously unremitted earnings of foreign subsidiaries; (3) a new provision designed to tax global intangible low-taxed income (GILTI); (4) the deduction for foreign-derived intangible income (FDII); (5) a new limitation on deductible interest expense; and (6) limitations on the deductibility of certain executive compensation. In response to the Tax Act, the SEC issued Staff Accounting Bulletin No. 118 (SAB 118), which provided companies with a one-year measurement period to complete the accounting for the tax effects of the Tax Act. The end of the measurement period for purposes of SAB 118 was December 22, 2018. The Company has completed the analysis in accordance with guidance available as of the date of this filing and has recorded the impact as explained below.

At December 31, 2017, the impact of the remeasurement of deferred tax assets and liabilities from 35% to 21% was an expense of $3.2 million which was fully offset by a change in the valuation allowance. The 2017 U.S. tax impact of the one-time transition tax on the mandatory deemed repatriation of foreign earnings was an expense of $3.0 million. This impact was fully offset with net operating loss carryforwards for which a full valuation allowance had been recorded. As a result, no tax expense was recorded. In finalizing its analysis in 2018 the Company recorded an immaterial amount of adjustments to the original provisional amounts. With respect to GILTI, the Company has adopted a policy to account for this provision as a period cost.

For the year ended December 31, 2018, an income tax benefit of $0.4 million was recorded for discontinued operations. For the year ended December 31, 2017,income tax benefit for discontinued operations was $0.6 million.

Income tax expense attributable to income from continued operations for years ended December 31, 2018 and 2017 consisted of:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Current income tax (benefit) expense:		
Federal and state	$ (191)	$ 253
Foreign	279	297
	88	550
Deferred income tax (benefit) expense):		
Federal and state	(3,552)	(1,730)
Foreign	(212)	575
	(3,764)	(1,155)
Total income tax benefit from continuing operations	$ (3,676)	$ (605)

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

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Continuing operations	$ (3,676)	$ (605)
Discontinued operations	(441)	(617)
Total income tax benefit	$ (4,117)	$ (1,222)

Income tax benefit for the years ended December 31, 2018 and 2017 differed from the amount computed by applying the U.S. federal income tax rate of 21% and 34%, respectively, to pre-tax continuing operations income as a result of the following:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Computed "expected" income tax benefit	$ (1,674)	$ (892)
Increase (decrease) in income taxes resulting from:		
Permanent differences, net	(117)	(118)
Foreign tax rate differential	(11)	23
State income taxes, net of federal income tax benefit	(121)	(103)
Non-deductible stock compensation expense	(329)	174
Acquisition costs	438	-
Impact of U.S. rate change	-	3,159
Tax credits	(242)	(14)
Change in reserve for uncertain tax position	203	(58)
Impact of change to prior year tax accruals	100	72
Impact of adoption of ASU 2016-09	-	(486)
U.S tax on foreign dividends	-	3,149
Foreign withholding taxes	-	38
Conversion of U.S foreign tax credits from credit to deduction	-	648
Change in valuation allowance allocated to income tax benefit	(1,850)	(6,152)
Other	(73)	(45)
Total income tax benefit	$ (3,676)	$ (605)

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.

Income tax (benefit) expense is based on the following pre-tax income from continuing operations for the years ended December 31, 2018 and 2017:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Domestic	$ (9,034)	$ (3,662)
Foreign	1,059	1,041
Total	$ (7,975)	$ (2,621)

The tax effects of temporary differences that give rise to significant components of the deferred tax assets and deferred tax liabilities at December 31, 2018 and 2017 are as follows:

	December 31,	
	2018	2017
	(in thousands)	
Deferred income tax assets:		
Accounts receivable	$ 57	$ 93
Inventory	1,147	891
Operating loss and credit carryforwards	20,095	8,287
Accrued expenses	1,692	-
Pension liabilities	110	151
Contingent consideration	-	2,273
Stock compensation	999	1,667
Other assets	172	122
Total gross deferred assets	24,272	13,484
Less: valuation allowance	(13,899)	(11,447)
Deferred tax assets	$ 10,373	$ 2,037
Deferred income tax liabilities:		
Indefinite-lived intangible assets	$ 1,975	$ 3,166
Definite-lived intangible assets	10,221	2,383
Property, plant and equipment	204	-
Other accrued liabilities	63	270
Total deferred tax liabilities	12,463	5,819
Deferred income tax liability, net	$ (2,090)	$ (3,782)

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

	December 31,	
	2018	2017
	(in thousands)	
Deferred income tax assets	$ 211	$ 182
Deferred income tax liabilities	(2,301)	(2,653)
Long term liabilities held for sale	-	(1,311)
Deferred income tax liability, net	$ (2,090)	$ (3,782)

As of December 31, 2018 and 2017, the Company maintained a total valuation allowance of $13.9 million and $11.4 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 movement in the valuation allowance 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.

The Company adopted the provisions of ASU 2016-09, *Improvements to Employee Share-based Payment Accounting,* on January 1, 2017. Upon adoption, the company recorded previously unrecognized excess tax benefits from the exercise of employee stock options as an increase in its deferred tax asset for net operating losses of approximately $0.5 million. The tax benefit of this increased deferred tax asset is fully offset by an increase in the valuation allowance. Following adoption, excess tax benefits or tax deficit is reflected as income tax benefit or expense in the year the tax impact is generated. Prior to the adoption of ASU 2016-09, these excess tax benefits could only be recognized when the related tax deduction reduces income taxes payable and the benefit would be reflected as a credit to additional paid-in capital if realized.

At December 31, 2018, the Company had federal net operating loss carryforwards of $27.2 million, a portion of which ($21.9 million) expires between 2019 and 2037; the remainder have an unlimited carryforward period. The Company's state net operating loss carryforwards of $17.5 million expire between 2019 and 2037. The Company has foreign tax credits of $0.2 million which begin to expire in 2020, as well as $8.6 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 Tax Act beginning in 2018. In addition, the Company had a total of $3.8 million of state investment tax credit carryforwards, research and development tax credit carryforwards, and EZ credit carryforwards, which begin to expire in 2019. 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 acquisitions in prior years, certain losses and carryforwards would be subject to such limitation. 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 to expire before use.

As of December 31, 2018 and December 31, 2017, cash and cash equivalents held by the Company's foreign subsidiaries was $3.2 million and $4.8 million, respectively. As of December 31, 2017, the Company changed its indefinite reinvestment assertion to provide that all foreign cash balances above the level required for local operating expenses would be repatriated to the U.S. in tax years after 2017. The Company maintains this modified assertion at December 31, 2018. 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 state income tax liability. As a result of the Company's assertion, the Company determined the potential state income tax liability related to available cash balances at foreign subsidiaries to be immaterial in 2018 and 2017. In addition, an accrued withholding tax liability of $38 thousand was recorded as of both December 31, 2018 and December 31, 2017, related to amounts determined to be available for repatriation.

At December 31, 2018 and 2017 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, 2016	$ 406
Decreases based on tax positions of prior years	(53)
Settlements	(30)
Balance at December 31, 2017	323
Release due to expiration of statute of limitations	(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

In 2017, a German income tax audit was settled for $30 thousand. 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.

The Company anticipates that the total unrecognized tax benefits will be reduced within the next 12 months by approximately $0.5 million 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, 2018 and at December 31, 2017, the Company had accrued interest and penalties of $0.1 million and $15 thousand respectively. During 2018 and 2017, the Company recognized a net expense of $31 thousand and $5 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 2014. 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 taxing jurisdictions. At December 31, 2018, the Company received notice of income tax examinations to begin in 2019 at foreign subsidiaries for which reserves have been recorded.

21. Commitments and Contingent Liabilities

From time to time, the Company may be involved in various claims and legal proceedings arising in the ordinary course of business. The Company is not currently a party to any such material claims or proceedings.

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 19 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,	
	2018	2017
	(in thousands)	
United States	$ 42,222	$ 3,800
Germany	5,022	5,793
United Kingdom	585	966
Rest of the world	2,601	3,214
Long-lived assets held for sale	-	6,327
Total long-lived assets (1)	$ 50,430	$ 20,100

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

Net assets by geographic area consist of the following:

	December 31,	
	2018	2017
	(in thousands)	
United States	$ 38,921	$ 15,502
Germany	17,261	18,354
United Kingdom	10,473	14,376
Rest of the world	16,069	17,472
Net assets held for sale	-	15,196
Total net assets	$ 82,724	$ 80,900

23. 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:

		Charged (credited) to			
	Beginning Balance	Bad Debt Expense (Recoveries)	Charged to Allowance (1)	Other (2)	Ending Balance
			(in thousands)		
Year ended December 31, 2017	$ 301	(57)	(68)	17	$ 193
Year ended December 31, 2018	$ 193	28	13	98	$ 332

(1) Consists of accounts written off, net of recoveries.

(2) For 2018 this amount consists of an addition to the allowance of $103,000 due to business combination as well as the effect of currency translation. For 2017, this amount consists solely of the effect of currency translation.

24. Quarterly Financial Information (unaudited)

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 newly acquired DSI.

Statement of Operations Data:

2017	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Fiscal Year
	(in thousands, except per share data)				
Revenues	$ 18,086	$ 18,958	$ 18,717	$ 21,646	$ 77,407
Cost of revenues	8,509	9,885	9,217	10,626	38,237
Gross profit	9,577	9,073	9,500	11,020	39,170
Total operating expenses	9,927	9,342	9,890	10,646	39,805
Operating (loss) income	(350)	(269)	(390)	374	(635)
Other expense, net	(400)	(463)	(274)	(849)	(1,986)
Loss from continuing operations before income taxes	(750)	(732)	(664)	(475)	(2,621)
Income tax benefit	(7)	(115)	(19)	(464)	(605)
Loss from continuing operations	(743)	(617)	(645)	(11)	(2,016)
(Loss) income from discontinued operations, net of tax	(323)	236	228	1,010	1,151
Net (loss) income	$ (1,066)	$ (381)	$ (417)	$ 999	$ (865)
Loss (earnings) per share:					
Basic (loss) earnings per common share from continuing operations	$ (0.02)	$ (0.02)	$ (0.02)	$ -	$ (0.06)
Basic (loss) earnings per share from discontinued operations	(0.01)	0.01	0.01	0.03	0.03
Basic (loss) earnings per common share	$ (0.03)	$ (0.01)	$ (0.01)	$ 0.03	$ (0.02)
Diluted (loss) earnings per common share from continuing operations	$ (0.02)	$ (0.02)	$ (0.02)	$ -	$ (0.06)
Diluted (loss) earnings per common share from discontinued operations	(0.01)	0.01	0.01	0.03	0.03
Diluted (loss) earnings per common share	$ (0.03)	$ (0.01)	$ (0.01)	$ 0.03	$ (0.02)

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 18, 2019

By: /s/ JEFFREY A. DUCHEMIN
Jeffrey A. Duchemin
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/ JEFFREY A. DUCHEMIN **Jeffrey A. Duchemin**	Chief Executive Officer and Director (Principal Executive Officer)	March 18, 2019
/s/ KAM UNNINAYAR **Kam Unninayar**	Chief Financial Officer (Principal Financial Officer and Principal Accounting Officer)	March 18, 2019
/s/ JAMES GREEN **James Green**	Director	March 18, 2019
/s/ JOHN F. KENNEDY **John F. Kennedy**	Director	March 18, 2019
/s/ BERTRAND LOY **Bertrand Loy**	Director	March 18, 2019
/s/ KATHERINE A. EADE **Katherine A. Eade**	Director	March 18, 2019
/s/ THOMAS W. LOEWALD **Thomas W. Loewald**	Director	March 18, 2019

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§	Share Purchase Agreement between Biochrom Limited, as Buyer, and Multi-Channel Systems Holding GmbH, as Seller, dated as of October 1, 2014	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed October 1, 2014) and incorporated by reference thereto
2.3§	Stock Purchase Agreement by and among Harvard Bioscience, Inc., as Buyer, Triangle BioSystems, Inc., and the sellers party thereto dated as of October 1, 2014	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed October 1, 2014) and incorporated by reference thereto
2.4§	Agreement for the Sale and Purchase of All Shares in HEKA GmbH by and among Multi Channel Systems MCS GmbH, as Purchaser, Dr. Peter Schulze GmbH & Co. KG, as Seller, and Dr. Peter Schulze, as Guarantor, dated as of January 8, 2015	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 9, 2015) and incorporated by reference thereto
2.5§	Agreement for the Sale and Purchase of All Shares in HEKA Canada between Ealing Scientific Limited, as Purchaser, and Dr. Peter Schulze, as Seller, dated as of January 8, 2015	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 9, 2015) and incorporated by reference thereto
2.6§	Merger Agreement, dated as of January 22, 2018, between Harvard Bioscience, Inc., Plymouth Sub, Inc. and Data Sciences International, Inc.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 26, 2018) and incorporated by reference thereto
2.7§	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	Amended and Restated Securityholders' Agreement dated as of March 2, 1999 by and among Harvard Apparatus, Inc., Pioneer Partnership II, Pioneer Capital Corp., First New England Capital, L.P. and Citizens Capital, Inc. and Chane Graziano and David Green	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
4.3	Shareholders Rights Agreement, dated as of February 5, 2008 between Harvard Bioscience, Inc., and Registrar and Transfer Company, as Rights Agent	Previously filed as an exhibit to the Company's Registration Statement on Form 8-A (filed February 8, 2008) and incorporated by reference thereto
10.1 #	Harvard Apparatus, Inc. 1996 Stock Option and Grant Plan	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
10.2 #	Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan	Previously disclosed in the Company's Proxy Statement on Schedule 14A (filed April 15, 2011) and incorporated by reference thereto
10.3	Harvard Bioscience, Inc. Employee Stock Purchase Plan	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
10.4	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
10.5	Lease of Unit 22 Phase I Cambridge Science Park, Milton Road, Cambridge dated May 8, 2008 between The Master Fellows and Scholars of Trinity College Cambridge and Biochrom Limited.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 11, 2009) and incorporated by reference thereto
10.6	Lease, dated February 23, 2004, by and between William Cash Forman and Hoefer, Inc.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 15, 2004) and incorporated by reference thereto
10.7 +	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

10.8	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
10.9 #	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
10.10 #	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
10.11 #	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
10.12	Amended and Restated Revolving Credit Loan Agreement, dated as of August 7, 2009, by and among Harvard Bioscience, Inc. and the Lenders from time to time party thereto, including Bank of America, N.A. (both in its capacity as "Lender" and in its capacity as "Agent"), and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed August 13, 2009) and incorporated by reference thereto
10.13	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
10.14 #	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
10.15 #	Director Compensation Arrangements	Filed with this report
10.16	Amendment No. 1 to the Harvard Bioscience, Inc. Employee Stock Purchase Plan, effective as of January 1, 2012	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 14, 2014) and incorporated by reference thereto
10.17 #	First Amendment to Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan, effective as of March 9, 2013	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 14, 2014) and incorporated by reference thereto
10.18	Second Amended and Restated Revolving Credit Agreement, dated as of March 29, 2013, by and among Harvard Bioscience, Inc. and the Lenders from time to time party thereto, including Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed April 3, 2013) and incorporated by reference thereto
10.19	Amendment No. 2 to the Harvard Bioscience, Inc. Employee Stock Purchase Plan, effective as of May 23, 2013	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 14, 2014) and incorporated by reference thereto
10.20	First Amendment to Second Amended and Restated Credit Agreement dated as of May 30, 2013, with an effective date as of April 30, 2013, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 14, 2014) and incorporated by reference thereto

10.21 #	Employment Agreement, dated August 26, 2013, between Harvard Bioscience, Inc. and Jeffrey A. Duchemin	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed August 29, 2013) and incorporated by reference thereto
10.22 #	Offer letter dated September 30, 2013 between Harvard Bioscience, Inc. and Yong Sun	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed February 19, 2014) and incorporated by reference thereto
10.23 #	Employment Agreement, dated October 2, 2013, between Harvard Bioscience, Inc. and Robert E. Gagnon	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed October 16, 2013) and incorporated by reference thereto
10.24	Second Amendment to Second Amended and Restated Credit Agreement and Waiver dated as of October 31, 2013, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 14, 2014) and incorporated by reference thereto
10.25	Intellectual Property Matters 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
10.26	Product 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
10.27	Tax Sharing 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
10.28	Transition Services 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
10.29 #	Amendment to Employment Agreement between Harvard Bioscience, Inc. and Jeffrey A. Duchemin, effective July 30, 2014.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 31, 2014) and incorporated by reference thereto
10.30 #	Amendment to Employment Agreement between Harvard Bioscience, Inc. and Robert E. Gagnon, effective July 30, 2014.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 31, 2014) and incorporated by reference thereto
10.31	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
10.32 #	Second Amendment to Employment Agreement, dated as of March 1, 2015, between Harvard Bioscience, Inc. and Jeffrey A. Duchemin	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed May 7, 2015) and incorporated by reference thereto

10.33	Third Amendment to Second Amended and Restated Credit Agreement and Waiver dated as of April 24, 2015, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed August 6, 2015) and incorporated by reference thereto
10.34	Fourth Amendment to Second Amended and Restated Credit Agreement and Waiver dated as of June, 30, 2015, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed August 6, 2015) and incorporated by reference thereto
10.35 #	Form of Deferred Stock Award Agreement under the Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option And Incentive Plan, as amended	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed November 5, 2015) and incorporated by reference thereto
10.36	Fifth Amendment to Second Amended and Restated Credit Agreement and Waiver dated as of November 5, 2015, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed April 29, 2016) and incorporated by reference thereto
10.37	Sixth Amendment to Second Amended and Restated Credit Agreement dated as of March 9, 2016, by and among Harvard Bioscience, Inc. Bank of America, N.A. and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed May 16, 2016) and incorporated by reference thereto
10.38	Limited Consent and Waiver dated as of May 5, 2016 by and among Harvard Bioscience, Inc., Bank of America, N.A and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed August 4, 2016) and incorporated by reference thereto
10.39 #	Third Amendment to Employment Agreement, dated as of May 26, 2016, between Harvard Bioscience, Inc. and Jeffrey A. Duchemin	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed May 27, 2016) and incorporated by reference thereto
10.40 #	Second Amendment to Employment Agreement, dated as of May 26, 2016, between Harvard Bioscience, Inc. and Robert E. Gagnon	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed May 27, 2016) and incorporated by reference thereto
10.41 #	Employment Agreement, dated as of May 26, 2016, between Harvard Bioscience, Inc. and Yong Sun	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed May 27, 2016) and incorporated by reference thereto
10.42	Limited Consent and Waiver dated as of November 1, 2016, and effective as of October 26, 2016 by and among Harvard Bioscience, Inc., Bank of America, N.A and Brown Brothers Harriman & Co.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 17, 2017) and incorporated by reference thereto
10.43	Lease Agreement, dated as of August 15, 2008, between AX US L.P. (as assigned to it by New Brighton 14th 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
10.44	First Amendment to Lease Agreement, dated as of February 26, 2008, between AX US L.P. (as assigned to it by New Brighton 14th 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

10.45	Second Amendment to Lease Agreement, dated as of August 4, 2008, between AX US L.P. (as assigned to it by New Brighton 14th 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
10.46	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
10.47 #	Employment Agreement, dated October 18, 2018, between Harvard Bioscience, Inc. and Kam Unninayar.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed October 22, 2018) and incorporated by reference thereto
10.48	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
10.49	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
10.50 #	Second Amendment to Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option Plan, effective as of May 28, 2015.	Filed with this report
10.51 #	Amendment No. 3 to Harvard Bioscience, Inc. Employee Stock Purchase Plan, effective as of May 18, 2017.	Filed with this report
10.52 #	Third Amendment to Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan, effective as of May 17, 2018.	Filed with this report
16.1	Letter from KPMG to the Securities and Exchange Commission, dated as of May 9, 2017	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed May 11, 2017) 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 10.15

Director Compensation Arrangements

Compensation of Non-Employee Directors Upon Initial Election to the Board

Each non-employee director will be entitled to receive a non-qualified stock option having an aggregate Black-Scholes cash value of $134,400, rounded to the nearest 100 shares, provided that in no case shall such stock option be less than 25,000 shares (so long as 25,000 shares are required to be granted under the equity incentive plan of the Corporation). Such option shall be for the purchase of common stock of the Corporation and shall vest annually over three years and be granted on the fifth business day following his or her initial election to the Board.

Annual Compensation of Non-Employee Directors

Annual Retainers

Each non-employee director will be entitled to receive annual retainer amounts for each respective role on the Board. In lieu of cash, such aggregate annual retainer amounts shall each be satisfied by the issuance of deferred stock awards of restricted stock units as described herein.

The respective annual retainer value for each particular role on the Board are as follows:

Role	Annual Retainer Value
Non-employee director	$ 35,280
Chairman of the Board	$ 35,280
Audit Committee chair	$ 18,144
Audit Committee member	$ 9,072
Compensation Committee chair	$ 12,096
Compensation Committee member	$ 6,048
Governance Committee chair	$ 5,040
Governance Committee member	$ 5,040

The annual retainer awards (each a "Retainer Award") are generally granted on the first trading day of January (the "Grant Date") and vest quarterly over the calendar year on each March 31, June 30, September 30 and December 31. The number of shares of common stock subject to a Retainer Award is equal to the amount of cash that would have been received had the retainers all been paid in cash, divided by the average daily closing market price of the common stock for the month of November immediately preceding the Grant Date, rounded to the nearest 100 shares.

In the event that a non-employee director is named Chairman or joins any committees of the Board of Directors during a fiscal year after the Grant Date, such director shall be granted a Retainer Award (the "Additional Retainer Award"), in relation to such additional roles and respective retainer amounts pro-rated for the remainder of such year. Such Additional Retainer Award shall be granted on the first trading day of the month after the individual is appointed to such roles. The Additional Retainer Award shall vest in equal amounts spread over the remaining quarterly vesting dates of the Retainer Awards for such calendar year subject to continued service as a non-employee director on the applicable vesting dates. The number of shares of common stock subject to an Additional Retainer Award is equal to the amount of cash that would have been received had the retainers all been paid in cash, divided by the average daily closing market price of the common stock for the calendar month that is two months prior to the month the director was appointed to the additional roles, rounded to the nearest 100 shares (i.e., the month of June if the director was appointed to the additional roles on August 15).

In the event a director's service (including as a Board member, or their role as Chairman, Committee Chairman, Committee member) ends during a particular quarter, the vesting date for such quarter in relation to the portion of the award attributable to such roles that are ending, shall be the last day of the director's term in the respective role such that the full quarterly amount attributable to such roles shall vest on that earlier vesting date.

Annual Equity Award

Each non-employee director will also be entitled to receive an equity award having an aggregate cash value of $80,640, rounded to the nearest 100 shares, vesting fully on the earlier to occur of (i) the date of the Corporation's next Annual Meeting of Stockholders after the grant date, immediately prior to the commencement of such meeting, and (ii) one year from the date of grant and granted on the fifth business day following the Corporation's Annual Meeting of Stockholders, with such award to be evidenced by a grant of deferred stock awards of restricted stock units.

Expenses

In addition, non-employee directors shall be reimbursed for their expenses incurred in connection with attending Board and Committee meetings.

EXHIBIT 10.50

SECOND AMENDMENT TO
HARVARD BIOSCIENCE, INC.
THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN

This Second Amendment to the Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan (the "Plan") is effective as of May 28, 2015 (the "Effective Date").

Pursuant to the authorization and approval of the Board of Directors and stockholders of Harvard Bioscience, Inc. in accordance with Section 17 of the Plan, the Plan is hereby amended as follows, effective as of the Effective Date:

1. Section 3(a): The first sentence in Section 3(a) is hereby deleted in its entirety and replaced with the following in its stead:

   "a) *Stock Issuable.* Subject to adjustment as provided in Section 3(b), the maximum number of shares of Stock reserved and available for issuance under the Plan shall be 17,508,929 shares of Stock which number reflects the total of 3,750,000 shares originally reserved, plus the effect of an evergreen provision through December 31, 2005, plus an additional 2,000,000 shares added to the Plan in 2006, plus an additional 2,500,000 shares added to the Plan in 2008 plus an additional 3,700,000 shares added to the Plan in 2011 plus an additional 1,941,254 shares to account for the adjustment required by Section 3(b) pertaining to the Awards issued in connection with the spin-off of Harvard Apparatus Regenerative Technology, Inc. by Harvard Bioscience, Inc. plus an additional 2,500,000 shares added to the Plan in 2015."

2. The following is added to the end of the Plan:

   "DATE SECOND AMENDMENT TO HARVARD BIOSCIENCE, INC. THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN APPROVED BY BOARD OF DIRECTORS: APRIL 3, 2015.

   DATE SECOND AMENDMENT TO HARVARD BIOSCIENCE, INC. THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN APPROVED BY STOCKHOLDERS: MAY 28, 2015."

3. Except as expressly amended hereby, the Plan shall remain in full force and effect.

IN WITNESS WHEREOF, Harvard Bioscience, Inc. has duly executed this amendment to be effective as the date first above written.

HARVARD BIOSCIENCE, INC.

By: /S/ Jeffrey A. Duchemin
Name: Jeffrey A. Duchemin
Title: Chief Executive Officer

EXHIBIT 10.51

AMENDMENT NO. 3 TO
HARVARD BIOSCIENCE, INC.
EMPLOYEE STOCK PURCHASE PLAN

This Amendment No. 3 to the Harvard Bioscience, Inc. Employee Stock Purchase Plan (the "Plan") is effective as of May 18, 2017 (the "Effective Date").

In accordance with Section 18 of the Plan, as approved by the stockholders of Harvard Bioscience, Inc. on the Effective Date, in order to increase the number of shares of common stock reserved for issuance under the Plan to One Million Fifty Thousand (1,050,000), the Plan is hereby amended as follows, effective as of the Effective Date:

1. The reference to "Seven Hundred Fifty Thousand (750,000) shares" in the initial paragraph of the Plan is hereby deleted and replaced with "One Million Fifty Thousand (1,050,000) shares".

2. The following is added to the end of the Plan:

   "DATE AMENDMENT NO. 1 TO PLAN APPROVED BY BOARD OF DIRECTORS: AUGUST 2, 2011.
   DATE AMENDMENT NO. 2 TO PLAN APPROVED BY BOARD OF DIRECTORS: FEBRUARY 26, 2013.
   DATE AMENDMENT NO. 2 TO PLAN APPROVED BY STOCKHOLDERS: MAY 23, 2013.
   DATE AMENDMENT NO. 3 TO PLAN APPROVED BY BOARD OF DIRECTORS: MARCH 31, 2017.
   DATE AMENDMENT NO. 3 TO PLAN APPROVED BY STOCKHOLDERS: MAY 18, 2017."

3. Except as expressly amended hereby, the Plan shall remain in full force and effect.

IN WITNESS WHEREOF, the Harvard Bioscience, Inc. has duly executed this amendment to be effective as the date first above written.

HARVARD BIOSCIENCE, INC.

By: /s/ Robert E. Gagnon
Name: Robert E. Gagnon
Title: Chief Financial Officer

EXHIBIT 10.52

THIRD AMENDMENT TO
HARVARD BIOSCIENCE, INC.
THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN

This Third Amendment to the Harvard Bioscience, Inc. Third Amended and Restated 2000 Stock Option and Incentive Plan (the "Plan") is effective as of May 17, 2018 (the "Effective Date").

Pursuant to the authorization and approval of the Board of Directors and stockholders of Harvard Bioscience, Inc. in accordance with Section 17 of the Plan, the Plan is hereby amended as follows, effective as of the Effective Date:

1. Section 3(a): The first sentence in Section 3(a) is hereby deleted in its entirety and replaced with the following in its stead:

   "a) *Stock Issuable.* Subject to adjustment as provided in Section 3(b), the maximum number of shares of Stock reserved and available for issuance under the Plan shall be 20,908,929 shares of Stock which number reflects the total of 3,750,000 shares originally reserved, plus the effect of an evergreen provision through December 31, 2005, plus an additional 2,000,000 shares added to the Plan in 2006, plus an additional 2,500,000 shares added to the Plan in 2008, plus an additional 3,700,000 shares added to the Plan in 2011, plus an additional 1,941,254 shares to account for the adjustment required by Section 3(b) pertaining to the Awards issued in connection with the spin-off of Harvard Apparatus Regenerative Technology, Inc. by Harvard Bioscience, Inc., plus an additional 2,500,000 shares added to the Plan in 2015, plus an additional 3,400,000 shares added to the Plan in 2018."

2. The following is added to the end of the Plan:

   "DATE THIRD AMENDMENT TO HARVARD BIOSCIENCE, INC. THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN APPROVED BY BOARD OF DIRECTORS: APRIL 2, 2018.

   DATE THIRD AMENDMENT TO HARVARD BIOSCIENCE, INC. THIRD AMENDED AND RESTATED 2000 STOCK OPTION AND INCENTIVE PLAN APPROVED BY STOCKHOLDERS: MAY 17, 2018."

3. Except as expressly amended hereby, the Plan shall remain in full force and effect.

IN WITNESS WHEREOF, Harvard Bioscience, Inc. has duly executed this amendment to be effective as the date first above written.

HARVARD BIOSCIENCE, INC.

By: /s/ Jeffrey A. Duchemin
Name: Jeffrey A. Duchemin
Title: Chief Executive Officer

Exhibit 21.1

Subsidiaries of the Registrant

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

EXHIBIT 23.1

Consent of Independent Registered Public Accounting Firm

The Board of Directors
Harvard Bioscience, Inc.:

We have issued our reports dated March 18, 2019, with the 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, 2018. 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 and File No. 333-225365).

/s/ GRANT THORNTON LLP

Boston, Massachusetts
March 18, 2019

EXHIBIT 31.1

Certification

I, Kam Unninayar, 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 18, 2019

/s/ KAM UNNINAYAR
Kam Unninayar
Chief Financial Officer

EXHIBIT 31.2

Certification

I, Jeffrey A. Duchemin, 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 18, 2019

/s/ JEFFREY A. DUCHEMIN
Jeffrey A. Duchemin
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, 2018 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 18, 2019

/s/ KAM UNNINAYAR
Name: Kam Unninayar
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, 2018 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 18, 2019

/s/ JEFFREY A. DUCHEMIN
Name: Jeffrey A. Duchemin
Title: Chief Executive Officer

Exhibit 1

Harvard Bioscience, Inc.

Reconciliation of US GAAP Net Loss to Non-GAAP Adjusted Net Income (unaudited):

	For the Year Ended December 31,	
	2018	**2017**
US GAAP net loss	$(2,922)	$(865)
Adjustments:		
Amortization of intangible assets	5,384	1,553
Denville Non-GAAP adjustments included in discontinued operations	(920)	1,072
Deferred revenue valuation charges on acquisition	284	-
Inventory valuation step-up charges on acquisition	3,816	-
Depreciation of fixed asset step-up on acquisition	619	-
Forensic investigation and remediation costs	-	386
Loss on sale of AHN	-	95
Severance and restructuring charges	772	426
Acquisition, disposition and integration costs	3,294	694
Stock-based compensation expense	2,894	3,382
Income taxes	(5,861)	(2,519)
Non-GAAP adjusted net income	$7,360	$4,224

Exhibit 2

Harvard Bioscience, Inc.

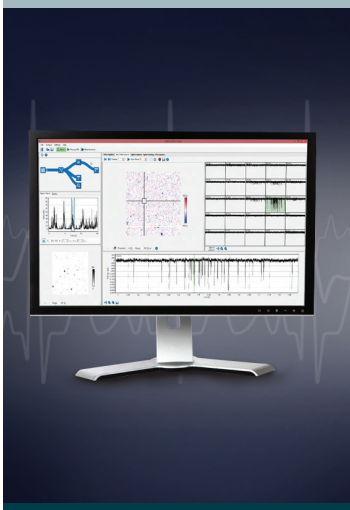
Reconciliation of US GAAP Diluted Loss per Common Share to Non-GAAP Adjusted Diluted Earnings Per Common Share (unaudited):

	For the Year Ended December 31,	
	2018	**2017**
US GAAP diluted loss per common share	$(0.08)	$(0.02)
Adjustments:		
Amortization of intangible assets	0.15	0.04
Denville Non-GAAP adjustments included in discontinued operations	(0.03)	0.03
Deferred revenue valuation charges on acquisition	0.01	-
Inventory valuation step-up charges on acquisition	0.10	-
Depreciation of fixed asset step-up on acquisition	0.02	-
Forensic investigation and remediation costs	-	0.01
Loss on sale of AHN	-	-
Severance and restructuring charges	0.02	0.01
Acquisition, disposition and integration costs	0.10	0.02
Stock-based compensation expense	0.08	0.10
Income taxes	(0.17)	(0.07)
Non-GAAP adjusted diluted earnings per common share	$0.20	$0.12

Forward-Looking Statements

This Annual Report contains forward-looking statements. In some cases, you can identify forward-looking statements by terms such as "capitalize," "increase," "guidance," "objectives," "emerging," "long-term," "growth," "potential," "future," "expects," "plans," "achieve," "could," "will," "lead," "opportunity," "estimate," "continue," "strategy," "intend," "believe,""see," "may," "should," "would," "seek," "aim," "anticipates," "projects," "predicts," "think," "optimistic," "new," "goal" and similar expressions. These statements include, but are not limited to, statements or inferences about our beliefs, plans or objectives, management's confidence or expectations, our business strategy and ability to execute such strategy, the outlook for the life sciences industry, and our positioning for growth and market demand.

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, plus factors described under the heading "Part I, Item 1A. Risk Factors" in our 2018 Annual Report on Form 10-K or in our other public filings.



CMOS Microelectrode Arrays

Based on complementary metal-oxide semiconductor (CMOS) technology with the possibility to have thousands of recording electrodes, Multichannel Systems microelectrode Arrays (MEA's) allow researchers to perform high resolution extracellular recordings on a sub-cellular level.

Suitable for neuronal preparations from brain slices to stem cells, the high resolution MEA platform offers new possibilities in drug discovery, safety pharmacology, connectivity studies, and functional monitoring.

Solutions to Advance Life Science

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