The Economic Impact of the U.S. Advanced Medical Technology Industry

Prepared by Battelle Technology Partnership Practice

Prepared for the Advanced Medical Technology Association (AdvaMed)

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The Economic Impact of the U.S. Advanced Medical Technology Industry

Simon Tripp, Martin Grueber, and Ryan Helwig
Battelle Technology Partnership Practice

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Executive Summary

The advanced medical technology industry\(^1\) is an R&D-driven, manufacturing sector that is important to the U.S. economy not only for the economic benefits it generates, but also the health care benefits provided by the application of its products. Using input/output analysis, Battelle has quantified the total impact of the industry generated in the economy. As Table ES-1 illustrates, the results of the analysis show that the advanced medical technology industry is responsible for generating:\(^2\)

- Almost 1.9 million U.S. jobs
- Over $113 billion in personal income for U.S. workers
- $191 billion in value-added activity, and
- $381 billion in national economic output.

Table ES-1: Economic Impacts of the U.S. Advanced Medical Technology Industry, 2009 ($ in billions)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Employment</th>
<th>Personal Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Impact</td>
<td>1,887,927</td>
<td>$113.59</td>
<td>$191.68</td>
<td>$381.62</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

The advanced medical technology industry is found to have multiple characteristics that make it a strategic, innovation-based industry for the U.S. and its constituent states:

- It produces medical products which are in demand across the globe and, therefore, generate significant exports for the U.S. economy. By producing products for a global marketplace, the industry generates significant export volume and has a positive net balance of trade for the U.S. economy. In 2010, the industry generated export revenues in excess of $40 billion, and generated a positive balance of trade of more than $3 billion. Furthermore, exports have increased every year for the past five years, growing by 37.9 percent between 2006 and 2010.

- It provides not only a diversity of job opportunities, but also family-sustaining wage levels. With an average total compensation (including benefits) of $84,156 per worker, the industry provides compensation of 1.85 times the national average.

- It is R&D intensive, innovative, and technologically sophisticated, thereby building comparative advantage for U.S. producers and creating barriers-to-entry for foreign competition. With the advanced medical technology industry spending between $15,000 and $22,000 on R&D per employee, the industry is driven by highly research intensive subsectors, far exceeding the average spending of non-R&D intensive industries which average just over $2,100 in R&D expenditures per employee.

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\(^1\) The advanced medical technology industry is defined as being comprised of eight subsectors, which include: In-vitro diagnostic substance manufacturing (NAICS 325413); electro-medical and electrotherapeutic apparatus manufacturing (NAICS 334510); irradiation apparatus manufacturing (NAICS 334517); surgical and medical instrument manufacturing (NAICS 339112); surgical appliance and supplies manufacturing (NAICS 339113); dental equipment and supplies manufacturing (NAICS 339114); ophthalmic goods manufacturing (NAICS 339115); dental laboratories manufacturing (NAICS 339116). A portion of a ninth subsector, the scientific R&D sector (NAICS 5417), is also included in the industry definition.

\(^2\) Measures include Employment: The number of full and part-time workers. Personal Income: Measures cash, benefits and non-cash payments received by individuals in the economy. Value Added: Represents the difference between an industry’s or an establishment’s total output and the cost of its intermediate inputs. Output: Is the dollar value of production (i.e., sales) and is the typical metric cited as “total economic impact”.
Unlike many industries which are heavily concentrated in just a small number of states, the advanced medical technology industry is geographically dispersed, providing direct jobs and income benefits in every state in the nation.

As a result of the increasing national demand for new devices to assist in prevention, diagnosis, and treatment of medical conditions coupled with an increase in global demand—led by an expanding global population, increasing global wealth, increasing access to health care, and an aging population in leading developed nations—it is anticipated that the advanced medical technology industry will continue to grow in importance to the U.S. economy. Furthermore, modern scientific and technological advancements show great promise for advancing U.S. medical technology development along enhanced and novel pathways. U.S. investment in expanding fields (such as nanotechnology, bioMEMS, tissue-engineering, genomics, materials science, and imaging) promise new and improved technologies for disease prevention, diagnosis and treatment. The advanced medical technology industry in the U.S. will likely be at the forefront in translating scientific and technological advancements into new tools and products to enhance health and as platforms for ongoing national economic growth.

For these opportunities to be realized, however, advanced medical technology companies need to operate in a business environment that encourages continued R&D investment and facilitates profitable business operations. Competition continues to be intense from traditional competing nations in Europe and from Japan, but developing nations are also focusing their attention and resources on advanced technology sectors such as medical technology. Sustaining a U.S. operating environment conducive to the growth and ongoing operations of the advanced medical technology industry, as shown in this report, carries significant economic benefits.

Every $1 billion in advanced medical technology industry revenues in the U.S. generates an additional $1.69 billion in national economic output, almost 13,000 jobs, and $778 million in personal income.

Likewise, however, any policies or changes that negatively impact the operating environment or otherwise reduce industry output will have the inverse effect—driving significant employment reductions, income reductions, and reducing business.

Given that the business environment is dynamic and subject to change (based on numerous business factors including global market conditions, healthcare insurance reform, changes in the regulatory environment, and governmental policy decisions), it is important to understand how both industry growth as well as decline can impact the overall national economy. At the request of AdvaMed, Battelle developed an economic scenario to model the impacts of a potential change in the industry stemming from an economic “event” that changes the business environment for the medical technology industry. Battelle’s analysis quantifies what the total impact on the U.S. economy would be due to a one-time event of this kind. The scale of this impact is subject to increases and decreases (as are all sectors) stemming from changes in the final demand and revenue derived from overall advanced medical technology industry sales (output). If this economic event were to become permanent, the industry baseline economic parameters would be reset by the amount of this one-year impact going forward. These potential revenue changes can come from a number of sources; examples include increasing or decreasing foreign competition, new breakthrough devices or instrumentation, changes in federal and state healthcare reimbursement policies, or changes in competitive pricing or demand occurring via business climate changes (such as taxes).

Battelle modeled a scenario or “economic event” whereby a change in the operating environment in the U.S. might result in the advanced medical technology industry declining by $3 billion. Table ES-2
illustrates that a $3 billion decline in the industry would result in the loss of nearly 39,000 jobs and $8 billion in output in the economy.

Table ES-2: Economic Impacts of $3 Billion Decline in U.S. Advanced Medical Technology Industry, 2009 ($ in billions)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Employment</th>
<th>Personal Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Impact</td>
<td>-38,840</td>
<td>-$2.33</td>
<td>-$4.02</td>
<td>-$8.07</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

It is clear that the advanced medical technology industry represents an innovative and important sector of the U.S. economy. The economic impact of the industry is felt broadly across the nation and there are significant opportunities for further growth. Realizing these growth opportunities, however, will require attention to be paid to sustaining a competitive operating environment for the industry within the United States.
I. Introduction

The United States’ advanced medical technology industry conducts research and develops, manufactures, and distributes a diverse range of products used in health care diagnoses and treatment applications. By providing technologies for monitoring health, diagnosing medical conditions, and developing the specialized tools and devices to treat patient injuries, illnesses and chronic conditions, the medical technology industry fulfills an important role in modern society. In manufacturing highly innovative and valued products, the advanced medical technology industry is also an economic engine for the U.S economy and the economies of individual states.

The report, herein, quantifies the economic impacts that occur in the U.S. and the 50 states, as a result of the presence and operations of the U.S. advanced medical technology industry. Using input/output analysis—a standardized method of calculating the economic inputs, outputs, and extent of trade between related industries—this report measures the total impact of the advanced medical technology industry.

Battelle’s analysis also examines the economic impacts that would be associated with hypothetical changes in the overall output of the advanced medical technology sector and the effect such changes would have as they ripple through the interrelated national economic system. The current economic environment is dynamic, influenced by global economic trends and international competition. In addition, the medical technology sector is influenced by unique factors such as the health care reimbursement environment, changing patient demographics, and public policy/regulatory conditions that can have a substantial impact on the sector’s economic health. Because many dynamic forces affect the advanced medical technology industry, it is important to understand the economic implications for the nation and individual states of positive or negative changes in the industry’s aggregate output. Battelle’s impact modeling provides estimates of the impacts that may occur under potential revenue-impacting event scenarios.

Finally, the advanced medical technology industry has other notable economic characteristics that are examined, including:

- **High skills/high wage jobs** – Leveraging U.S. investment in education and skills training to produce advanced products and provide family sustaining wages;

- **Exports** – Generating significant export volume as a result of the global marketplace to produce a positive net balance of trade for the U.S. economy; and

- **Support of the U.S. Innovation System** – Leveraging U.S. investment in biomedical research and other science and technology disciplines to create high value, globally competitive products.

Methodology

The Battelle economic impact analysis for the U.S. advanced medical technology industry makes use of a custom economic input/output (I/O) model that quantifies the interrelationships between economic sectors in the economy of the United States. I/O data matrices track the flow of commodities to

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3 The advanced medical technology industry is defined as being comprised of eight subsectors, which include: In-vitro diagnostic substance manufacturing (NAICS 325413); electro-medical and electrotherapeutic apparatus manufacturing (NAICS 334510); irradiation apparatus manufacturing (NAICS 334517); surgical and medical instrument manufacturing (NAICS 339112); surgical appliance and supplies manufacturing (NAICS 339113); dental equipment and supplies manufacturing (NAICS 339114); ophthalmic goods manufacturing (NAICS 339115); dental laboratories manufacturing (NAICS 339116). A portion of a ninth subsector, the scientific R&D sector (NAICS 5417), is also included in the industry definition.
industries from producers and institutional consumers within the nation. The data also show expenditure and consumption activities by workers, owners of capital, and imports. These trade flows built into the model permit estimating the impacts of one sector on all other sectors with which it interacts.

The measured economic impacts consist of three types: direct impacts (the specific impact of advanced medical technology sector expenditures in the first round of spending), indirect impacts (the impact of expenditures by suppliers to the advanced medical technology sector), and induced impacts (the additional economic impacts of the spending of advanced medical technology sector employees and suppliers’ employees in the overall economy). Together, these three impacts comprise the cited total economic impact. I/O analysis thus models the flow of funds that originate from direct advanced medical technology industry expenditures in the economy and the ongoing ripple (multiplier) effect of these expenditures. In other words, economic impact models are based on the concept of the “multiplier”—i.e., every dollar spent in the economy is re-spent one or more times in the local economy, thereby generating additional economic activity and impact. I/O analysis represents the generally accepted standard for measurement of economic impacts.

The current estimated impacts of the advanced medical technology industry were calculated using 2009 U.S. and state-specific I/O models generated by the IMPLAN Group (one of two major developers of nationally and regionally-specific I/O tables and analytical systems). The analysis builds upon a foundation of employment data included within the IMPLAN input/output model that is built primarily from the United States Department of Labor’s Quarterly Census of Employment and Wages (QCEW, tied to unemployment insurance reporting), collected in 2010 for the year 2009. These data, which are the latest data for the IMPLAN model, provide detailed intelligence on the number of establishments, monthly employment, and quarterly wages, by North American Industry Classification System (NAICS) industry, by county geography, by ownership sector, and for the entire U.S. The IMPLAN model employment data is further enhanced by U.S. Bureau of Economic Analysis data to account for sole proprietorships and other very small firms that fall outside of the QCEW data collection protocols.

Battelle acquired the necessary data files for use with the IMPLAN system and developed a customized model to quantify the direct, indirect and induced impacts of the advanced medical technology industry. The model incorporates detail of the advanced medical technology industry and its interrelationships with more than 430 other individual sectors that cover the entire national economy. With these data, the analysis is able to show not only the overall impact on the U.S. economy, but impacts on specific sub-sectors of the economy that are strongly dependent on economic activity generated by the advanced medical technology sector.
II. Economic Impact of the U.S. Advanced Medical Technology Industry

Total Impact of Advanced Medical Technology Sector Spending

Before the I/O model is even applied, it is important to note that the direct impact of the advanced medical technology industry is significant. The advanced medical technology industry directly accounts for nearly 519,000 jobs in the U.S. economy and nearly $150 billion in direct output.4

When the I/O model is applied and indirect and induced impacts are taken into account, the total impact of the advanced medical technology industry is sizeable. Table 1 presents the findings from Battelle’s I/O analysis of the U.S. advanced medical technology industry for 2009 for four measures—employment (number of full and part-time workers), personal income (measures cash, benefits and non-cash payments received by individuals in the economy), value added (the difference between an industry’s or an establishment’s total output and the cost of its intermediate inputs), and output (the dollar value of sales and often cited as the “total economic impact”).

The total economic output of the advanced medical technology industry on the U.S. economy amounts to nearly $382 billion on an annual basis (See Table 1). This impact is comprised of direct impacts of advanced medical technology firms’ output and additional indirect and induced impacts.

Table 1: Economic Impacts of the U.S. Advanced Medical Technology Industry, 2009 ($ in billions)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Employment</th>
<th>Personal Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Impact</td>
<td>1,887,927</td>
<td>$113.59</td>
<td>$191.68</td>
<td>$381.62</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

From an employment perspective, the advanced medical technology industry is responsible for the creation and support of almost 1.9 million jobs in the U.S. economy. The advanced medical technology industry directly accounts for nearly 519,000 jobs in the U.S. economy. In turn, the spending of the industry generates an additional 512,000 jobs among its suppliers. Finally, the spending of all these workers throughout the economy generates a further 857,000 jobs. At this level the industry’s employment multiplier is 3.64—every advanced medical technology industry job generated an additional 2.64 jobs in the economy.

This significant level of employment in turn generates a total personal income impact of more than $113 billion in the U.S. economy. The strong personal income basis for the advanced medical devices industry is highlighted by an average personal income (wages and benefits combined) of more than $84,000 per industry worker. In turn, the industry generates employment through suppliers. Together, industry and its suppliers generate additional personal income for the economy as a whole.

The advanced medical technology industry also has a significant impact on key suppliers. The ripple effects of the advanced medical technology industry (indirect and induced impacts) are connected to a broad range of U.S. industry sectors. The I/O analysis allows the impact of the advanced medical technology industry on every other sector in the economy to be measured. As the analysis indicates in Table 2, key industry supplier sectors (key suppliers measured by “indirect” output) benefit from particularly robust advanced medical technology industry dependencies.

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4 The direct employment figure of 518,684 jobs provides the baseline metric driving the overall IMPLAN economic impact modeling performed by Battelle and discussed in this report.
Due to these connections, the economic prosperity of these supply chain partners is closely linked to the growth or decline of the overall advanced medical technology industry.

**Opportunity Cost: Hypothetical Changes to the Advanced Medical Technology Industry**

As just detailed, the significant economic impact of the advanced medical technology industry affects many other key areas of the U.S. economy. The scale of this impact is subject to increases and decreases (as are all sectors) stemming from changes in the final demand and revenue derived from overall advanced medical technology industry sales (output). These potential revenue changes can come from a number of sources; examples include increasing or decreasing foreign competition, new breakthrough devices or instrumentation, changes in federal and state healthcare reimbursement policies, or changes in competitive pricing occurring via business climate changes (such as taxes).

At the request of AdvaMed, Battelle developed an economic scenario to model the impacts of a potential change in the industry stemming from an economic “event” of this kind. This event stimulus is

<table>
<thead>
<tr>
<th>NAICS Industry Sector Title</th>
<th>2009 Employment</th>
<th>2009 Output ($B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced Medical Technology Industry (Direct Effects)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>518,684</td>
<td>$149.78</td>
</tr>
<tr>
<td><strong>Key (Top 20) Industry Supplier Sectors (Indirect &amp; Induced Effects)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wholesale trade businesses</td>
<td>80,934</td>
<td>$16.03</td>
</tr>
<tr>
<td>Real estate establishments</td>
<td>71,131</td>
<td>$10.27</td>
</tr>
<tr>
<td>Management of companies and enterprises</td>
<td>41,187</td>
<td>$8.50</td>
</tr>
<tr>
<td>Petroleum refineries</td>
<td>691</td>
<td>$6.44</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>11,559</td>
<td>$5.17</td>
</tr>
<tr>
<td>Commercial banking</td>
<td>18,544</td>
<td>$5.14</td>
</tr>
<tr>
<td>Petrochemical manufacturing</td>
<td>776</td>
<td>$4.29</td>
</tr>
<tr>
<td>Non-depository credit and financing</td>
<td>9,147</td>
<td>$4.14</td>
</tr>
<tr>
<td>Leasing of nonfinancial intangible assets (e.g., IP, patents, etc.)</td>
<td>1,364</td>
<td>$3.57</td>
</tr>
<tr>
<td>Legal services</td>
<td>21,349</td>
<td>$3.57</td>
</tr>
<tr>
<td>Transport by truck</td>
<td>24,028</td>
<td>$3.23</td>
</tr>
<tr>
<td>Software publishers</td>
<td>6,213</td>
<td>$3.17</td>
</tr>
<tr>
<td>Electric power generation, transmission, and distribution</td>
<td>4,773</td>
<td>$3.12</td>
</tr>
<tr>
<td>Semiconductor and related device manufacturing</td>
<td>4,357</td>
<td>$2.77</td>
</tr>
<tr>
<td>Management, scientific, and technical consulting services</td>
<td>19,186</td>
<td>$2.57</td>
</tr>
<tr>
<td>Plastics material and resin manufacturing</td>
<td>1,663</td>
<td>$2.48</td>
</tr>
<tr>
<td>Advertising and related services</td>
<td>14,758</td>
<td>$2.00</td>
</tr>
<tr>
<td>Plastics packaging materials and plastic film and sheet manufacturing</td>
<td>4,225</td>
<td>$1.64</td>
</tr>
<tr>
<td>Iron and steel mills and ferroalloy manufacturing</td>
<td>1,311</td>
<td>$1.46</td>
</tr>
<tr>
<td>Other plastics product manufacturing</td>
<td>6,409</td>
<td>$1.42</td>
</tr>
<tr>
<td><strong>Total of Key Supplier Sectors (Indirect &amp; Induced Effects)</strong></td>
<td>343,602</td>
<td>$90.99</td>
</tr>
<tr>
<td><strong>Remaining Sectors of Economy (Indirect &amp; Induced Effects)</strong></td>
<td>1,025,641</td>
<td>$140.84</td>
</tr>
<tr>
<td><strong>Total, Advanced Medical Technology Industry Impacts (Direct, Indirect &amp; Induced Effects)</strong></td>
<td>1,887,927</td>
<td>$381.62</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model
modeled as a $1 billion change in industry output. The results in Table 3 and 4 show that for every $1 billion change in industry output, total employment would increase or decrease by nearly 13,000 workers. These related employment impacts would in turn affect $778 million in personal income in the U.S. This $1 billion change would also lead to a growth or decline of $2.69 billion in total output in the economy.

Table 3: Economic Impacts of $1 Billion Change in U.S. Advanced Medical Technology Industry, 2009 ($ in billions)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Employment</th>
<th>Personal Income</th>
<th>Value Added</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Impact</td>
<td>12,947</td>
<td>$0.78</td>
<td>$1.34</td>
<td>$2.69</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

Based upon the structure of the impact model, the scenario-based economic impacts are also linear, and thus a different output value for the economic event would produce impacts proportional to the size of the event. For example, the annual impact of an output decline of $3 billion would yield negative economic impacts three times as large (see Table 4).

Table 4: Economic Impacts of $3 Billion Decline in U.S. Advanced Medical Technology Industry, 2009 ($ in billions)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Employment</th>
<th>Personal Income</th>
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<th>Output</th>
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<tr>
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<td>-38,840</td>
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<td>-$4.02</td>
<td>-$8.07</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

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5 The actual impact event is modeled as a $1 billion change to the output of the core manufacturing segments of the advanced medical technology industry (NAICS 325413, 334510, 334517, and 339112-339116).
State-Level Economic Impacts of Advanced Medical Technology Sector Spending

To further understand the overall economic impact of the advanced medical technology sector, Battelle examined the total economic impacts of the sector on each of the 50 states. The results of these analyses are summarized, for all states in 2009, in Table 7. The ten states with the largest economic impacts in total economic output and total employment are presented below in tables 5 and 6, respectively.

Separately, estimates of the impacts of a $3 billion change in national industry output are presented in Table 8 based on the current shares of industry output that reside in each state. Economic impacts are presented here as an increase in national output; however, an output decline would yield the same magnitudes but as a negative change.

Table 5: Economic Impacts of the Ten Largest States in Advanced Medical Technology Industry Total Output, 2009 ($ in millions)

<table>
<thead>
<tr>
<th>State</th>
<th>Total Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>$80,610.2</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$34,006.5</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>$22,592.9</td>
</tr>
<tr>
<td>Florida</td>
<td>$19,517.6</td>
</tr>
<tr>
<td>New Jersey</td>
<td>$19,478.1</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$17,418.0</td>
</tr>
<tr>
<td>New York</td>
<td>$17,216.9</td>
</tr>
<tr>
<td>Illinois</td>
<td>$14,671.2</td>
</tr>
<tr>
<td>Indiana</td>
<td>$13,969.3</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$12,602.4</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN 2009 Model for each state.

Table 6: Economic Impacts of the Ten Largest States in Advanced Medical Technology Industry Total Employment, 2009 ($ in millions)

<table>
<thead>
<tr>
<th>State</th>
<th>Total Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>366,615</td>
</tr>
<tr>
<td>Minnesota</td>
<td>158,075</td>
</tr>
<tr>
<td>Florida</td>
<td>105,933</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>98,174</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>92,444</td>
</tr>
<tr>
<td>New York</td>
<td>81,178</td>
</tr>
<tr>
<td>New Jersey</td>
<td>79,440</td>
</tr>
<tr>
<td>Indiana</td>
<td>71,757</td>
</tr>
<tr>
<td>Illinois</td>
<td>67,119</td>
</tr>
<tr>
<td>Texas</td>
<td>66,304</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN 2009 Model for each state.
Table 7: Economic Impacts of the U.S. Advanced Medical Technology Industry, 2009 ($ in millions)

<table>
<thead>
<tr>
<th>State</th>
<th>Employment Direct</th>
<th>Employment Total</th>
<th>Multiplier</th>
<th>Personal Income Total</th>
<th>Output Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>3,443</td>
<td>9,339</td>
<td>2.7</td>
<td>$421.3</td>
<td>$1,314.8</td>
</tr>
<tr>
<td>Alaska</td>
<td>387</td>
<td>841</td>
<td>2.2</td>
<td>$29.0</td>
<td>$126.1</td>
</tr>
<tr>
<td>Arizona</td>
<td>7,315</td>
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<td>$81.4</td>
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<td>$102.4</td>
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<td>9,744</td>
<td>3.2</td>
<td>$516.5</td>
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<td>2.9</td>
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<td>45,015</td>
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<td>$2,291.3</td>
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<td>$59.5</td>
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<td>Ohio</td>
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<td>$7,963.1</td>
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<td>346</td>
<td>636</td>
<td>1.8</td>
<td>$127.</td>
<td>$64.3</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN 2009 Model for each state.
### Table 8: Economic Impacts of $3 Billion Change in U.S. Advanced Medical Technology Industry, 2009 ($ in millions)

<table>
<thead>
<tr>
<th>State</th>
<th>Change in Employment Total</th>
<th>Change in Output Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>200</td>
<td>$26.5</td>
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<tr>
<td>Alaska</td>
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<td>$3.0</td>
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<td>Arkansas</td>
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<td>$25.8</td>
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<td>California</td>
<td>7,287</td>
<td>$1,649.7</td>
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<tr>
<td>Colorado</td>
<td>883</td>
<td>$187.9</td>
</tr>
<tr>
<td>Connecticut</td>
<td>896</td>
<td>$214.2</td>
</tr>
<tr>
<td>Delaware</td>
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<td>$31.1</td>
</tr>
<tr>
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</tr>
<tr>
<td>Georgia</td>
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<td>$119.8</td>
</tr>
<tr>
<td>Hawaii</td>
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<td>$6.4</td>
</tr>
<tr>
<td>Idaho</td>
<td>98</td>
<td>$11.5</td>
</tr>
<tr>
<td>Illinois</td>
<td>1,349</td>
<td>$312.5</td>
</tr>
<tr>
<td>Indiana</td>
<td>1,643</td>
<td>$327.1</td>
</tr>
<tr>
<td>Iowa</td>
<td>126</td>
<td>$15.5</td>
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<tr>
<td>Kansas</td>
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<td>$25.7</td>
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<tr>
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<tr>
<td>Mississippi</td>
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<td>$6.9</td>
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<tr>
<td>Missouri</td>
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<td>$96.2</td>
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<tr>
<td>Montana</td>
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<td>$4.5</td>
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<tr>
<td>Nebraska</td>
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<td>$60.9</td>
</tr>
<tr>
<td>Nevada</td>
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<td>New Jersey</td>
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<td>New Mexico</td>
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<td>$14.8</td>
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<td>New York</td>
<td>1,722</td>
<td>$357.6</td>
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<tr>
<td>North Carolina</td>
<td>873</td>
<td>$148.8</td>
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<tr>
<td>North Dakota</td>
<td>18</td>
<td>$1.4</td>
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<td>Oklahoma</td>
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<td>$78.2</td>
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<td>$24.7</td>
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<tr>
<td>South Carolina</td>
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<td>$64.7</td>
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<tr>
<td>South Dakota</td>
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<td>$22.8</td>
</tr>
<tr>
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<td>$179.1</td>
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<tr>
<td>Texas</td>
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<td>$252.4</td>
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<tr>
<td>Utah</td>
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<tr>
<td>Vermont</td>
<td>97</td>
<td>$21.0</td>
</tr>
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<td>$55.5</td>
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<td>Washington</td>
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<td>$167.6</td>
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<tr>
<td>West Virginia</td>
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<td>$12.4</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1,171</td>
<td>$283.0</td>
</tr>
<tr>
<td>Wyoming</td>
<td>19</td>
<td>$1.6</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN 2009 Model for each state.
III. Notable Economic Characteristics of the Advanced Medical Technology Industry

In terms of impacts and benefits for the U.S. economy, all industries are not created equal. Industries vary widely in their ability to compete in an increasingly competitive global marketplace, in their ability to pay high wages, in their export volume and contribution to the U.S. balance of trade, and in their degree of innovation and protected intellectual property generation. Economists once thought that the U.S. could move into a “post-industrial” services and information driven economy—but, the reality of this economic model to date has been disappointing with services and information products proving difficult to export and difficult to protect in terms of intellectual property. The value-chain is also relatively short in services and information products—whereas in manufacturing, this chain is robust and diverse, requiring multiple inputs to production and a sophisticated set of activities in the supply of raw materials, components, goods and services to feed the production process.

The advanced medical technology industry is an innovative, R&D-driven manufacturing sector producing sophisticated products. Requiring specialized materials, manufacturing, and machining technologies (including advanced aseptic processing technologies in some products), the advanced medical technology industry is among the signature industries for the U.S. and stands among a select group of ideal industries in terms of:

- Being R&D driven, innovative and technologically sophisticated thereby building comparative advantage for U.S. producers and creating barriers-to-entry for international competition;
- Producing a product in demand across the globe thereby generating significant exports for the U.S. economy and addressing an expanding global market demand with strong growth potential;
- Being a value-added consumer of U.S. produced materials, supplies, components and know-how thereby enhancing the industry’s multiplier effect throughout the national economy;
- Building upon the nation’s long-standing investment in basic and applied R&D across academic, government, and independent research institutions;
- Providing a diversity of job opportunities and providing high, family-sustaining wage levels; and
- Being geographically distributed across the U.S. thereby providing economic opportunities across a diverse set of states and communities.

The advanced medical technology industry has all of the above characteristics and, of course, carries the added benefit of producing products to sustain and enhance human health and quality of life. As Figure 1 illustrates, the advanced medical technology industry is engaged in a continuously innovative product development cycle to develop, manufacture and distribute a wide range of supplies, instruments, and devices to diagnose, prevent, mitigate, and treat disease and abnormal physical conditions.
The previous section’s I/O analysis discusses the extent of impacts generated directly and indirectly in the economy attributable to the direct expenditures of the advanced medical technology industry and its related supply chain. In this section of the report, Battelle discusses several of the other defining economic characteristics of the industry: high quality job creation; export volumes and impact on the U.S. balance of trade, and the role and importance of the advanced medical technology industry within the U.S. innovation economy.

**Advanced Medical Technology and High Quality Job Creation**

The advanced medical technology industry, whether in its R&D, manufacturing or sales and distribution functions, generates high quality U.S. jobs. As Table 9 illustrates, relatively high levels of wages and salaries are provided within the industry, as are family-sustaining benefits packages—helping to support a high quality of life for the more than 518,000 persons directly employed in the industry.
<table>
<thead>
<tr>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of advanced medical technology industry jobs</td>
<td>518,684 Including advanced medical technology R&amp;D, production and associated direct jobs</td>
</tr>
<tr>
<td>Average total compensation per worker</td>
<td>$84,156 This is 1.85 times the U.S. total compensation average (includes wages and benefits)</td>
</tr>
</tbody>
</table>

Source: Battelle analysis; IMPLAN U.S. 2009 Model

The quality of advanced medical technology industry jobs is part of what makes the sector such a key driver within the U.S. economy. The annual average personal income (including pay and benefits) of an advanced medical technology worker was $84,156 in 2009 as compared to $45,320 in the overall economy. The advanced medical technology industry is able to provide higher than average compensation packages because the sector is R&D intensive and provides value-added, sophisticated and technologically-advanced manufactured products. Furthermore, such production mandates a workforce with specialized technical skills and education (at all levels, from those with entry level technical training through to graduate engineers and PhD scientists).

**Advanced Medical Technology and U.S. Exports**

The U.S. advanced medical technology industry is a significant contributor to the U.S. export economy. The U.S. International Trade Commission/U.S. Census tracks export and import data for six of the nine NAICS codes used by Battelle in defining the advanced medical technology industry. These data, for the calendar year 2010, show that the U.S. exported advanced medical technologies valued at $40 billion. Furthermore, the nation recorded a positive balance of trade for the sector of over $3 billion in 2010.

As Figure 2 illustrates, in the five year period 2006–2010, U.S. exports of advanced medical technology tracked by the International Trade Commission totaled more than $174.6 billion, and generated a net positive trade balance in each of the five years. Also of note, despite the recession, the U.S. advanced medical technology industry has seen its export volume rise each year during the past five years, with the volume exported increasing from $29 billion in 2006 to $40 billion in 2010 (a 37.9 percent increase over five years).

---

Figure 2: The Advanced Medical Technology Industry – U.S. Exports and Imports 2006 through 2010\(^7\) (\$ '000's)

<table>
<thead>
<tr>
<th>Year</th>
<th>Exports (Thousands)</th>
<th>Imports (Thousands)</th>
<th>Net Balance of Trade (Thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>29,032,869</td>
<td>28,131,117</td>
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</tr>
<tr>
<td>2007</td>
<td>32,001,287</td>
<td>31,006,617</td>
<td>994,670</td>
</tr>
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<td>2008</td>
<td>36,734,516</td>
<td>34,359,974</td>
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<tr>
<td>2009</td>
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<tr>
<td>2010</td>
<td>40,064,329</td>
<td>37,043,134</td>
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</tr>
<tr>
<td></td>
<td>174,622,840</td>
<td>163,082,529</td>
<td>11,540,311</td>
</tr>
</tbody>
</table>


To place these numbers in perspective, the advanced medical technology industry’s level of exports is comparable to the automobile industry ($38.4 billion), and is significantly higher than some other technology-oriented sectors such as plastics and rubber products ($25.9 billion); communications equipment ($27 billion); and computers ($12.5 billion).

It should also be noted that these medical technology products are contributing to the health and wellbeing of people across the globe. As with other medical and health care product exports from the U.S., advanced medical technologies serve as an effective “good-will ambassador” for America, benefiting people worldwide.

Advanced Medical Technology and the U.S. Innovation Economy

Innovation is of central importance to U.S. economic growth. The development of innovative new and improved products, and innovation to enhance the efficiency of production processes, is a primary driver of economic progress. The U.S. track record of innovation in a range of sectors, from information technology and aerospace to drugs and medical technologies has been a core driver of late 20th Century and early 21st progress.

In the biomedical arena of the economy, innovation is particularly important and challenging. Developing and designing products for application to human health mandates a careful and thorough approach to research and takes place within a highly regulated environment. Developing new and improved diagnostic and therapeutic medical products requires a large-scale commitment of financial and human capital resources to R&D. The advanced medical products industry stands among the most R&D intensive industries in the world, with U.S. advanced medical technology companies investing nearly 12 percent of sales in R&D (an amount that AdvaMed notes is more than four times the average for U.S. manufacturers).

The advanced medical technology R&D space is also highly diverse. In advancing product development, the industry draws upon a highly diverse range of scientific and technological disciplines, including areas such as: materials science; electronic and mechanical engineering; physics and nuclear science; chemistry; biology; and computing and information sciences to name just a few. For many of the sector’s products, the R&D pipeline has to span the “bench to bedside” R&D continuum with products progressing over time from basic science discoveries through early phase bench testing, and onwards into complex clinical trials. The capital needs to power this process are high, and the attrition rate for regulated medical products along the development pathway is significant.

With over 7,000 companies operating in the advanced medical technology sector and the sector intensively engaged in R&D, it should not be surprising that the industry generates innovations on a large-scale. The Battelle BIO report for 20108 identified 19,267 U.S. patents for “surgical and medical instruments” and 7,884 patents for “other medical equipment” between 2004–2009 (a combined total of 27,151 patents). This places the advanced medical technology industry at the top of the patent classification system (together with the biopharmaceuticals cluster with 21,755 patents for the same 2004–2009 time period).

Generating patents and other intellectual property (IP), and then realizing the economic benefits associated with IP, requires a concerted commitment to investment in R&D. The advanced medical technology industry is an IP intensive industry that spends considerably more per employee on IP than the average non-IP intensive industry. A recent study by NDP Consulting reports that for 12 non-IP intensive industries, the average R&D spending per employee was $2,164 (average for the time period 2000–2007)9. Based on National Science Foundation information for R&D in 2006, the sectors that include advanced medical technology spend within a range of $15,000 to $22,000 per employee on R&D.10 The importance and intensity of R&D activity in the advanced medical technology industry is

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further highlighted by the fact that the life cycle for many of the industry’s products is only about 18-24 months before they are replaced with successive innovations.\textsuperscript{11}

The implication here is that sustaining a healthy R&D continuum in the U.S. is very important in securing future economic growth and that within the biomedical products arena it is a particularly critical factor.

IV. Looking Ahead

As a result of the increasing national demand for new devices to assist in prevention, diagnosis, and treatment of medical conditions coupled with an increase in global demand—led by an expanding global population, increasing global wealth, increasing access to health care, and an aging population in leading developed nations—it is anticipated that the growth of the advanced medical technology industry will continue. Infectious diseases, chronic diseases and traumatic injuries continue to demand innovative devices to make treatment more effective, to reduce recovery times, and preserve patients’ independence and quality of life. While millions of people benefit from current prevention, diagnostic and treatment tools and devices, millions of people still suffer from diseases and disorders for which there are not yet effective or affordable solutions. The demand and needs are such that the industry will likely experience demand increases for the foreseeable future.

Modern scientific and technological advancements show promise for further advancing U.S. medical technology development along enhanced and novel pathways. U.S. investment in expanding fields (such as nanotechnology, bioMEMS, tissue-engineering, genomics, materials science, and imaging) promise new and improved technologies for disease prevention, diagnosis and treatment. The advanced medical technology industry in the U.S. will be at the forefront in translating scientific and technological advancements into new tools and products to enhance health and as platforms for ongoing national economic growth.

For these opportunities to be realized, however, advanced medical technology companies need to operate in a business environment that encourages continued R&D investment and facilitates profitable business operations (generating profits for reinvestment in the innovation cycle). Competition continues to be intense from traditional competing nations in Europe and from Japan, but increasingly developing nations are also focusing their attention and resources on advanced technology sectors such as medical technology. Sustaining a U.S. operating environment conducive to the growth and ongoing operations of the advanced medical technology industry, as shown in this report, carries significant economic benefits. As detailed herein, every $1 billion in advanced medical technology industry revenues in the U.S. generates an additional $1.69 billion in national economic output, nearly 13,000 jobs, and $778 million in personal income. Likewise, however, any policies or changes that negatively impact the operating environment or otherwise reduce industry revenues will have the inverse effect—driving significant employment reductions, income reductions, and declining business output.