

Appendix D: Priority Industry Analysis

N² INNOVATION CORRIDOR ECONOMIC DEVELOPMENT STRATEGY & MARKETING PLAN

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About Camoin Associates

Camoin Associates has provided economic development consulting services to municipalities, economic development agencies, and private enterprises since 1999. We specialize in real estate market analysis to evaluate the feasibility and impacts of proposed projects. Through the services offered, Camoin Associates has had the opportunity to serve EDOs and local and state governments from Maine to California; corporations and organizations that include Lowes Home Improvement, FedEx, Volvo (Nova Bus) and the New York Islanders; as well as private developers proposing projects in excess of \$600 million. Our reputation for detailed, place-specific, and accurate analysis has led to projects in over twenty states and garnered attention from national media outlets including *Marketplace* (NPR), *Forbes* magazine, and *The Wall Street Journal*. Additionally, our marketing strategies have helped our clients gain both national and local media coverage for their projects in order to build public support and leverage additional funding. The firm currently has offices in Saratoga Springs, NY, Portland, ME, and Brattleboro, VT. To learn more about our experience and projects in all of our service lines, please visit our website at www.camoinassociates.com. You can also find us on Twitter [@camoinassociate](https://twitter.com/camoinassociate) and on [Facebook](https://www.facebook.com/camoinassociates).

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Introduction

As part of the research for the N² Innovation Corridor, a priority industry sector analysis was conducted. This analysis is a deeper examination of industries identified in the economic base analysis and through other information collection that are in some way significant and/or relevant to the Newton and Needham innovation economy and provides an understanding of the potential for growth. The priority industry areas include:

- Information technology
- Professional, scientific, and technical services
- Biotech and life sciences

These sectors were identified as having potential for the N² Corridor, either for their component industries' concentration in employment (e.g. software publishing, with a location quotient of 6.39) or growth over the last decade (e.g. management consulting added over 300 jobs), recent national trends that show increasing demand (e.g. biotechnology). It should be noted that these are highly aligned with the MasTLC 2015 State of Technology Report that names the Internet of things, security, and health care / life sciences information technologies as three emerging technology areas that Massachusetts has the potential to dominate.

Sources for this analysis include IBISWorld, a global market research firm to which Camoin subscribes for its leading business intelligence research and insights into market conditions for targeted industries; Economic Modeling Specialists Intl. for local and industry-specific employment data and employment trends; as well as from reports from industry organizations and entities important to the Boston area's larger innovation economy.

Each section includes a description of the industry, a summary of performance in the N² area, a discussion highlighting relevant industry trends.

Executive Summary

Our research of Newton and Needham's economic base and national trends for these industries has further affirmed that these areas should be prioritized by the N² Corridor as industries to monitor, cultivate, and target in marketing efforts.

Of the industries studied, Newton and Needham have performed particularly strongly in the past five years in internet publishing; custom computer programming; marketing consulting; process, physical distribution, and logistics consulting; R&D in the physical, engineering, and life sciences; and other scientific and technical consulting services. Computer facilities maintenance services also grew significantly, albeit at a lower overall employment level.

Most of the industries of highest relevance to the N² Innovation Corridor vision are in the growth stage of the business life cycle, that is, they are increasing in their importance to the overall economy. All the industries studied are projected to outpace gross domestic product growth over the next five years, with the exception of R&D in the social sciences and humanities, as shown in the table here. Biotechnology's growth is expected to be nearly quadruple that of GDP, and robust growth rates are also projected for pharmaceutical manufacturing, internet publishing, and medical equipment and supplies manufacturing.

Projected Growth for Priority Industries (Nationally)

| Industry | Projected Annualized Growth Rate for 2015-2020 |
|---|--|
| Biotechnology | 8.3% |
| Pharmaceutical manufacturing (brand name) | 6.2% |
| Internet publishing and broadcasting | 5.6% |
| Medical equipment and supplies manufacturing | 5.3% |
| Scientific and economic consulting | 3.8% |
| Management consulting (inclusive of marketing consulting) | 3.6% |
| IT consulting | 3.2% |
| HR consulting | 3.2% |
| Software publishing | 3.0% |
| R&D in the physical, engineering, and life sciences | 2.8% |
| R&D in the social sciences & humanities | 1.2% |
| GDP | 2.2% |

Source: IBISWorld reports.

Even those industries that are closer to the bottom of this list and may be designated as “mature” are ones that could be shifted back into a “quality growth” status by the confluence of key technological developments that forge new markets and demand for new products.

Most industries studied are characterized by extremely high levels of technological change, even in more mature industries like scientific research and development, and are in fact fueling their own technological change. An array of emerging disruptive technologies is creating as-yet-unshaped opportunities across the IT industry (the Internet of things, artificial intelligence, big data analytics) and the biotechnology / life sciences industry (genomics, biomass energy production). While management and scientific consulting services are typically not drivers of technological change, the pervasiveness of technology, along with the growing importance of sustainable energy, is also a major driver of demand for those services.

Relatedly, high levels of R&D and innovation are necessary conditions for the success of most IT and biotechnology / life sciences industries. And they require a great deal of high-skilled labor. Consequently, many industry players cluster in regions with key higher educational and research institutions, large enterprises in related fields, and innovation support ecosystems that help them attract investment and other resources.

Generally improving macroeconomic conditions are important factors for these industries’ strong growth prospects, and in many cases the aging population and surging demand for and access to health care are also growth drivers, directly or indirectly.

All industries studied here are undergoing some degree of consolidation. But even though merger and acquisition activity is robust throughout the IT and biotechnology / life sciences industries, they continue to feature a high number of new entrants, with successful entrepreneurs and start-ups continually being acquired by larger firms seeking to add niche new technologies and knowledge to their portfolios.

The table below summarizes the industries analyzed in terms of their life cycle stages, market share concentration levels (nationally), levels of technological change, and barriers to entry.



Life Cycle and Other Industry Categorizations

| NAICS | Industry | Life Cycle Stage | Market Share Concentration | Technological Change | Barriers to Entry |
|--------|--|------------------|----------------------------|----------------------|-------------------|
| 51121 | Software Publishing | Quality Growth | Low | High | Medium |
| 51913b | Internet Publishing and Broadcasting | Quality Growth | High | High | Low |
| 51913a | Search Engines | Quality Growth | High | High | High |
| 54151 | IT Consulting (Computer Systems Design) | Quality Growth | Low | High | Low |
| 54161 | Management Consulting | Maturity | Low | Low | Low |
| 54162 | Environmental Consulting | Quality Growth | Low | Low | Low |
| 54169 | Scientific & Economic Consulting | Quality Growth | Low | Medium | Low |
| -- | Biotechnology | Quality Growth | Medium | High | Medium |
| 54171 | Scientific Research & Development | Maturity | Low | High | High |
| 33911 | Medical Equipment & Supplies Manufacturing | Mature/Declining | Low | High | Medium |
| 32541 | Pharmaceutical Manufacturing (brand name) | Maturity | Medium | High | High |
| 32541 | Pharmaceutical Manufacturing (generic) | Quality Growth | Low | High | High |

Source: IBISWorld

All information concerns industries in the U.S. only

Maturity: Company consolidation; level of economic importance is stable

Quality Growth: High growth in economic importance; weaker companies close down; developed technology and markets

Quantity Growth: Many new companies; minor growth in economic importance; substantial technology change

Decline: Shrinking economic importance

Information Technology

Industry Area Description

Camoin Associates has defined an Information Technology industry cluster of particular relevance to the innovation economy and to the N² Corridor's existing and potential strengths. It includes the following industries:¹

- Software publishers
- Internet publishing and broadcasting and web search portals
- Computer systems design and related services (part of IT consulting)
- Cybersecurity

Software publishers are defined as firms that market and distribute software products and that may also design the software, produce support materials and provide support services.

Internet publishers offer nonphysical products, such as news, music and video, and social networking, exclusively through the Internet. Revenue in this industry is derived from the sale of advertising space or subscriptions to consumers, and/or revenue from intellectual property licensing and the sale of user information to third parties. Web search portal firms operate search engines and other types of search-based websites that display advertisements.

"Computer systems design and related services" is an industry comprising a range of companies that provide expertise in the IT field. They may do so by writing, modifying, testing, and supporting software for individual

¹ Definitions are adapted from IBIS reports for the associated NAICS codes.



customers; by planning and designing computer systems; by managing clients' computer systems or data processing facilities; or by providing other computer-related services.

Cybersecurity is a field that cuts across multiple industry designations. While some cybersecurity companies would be classified as providing custom computer programming services, others may be software publishers, computer systems designers, or some other designation; and not all firms in these industries are cybersecurity enterprises. The World Economic Forum characterizes the market opportunity for cybersecurity as embedding security into the lifecycle of products and communications. Applications include secure communications, using big data to identify "insider" risks, a "genetic" approach to malware, software-defined firewalls, security as a service, network instrumentation, and embedded SCADA (supervisory control and data acquisition).²

Industry Market Trends

The IT industry is constantly changing with advancements in technology, new uses, emerging media, and overall increase in the use of technology in nearly every aspect of life. Nearly all IT industries are in the "quality growth" stage of the industry life cycle—that is, they are experiencing high growth in their overall economic importance, weaker companies are exiting the industry, and markets and technology are substantially developed.

All industries reviewed for this analysis are highly dependent on investments in R&D, protection of patents, a highly skilled workforce, and access to the latest available and most efficient technology and techniques. There is significant overlap in their external drivers of demand, with multiple industries' growth driven by increased corporate profits (i.e. the ability of businesses to invest in IT) and the rise of mobile Internet devices. Most of these industries are characterized by the presence of large industry players complemented by a vast number of small firms and new entrants, as well as by perpetual merger and acquisition activity in which the larger firms acquire the intellectual property portfolios of newer niche firms in order to stay competitive in these fast-evolving IT fields.

Each of these IT industries is characterized by a very high degree of technological and product innovation, and are engaged in heavy and continuous research and development investments. Further shifts in technological innovation and the evolution of both consumer and business preferences are expected to propel all of them forward over the next five years. The rise of mobile devices, the Internet of things (IoT), big data and predictive analytics, and cloud computing are common themes driving as-yet unshaped opportunities for the software publishing, Internet publishing, IT consulting, and cybersecurity industries.

Local Industry Performance

Within Newton and Needham, there are close to 5,700 jobs in the IT cluster, a number that has increased by more than 50% over the last ten years. Computer Systems Design, including custom programming and systems design services, makes up about two thirds of cluster jobs, and accounted for about half of the cluster's growth in the last decade. Specifically, the Custom Computer Programming Services subsector more than doubled, adding over 1,100 jobs in the two communities.

Internet Publishing and Web Search Portals tripled its employment over the last decade, adding close to 600 jobs. As of 2015, this industry's national location quotient is 9.23, indicating that this industry's share of total employment is over nine times higher in Newton and Needham as compared to the U.S. overall.

² World Economic Forum, "Risk and responsibility in a hyper-connected world," in collaboration with McKinsey, January 2014.

Average earnings for these industries collectively are more than double the economy-wide average wage of \$74,467 for Newton and Needham.³

Information Technology Cluster, Newton and Needham

| NAICS | Description | 2005 Jobs | 2015 Jobs | 2005–15 Change | 2005–15 % Chg. | 2015 Nat'l LQ | 2015 Avg. Earnings* |
|--------------|---|--------------|--------------|-------------------|-------------------|------------------|------------------------|
| 51121 | Software Publishers | 765 | 1,064 | 299 | 39% | 6.39 | \$137,104 |
| 51913 | Internet Publishing and Broadcasting and Web Search Portals | 298 | 887 | 589 | 198% | 9.23 | \$181,437 |
| 54151 | Computer Systems Design and Related Services | 2,620 | 3,707 | 1,087 | 41% | 3.53 | \$155,823 |
| 541511 | Custom Computer Programming Services | 1,104 | 2,222 | 1,118 | 101% | 4.81 | \$171,121 |
| 541512 | Computer Systems Design Services | 1,400 | 1,355 | (45) | (3%) | 2.74 | \$134,871 |
| 541513 | Computer Facilities Management Services | 22 | 38 | 16 | 73% | 1.16 | \$83,724 |
| 541519 | Other Computer Related Services | 94 | 91 | (3) | (3%) | 1.50 | \$124,593 |
| Total | | 3,683 | 5,657 | 1,974 | 54% | | \$156,319 |

*Includes wages and supplements

Source: EMSI Complete Employment 2015.3

Local Companies

Examples of companies in the N² Corridor that fall under these NAICS codes include Forum Systems and Promisec, both of which made the "Cybersecurity 500" list of the hottest cybersecurity companies to watch in 2016.⁴ The other 33 Massachusetts firms that made the list are concentrated in Boston and Waltham (home to Raytheon).

CyberArk, an Israeli-invested company headquartered in Newton's Wells Avenue Office Park, may be the N² Corridor's highest profile cybersecurity firm. It's notable for having secured the third largest volume of venture capital in Massachusetts in 2011, and is an example of Israeli entrepreneurs choosing Massachusetts as the base from which to pursue the American market.

PTC is an example of a software publisher in the N² Corridor, and is one that is potentially helping to disrupt the field of manufacturing, which constitutes its main market. PTC delivers technology solutions comprised of software & services that help manufacturers and other companies design products, manage product information and improve their product development and services processes. It is helping to define the Internet of things (IoT) field, including through integration of augmented reality (the overlaying of digital data onto the physical

Example Companies

- TripAdvisor
- CyberArk
- Forum Systems
- Promisec
- PTC
- Building36
- Adobe
- Turbine
- EMC

³ EMSI Complete Employment 2015.3. Average earnings include wages, salaries, supplements (additional employee benefits), and proprietor income.

⁴ <http://www.cybersecurity500.com/>

world)—a subject on which its CEO is known for his thought leadership.

Building36, which also operates in the IoT space in the area of home systems automation, just moved back to the N² Corridor and is promoting its “innovation district” location.

TripAdvisor, which is sometimes classified under computer systems design and related services, is the Corridor’s highest profile innovation company, having moved about 1,000 people to its new headquarters there last summer.

Adobe, the major transnational computer software company known for Photoshop, Acrobat, and other universally used applications, has major development operations in Newton but outside the N² Corridor.

Turbine is an online game developer with breakthroughs in free-to-play model and successful long-running titles like The Lord of the Rings Online™ and Dungeons & Dragons Online™. The studio employs more than 350 people, and among those positions available within the company are roles for game designers, artists, animators, programmers, systems engineers, and game testers.

EMC, a data storage provider acquired last year by Dell, is a multinational company has its corporate headquarters in Hopkinton, MA, and a facility in the Wells Avenue Office Park. It is a major player in helping businesses and service providers to transform their operations and deliver information technology as a service (ITaaS).

Regional Ecosystem

Massachusetts and the Boston area in general have tremendous strengths in IT industries,⁵ and are home to a first-rate array of university research and training programs of relevance to IT field.

The state government and various statewide organizations have leaned in to further cultivate Massachusetts’ leadership in several relevant fields. There is a Massachusetts Big Data Initiative, started by MassTech in 2012 under former Governor Deval Patrick, whose mission is to expand the Commonwealth’s position as a world leader in the growing big data industry and enable the region to become the premier global hub for big data innovation and technology. Governor Patrick also held an IoT week during his last year in office. There is an Advanced Cyber Security Center—a nonprofit consortium, launched 2011 and supported by Mass Insight Global Partnerships—that brings together industry, university, and government partners to address the most advanced cyber threats through sharing of cyber threat information, engagement in next-generation cybersecurity R&D, and support for educational programs to address the workforce gap. The Massachusetts Open Cloud project is the first of its kind, a government/industry/university collaboration designed to create new public cloud-computing infrastructure to spur big data innovation.

Software publishers

General Outlook and Life Cycle Position for Software Publishers

Software publishing has grown dramatically over the past five years, and is predicted to experience 3% annualized growth over the next five years (above expected annualized GDP growth of 2.2%), as software becomes more prevalent in day-to-day activities and as a range of technological advancements create new downstream markets for new software products. The industry is marked by a trend, which analysts expect to continue, of large software

⁵ EMSI research; Massachusetts Technology Leadership Council 2015 State of Technology Report.

publishers actively purchasing smaller ones with niche specialties, in order to compete in an ever-increasing array of platforms.⁶

Industry Drivers and Performance Factors for Software Publishers⁷

All major external drivers for the software publishing industry are expected to see positive movement in 2016. These include business and government investment in computers and software; the rapid proliferation of broadband-enabled mobile devices; the flourishing entertainment software sub-industry; and higher rates of personal computers along with increasing per capita disposable income. Advancements in the semiconductor and telecommunications sectors, and the attendant proliferation of computing platforms, are stimulating the development of new software markets.

There is a high level of merger and acquisition churn in software publishing, driven by large companies' appetites for strategic and diverse intellectual property portfolios. This in turn is attracting large numbers of new startups to the industry, which is in turn driving employment growth. The industry is characterized by low barriers to entry and low market share concentration.

Emerging Technologies and Opportunities for Software Publishers⁸

Emerging opportunities in this field will be especially defined by the rise of artificial intelligence and predictive analytics (e.g. software to help businesses use big data to predict demand patterns). Technological advancements are expected to expand product offerings and the potential markets that are served by software publishers. Mobile computing devices are providing new platforms on which software publishers can compete. The rapid move toward cloud computing is opening a wider array of software possibilities for mobile phones and tablets no longer hampered by low storage capacities. Connected cars, logistics, sensors and monitors, as well as smart appliances, are expected to enter the everyday life of American businesses and consumers.

The software publishing industry is undergoing business model shifts, especially toward subscription-based models like software as a service (SaaS) and cloud computing, which produce more stable revenues than the traditional develop-and-release format. This can be seen as an ongoing shift toward software being delivered online.

Internet publishers

General Outlook and Life Cycle Position for Internet Publishers

The Internet publishing and broadcasting industry has grown rapidly and is projected to grow at an annualized rate of 5.6% over the next five years, driven by the fact that its products are an increasingly favored medium for the advertising industry. Growth is not as steadily attributable to the "paid" segment of the industry due to piracy challenges for paid Internet content. Major players like Facebook and Google are expected to capture a large portion of the projected growth. IBISWorld predicts that the industry will continue to be dominated by large, horizontally integrated players and small independent publishers, with very little in between, and with the entry of

⁶ IBISWorld Industry Report 51121: Software Publishing in the U.S., December 2015.

⁷ IBISWorld Industry Report 51121: Software Publishing in the U.S., December 2015.

⁸ IBISWorld Industry Report 51121: Software Publishing in the U.S., December 2015.

another 66,000 new enterprises by 2020. These new entrants' viability is dependent on their ability to attract Internet traffic; most will generate only modest revenue or eventually exit the industry.⁹

Emerging Technologies and Opportunities for Internet Publishers

The rise of mobile broadband-enabled devices is the largest technological change reshaping the Internet publishing industry. There will be increasing demand for mobile content, especially content that can enable interactive advertising with mobile users—think text message ads, media-rich ads, and geolocation-enabled targeted marketing.

IT consulting & Computer Systems Design

General Outlook and Life Cycle Position for IT Consulting

IT consulting—including computer systems design firms—has also been a strong growth industry nationally and is also projected to see strong continued growth of 3.2% (annualized) between 2015 and 2020. This is occurring on the back of improved macroeconomic conditions, favorable shifts in technological innovation, and business trends that have boosted demand for the industry's services.¹⁰

Industry Drivers and Performance Factors for IT Consulting¹¹

Demand for this industry's services is derived primarily from private consumer investment in computers and software; from corporate profit growth enabling large IT investments; from the finance and insurance industry in particular, given its need for products that help them manage large amounts of sensitive client and proprietary data; and from federal and state governments, whose slow budget growth is a potential threat to the IT consulting industry.

Emerging Technologies and Opportunities for IT Consulting¹²

The rise of cloud computing and big data analytics has been very disruptive to traditional IT consulting firms focused on services like on-premise server and software solutions. But this trend is benefiting firms who are able to leverage their expertise toward infrastructure solutions for a cloud-based future, and large firms who are able to shift away from low-profit hardware business segments into high-value-added activities associated with the shift toward integrated computer systems. A clear example of this is IBM's recent divestment of its microelectronics business and investment of billions of dollars to develop a platform-as-a-service (PaaS) and big data analytics segment.

Big data will continue to drive the industry over the next five years, as the IT consulting industry is called on to provide solutions for organizing, managing, and analyzing the increasingly vast volume of data. Like the other industries analyzed here, larger operators are best positioned to compete in this sphere and to benefit from projected growth, but ongoing technological changes will also create opportunities for smaller and newer entrants as well as drive ongoing merger and acquisition activity.

The rise of mobile Internet devices and the Internet of things will help drive change and new opportunities for this industry as well, as they create demand for application and system design.

⁹ IBISWorld Industry Report 51913b: Internet Publishing and Broadcasting in the U.S., September 2015 2015.

¹⁰ IBISWorld Industry Report 54151: IT Consulting in the U.S., October 2015.

¹¹ IBISWorld Industry Report 54151: IT Consulting in the U.S., October 2015.

¹² IBISWorld Industry Report 54151: IT Consulting in the U.S., October 2015.

IBISWorld assesses that despite a concentration of employment growth in the larger end of firm sizes, there are still plenty of opportunities for small-scale IT consultants. Moreover, a comparison of growth in the number of establishments versus (slower) growth in the number of enterprises indicates that there are new locations resulting from expansion among existing firms and widespread acquisition of niche companies.

Cybersecurity

General Outlook and Life Cycle Position for the Cybersecurity Industry

Globally, the cybersecurity market reached \$75 billion in 2015, and is projected to more than double to \$170 billion by 2020.¹³ Cybersecurity is the target of significant venture capital interest; alongside corporate investors, there are several new cybersecurity VC investment funds that have raised hundreds of millions of dollars to invest as of 2015. Corporate investors are major funding sources for cybersecurity startups, alongside the VC firms.¹⁴

Industry Drivers and Performance Factors for Cybersecurity Firms

Banking and financial services constitute the fastest growing non-government cybersecurity market.¹⁵ The U.S. government alone has spent \$100 billion on cybersecurity over the past decade, and after declaring a national emergency regarding the threat of cyberattacks, the president requested a budget of \$14 billion for cybersecurity in 2016.¹⁶ The rise of web-based solutions and the increasing popularity of mobile devices have triggered an explosion of increasingly private and sensitive data, requiring more complex security software products.¹⁷ The mobile security market is exploding with 30%-plus growth projected through 2019, driven by mass-adoption of smart phones, tablets, and other mobile devices by consumers and corporations globally.¹⁸ Foreign demand is also an important driver: The U.S. is the larger exporter of cyber products, with Israel coming in second.¹⁹

Emerging Technologies and Opportunities for Cybersecurity Firms

All of the technological shifts mentioned above—like the move to new computing platforms and the growth of vast amounts of sensitive data—will also create opportunities in the cybersecurity arena, which cuts across many of the industry areas treated earlier. For cybersecurity, the hot areas for growth are security analytics / SIEM (security information and event management); threat intelligence; mobile security; and cloud security.²⁰ During the next five years, as data breaches increase in frequency and intensity, data security firms will benefit from opportunities to develop solutions to these issues, which will boost help boost revenue in industries like IT consulting.²¹

¹³ "Cyber Security Market Worth \$170.21 Billion by 2020," MarketsandMarkets, <http://www.marketsandmarkets.com/PressReleases/cyber-security.asp>.

¹⁴ Steve Morgan, "The Business of Cybersecurity: 2015 Market Size, Cyber Crime, Employment, and Industry Statistics," *Forbes*, October 16, 2015, <http://www.forbes.com/sites/stevemorgan/2015/10/16/the-business-of-cybersecurity-2015-market-size-cyber-crime-employment-and-industry-statistics/3/#1e07d741219120588cdc26f9>.

¹⁵ Morgan 2015.

¹⁶ Morgan 2015.

¹⁷ IBISWorld Industry Report 51121: Software Publishing in the U.S., December 2015.

¹⁸ Morgan 2015.

¹⁹ Morgan 2015.

²⁰ Morgan 2015.

²¹ IBISWorld Industry Report 54151: IT Consulting in the U.S., October 2015.

The multi-trillion dollar global Internet of Things (IoT) market is expected to further lift security research and spending through 2025. A huge but as-yet undefined market for securing non-computer devices will come in to sharp focus over the next few years.²² Automobiles are among them: there's a cybersecurity market emerging around protecting cars from being hacked.²³ PTC is well positioned to exploit these opportunities.

The security analytics sector has emerged out of the broader \$100 billion-plus big data and analytics market. A lot of new startups are getting funded in this crowding sector.²⁴

Professional, Scientific, and Technical Services

Industry Area Description

Camoin Associates has defined a professional, scientific, and technical services industry cluster of particular relevance to the innovation economy and to the N² Corridor's existing and potential strengths. The industry cluster includes the following industries.²⁵

- Management consulting services: Individuals in this profession work with businesses, non-profits and the public sector to streamline overall business procedures through: organizational design, human resources, corporate strategy, information technology strategy, marketing, sales, finances and logistics. The private and public sectors use consultants in this industry to determine the best course forward in efficiency and competitiveness for their market.
 - Human resources consulting: Professionals who work in this subsector of management consulting offer assistance to the private and public sector in dealing with human relations subjects like: resource and personnel policies, employee benefits, compensation systems, wage and salary, recruitment and retention and professional development.
- Other scientific and technical consulting services: In this industry, consultants specialize in a range of subjects, but broadly range in the fields of economics, energy, security, and agricultural sectors. However, nearly 50% of the industry advises on other consulting services.
- Research and development in the social sciences humanities: This industry comprises establishments primarily engaged in conducting research and analyses in cognitive development, sociology, psychology, language, behavior, economic, and other social science and humanities research.²⁶

It should be noted that although there is significant employment in architectural and engineering services, these were not studied; instead we considered these subsectors as part of the real estate cluster that, while high performing, follows and supports an innovation economy rather than driving it.

Local Industry Performance

The professional services cluster grew by 22% between 2005 and 2015, comprising a total of 2,255 jobs in 2015. Management consulting services, and specifically its marketing consulting services sub-industry, drove the majority of this growth. Marketing consulting services doubled its employment over this period, adding 370 jobs.

²² Morgan 2015.

²³ <http://sandhill.com/article/huge-cybersecurity-market-protecting-cars-from-being-hacked/>

²⁴ Morgan 2015.

²⁵ Definitions are modified from IBIS reports for the associated NAICS code.

²⁶ U.S. Census definition for 2012 NAICS.

The “other scientific and technical services” category, which includes specialty consulting activities primarily focused in the areas of economic, energy and mineral, security, and agricultural analysis, also experienced significant growth, doubling and adding over 100 jobs.

Average earnings for these industries collectively are about 36% higher than the economy-wide average wage of \$74,467 for Newton and Needham.²⁷

Newton and Needham’s strength in this cluster represents an asset for the prospects of young tech companies that require management expertise, sometimes from consultants, to grow successfully.

Professional, Scientific, & Technical Services Cluster, Newton and Needham

| NAICS | Description | 2005 Jobs | 2015 Jobs | 2005–15 Change | 2005–15 % Chg. | 2015 Nat'l LQ | 2015 Avg. Earnings* |
|--------------|--|--------------|--------------|-------------------|-------------------|------------------|------------------------|
| 54161 | Management Consulting Services | 1,562 | 1,873 | 311 | 20% | 2.96 | \$98,398 |
| 541611 | Administrative Management and General Management Consulting Services | 820 | 722 | (98) | (12%) | 2.23 | \$100,896 |
| 541612 | Human Resources Consulting Services | 114 | 100 | (14) | (12%) | 2.11 | \$124,401 |
| 541613 | Marketing Consulting Services | 361 | 731 | 370 | 102% | 5.04 | \$92,759 |
| 541614 | Process, Physical Distribution, and Logistics Consulting Services | 233 | 291 | 58 | 25% | 4.58 | \$96,722 |
| 541618 | Other Management Consulting Services | 34 | 29 | (5) | (15%) | 0.56 | \$105,777 |
| 54169 | Other Scientific and Technical Consulting Services | 107 | 214 | 107 | 100% | 1.52 | \$125,771 |
| 54172 | Research and Development in the Social Sciences and Humanities | 174 | 169 | (5) | (3%) | 5.23 | \$109,729 |
| Total | | 1,843 | 2,255 | 412 | 22% | | \$101,605 |

*Includes wages and supplements

Source: EMSI Complete Employment 2015.3

Local Companies

SocialMadeSimple, with about 18 employees, is a seven-year-old social media marketing consulting firm in the Wells Avenue Office Park. SnapApp, located outside the Corridor but in Newton, is a content marketing startup that made headlines when it raised \$12 million in funding in November.

Strategy Analytics, a firm in the Wells Avenue Office Park that at one point reported 50 employees at the location, is also in

Example Companies

- SocialMadeSimple
- SnapApp
- Strategy Analytics
- Cambridge Technology
- American Liver Foundation
- Adelson Medical Research Fund
- Education Development Center

²⁷ EMSI Complete Employment 2015.3. Average earnings include wages, salaries, supplements (additional employee benefits), and proprietor income.

the management consulting industry focused on tactical marketing and technology issues for a range of businesses.

Cambridge Technology is an example of a firm in the “other scientific and technical consulting services” industry, although it is not within the Corridor. Its founders invented galvanometer scanning 40 years ago and designs laser scanning systems for a range of markets, including biomedical, materials processing, and military applications.

The American Liver Foundation, located just inside the Corridor with about six employees, belongs to the “R&D in the social sciences and humanities” industry; they facilitate, advocate, and promote education, support, and research for the prevention, treatment, and cure of liver disease. The Adelson Medical Research Fund is also in the Corridor, with about seven employees. The Education Development Center, a global nonprofit organization with 1,400 employees globally and about 10-19 in Newton (outside the Corridor), conducts health and human development work with funding from a number of government agencies and private foundations.

Camoin Associates considers the Lewis Institute at Babson College, which “activates unexpected and fruitful collaborations and integrative designs for action” with the goal of business prosperity and societal improvement, to be relevant to the “R&D in the social sciences and humanities” industry.

In addition, there are 2,002 self-employed individuals in Newton and Needham in the Professional, Scientific and Technical Services fields, comprising a potential pool of entrepreneurial firms in this sector.

Industry Overview

The overall positive forecast for the U.S economy is beneficial to the consulting industry, as companies who are able to capitalize on the rebounding and growing economy will look to invest their profits in consulting in various subsectors to increase their competitiveness. The following text examines the sub-industries within the defined professional, scientific & technical services cluster, surveying general outlook, industry drivers, and emerging opportunities.

Management Consulting and Human Resources Consulting²⁸

General Outlook and Life Cycle Position

The industry outlook is positive over the next decade for management consulting firms, particularly as a result of overall economic growth prospects. Due to its dependency on macroeconomic conditions, the consulting industry’s profits fell during the 2008 recession and the subsequent years, though it maintained some demand from companies that still had any funds to expend on consultants who could find efficiencies and alternative revenue streams in hopes of mitigating the financial downturn. The overall management consulting industry is projected to grow at an average annual rate of 3.6% over the coming five years. Although the industry features a vast portion of self-employed individuals, IBISWorld predicts that a majority of new contracts will be concentrated in “prestigious” consulting firms like KPMG, PricewaterhouseCoopers and Deloitte. Management consulting is considered a mature industry, as it largely tracks GDP growth, is experiencing an intensification of merger and acquisition activity (especially through acquisition of smaller firms), and provides a set of services that are widely accepted among consumers.

Like other management consultants, business for human resources (HR) consultants has been boosted by the economy’s recovery. Additionally beneficial to HR consultants is the degree to which the entire US economy

²⁸ IBISWorld Industry Report 54161: Management Consulting in the U.S., May 2015.

increasingly depends on service-oriented jobs, arguably raising the importance of employee relations and employee retention within firms. The HR consulting subsector saw annualized growth of 7.1% over the past five years, and is projected to see 3.2% annual growth over the next five, however it is generally considered mature. Newer areas of demand for HR consultants include professional development and nontraditional work arrangements, as the creation of such opportunities becomes more important to businesses needing to attract and retain a highly skilled workforce. The future outlook for the HR consulting sub-industry involves a continued and larger number of mergers and acquisitions, so that larger companies can offer a greater number of services all under one umbrella.

Industry Drivers and Performance Factors for Management Consulting

Corporate profit is the greatest driver of the management consulting industry. Currently, financial services firms are the largest market for HR consultants, so economic recovery translates directly into increases in business for management and HR consultants. Corporate profits have been on the rise in the last five years, however dropping oil and energy prices are a major variable for financial industry profits in coming years. Additional factors that contribute to the stability and growth of the management consulting industry include private investment in physical structures, equipment and software; these are overall indicators of greater investments in businesses' future and tend to be expended alongside additional consulting services to help manage expansion plans.

Although a majority of management consulting revenue is derived from the private sector, public sector clients are also an important source of demand. But public spending on private consultants has been limited in the past five years due to concerns about the federal deficit and state budget woes, and although government consumption is expected to trend upwards, the government will remain vigilant as to the optics of expenditures on consulting services.

Emerging Technologies and Opportunities in Management Consulting

In Management Consulting, increasing digitization of work processes will require management consultants to be called in by companies looking for maximum efficiency. The increased use of technology in business, especially on mobile phones with Internet capabilities, has led many firms to seek the help of management consultants to understand how to weave technology into their everyday service lines. Consultants that can offer solutions for the efficient and effective use of technologies will be valuable to companies large and small. However, there will also be greater competition from other more specialized technology industries, like IT Consulting (discussed elsewhere in this report). Larger consulting firms will look to acquire smaller firms with specializations in IT or other valuable fields, to add to their portfolio of services.

While a majority of revenue for U.S. management consultants is earned within the U.S., expansion to emerging markets in regions like the Asia Pacific and Middle East will be a source of additional revenue. Larger corporations have been opening local offices in these regions to take advantage of growing demand.

In a tie-in to biotechnology, IBISWorld predicts that high merger and acquisition activity in the health care and life sciences fields will help drive growth for management consultants that assist in that activity. Healthcare industry restructuring in the wake of the Affordable Care Act will also continue to offer a source of demand for management consultants.



Scientific and Economic Consulting²⁹

General Outlook and Life Cycle Position of Scientific and Economic Consultants

According to IBISWorld, the scientific and technical subsector of consulting is relatively well positioned to withstand economic instability because it covers a wide range of markets, protecting it from major losses in any one area. In the last five years, the industry's revenue grew by an average annual rate of 5.0%; in the next five, above-GDP growth is expected to continue at an average annual rate of 3.8%. Revenue has performed well because demand for services in the industry have risen, while wages have not grown as quickly.

Markets that have contributed most strongly to the industry's growth in recent years include energy and mining firms, which are frequently required to conduct feasibility or safety studies pertaining to their work. While revenue in the industry grew in the last five years, the total number of firms in the industry has fallen at an annualized rate of 1.3% per year, and 80% of those losses were "non-employers"—typically self-employed individuals. In the same time frame where smaller companies were exiting the industry, the number of large firms increased, albeit slowly, at an annualized rate of 0.5% per year. Merger and acquisition activity is therefore changing the landscape of this subsector, a trend that is expected to continue, yet small scale establishments are expected to remain numerous.

IBISWorld considers scientific and economic consulting to be a growth-stage industry, mostly because it is expanding at a rate almost double that of the overall economy. Other factors that contribute to its classification as a growing industry include a projected increase in the number of establishments due to increased demand, and the continual offering of new services to meet the technological changes common to its markets.

Industry Drivers and Performance Factors for Scientific and Economic Consultants

Like in management consulting, corporate profit levels greatly dictate the market for scientific and economic consultants. Businesses need to have the financial stability and willingness to hire outside firms to assess and report on their standings.

Successful consultants in this field manage their operating costs so they are able to stay competitive in the market but still able to remain flexible and adapt to changing business landscapes. Consultants must strive to stand out among the crowd, through name recognition or specializing in niche markets, all while keeping a pulse on the next direction of business needs. To provide competitive services, consultants in this field must also have access to, and be able to retain, the best workforce available to them.

Research and development (R&D) spending is another driver of this subsector. Although the subsector covers a wide range of markets, energy and mining and agricultural sectors make up a combined quarter of services in this industry. Scientific exploration into alternative energy sources and agribusinesses trickle down to consultants in this field.

Technological and scientific progress has driven industry performance over the last decade and will continue to be a strong determinant of demand. Government-derived demand has been important to the economic consulting segment of the industry during periods like the Great Recession, when such consultants were retained to calculate stimulus package and realign budgets, however this is not expected to provide a stable source of demand going forward.

²⁹ IBISWorld Industry Report 54169: Scientific & Economic Consulting in the U.S., April 2015.

Emerging Technologies and Opportunities for Scientific and Economic Consultants

R&D in the biotechnology-related fields of genomics and pharmaceuticals will benefit the scientific and economic consulting industry. So too will the growing fields of public safety and national security, even as overall government spending slows. Growth in renewable energy fields will also be a boon to the industry, providing opportunities to consulting firms that can offer expert advice and be flexible and keep up to date with new energy technologies. All of these opportunities for consultants in this field will be somewhat dependent on the level of R&D invested in each subject.

R&D in the Social Sciences & Humanities

Revenues for this industry increased by an annualized 4.4% from 2010-2015, with growth projected to slow to an annual rate of 1.2% between 2015 and 2020.³⁰ Market research information regarding this industry is difficult to obtain. For purposes of studying the N² Corridor, we have separated this industry from its scientific research and development corollary because of the latter's high relevance to biotechnology. With a strong location quotient of 5.23 in Newton and Needham, social sciences R&D is also an area of relevance to the innovation economy: It employs highly educated people in key knowledge economy occupations, attracts research funding from outside the community, has strong creative elements, is often cross-disciplinary, and in some cases intersects strongly with technology development in pursuing solutions to health, economic, social, and other problems.

Biotechnology and Life Sciences

IBISWorld defines the biotechnology industry as consisting of companies that primarily use living organisms or molecular and cellular techniques to provide chemicals, food and services that meet human needs; but excludes companies primarily involved in developing small-molecule pharmaceuticals, performing contract research or manufacturing biological equipment.³¹

Camoin Associates, for purposes of analyzing the biotechnology and life sciences cluster in the N² Corridor, has adapted this definition to consist of medical equipment and supplies manufacturing; pharmaceutical manufacturing; and all R&D in the physical, engineering, and life sciences. Pharmaceutical manufacturing is not studied here because it is not present in the Corridor and because of the low competitiveness of Corridor properties for significant new manufacturing operations. Health care, while clearly related to the biotechnology field, is not studied as a part of the cluster; although it is an important source of jobs and a high-growth industry, it is not an innovation industry except in places that are home to a research hospital.

Local Industry Performance

Employment in the Biotechnology and Life Sciences cluster in Newton and Needham remained stable over the last ten years, growing by a modest 4%, or 34 jobs. Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) added 88 jobs over this period, tempering losses in Biotechnology Research and Development and also Surgical and Medical Instrument Manufacturing, both of which lost about 30 jobs.

³⁰ "Forecast: Revenue of Social Science and Humanities R&D (NAICS 54172) in the U.S. from 2008-2020," Statista.com.

³¹ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

Although Biotech R&D lost employment, it still remains highly concentrated in the two communities, with a location quotient over 5, the highest within the cluster.

Average earnings for these industries collectively are about 66% higher than the economy-wide average wage of \$74,467 for Newton and Needham.³²

Biotechnology & Life Sciences Cluster, Newton and Needham

| NAICS | Description | 2005 Jobs | 2015 Jobs | 2005–15 Change | 2005–15 % Chg. | 2015 Nat'l LQ | 2015 Avg. Earnings* |
|--------------|---|------------|------------|----------------|----------------|---------------|---------------------|
| 33911 | Medical Equipment and Supplies Manufacturing | 182 | 145 | (37) | (20%) | 0.86 | \$139,836 |
| 339112 | Surgical and Medical Instrument Manufacturing | 168 | 136 | (32) | (19%) | 2.11 | \$144,821 |
| 339113 | Surgical Appliance and Supplies Manufacturing | <10 | <10 | Insf. Data | Insf. Data | 0.03 | Insf. Data |
| 339114 | Dental Equipment and Supplies Manufacturing | 0 | 0 | 0 | 0% | 0.00 | \$0 |
| 339115 | Ophthalmic Goods Manufacturing | 0 | 0 | 0 | 0% | 0.00 | \$0 |
| 339116 | Dental Laboratories | <10 | <10 | Insf. Data | Insf. Data | 0.27 | Insf. Data |
| 54171 | Research and Development in the Physical, Engineering, and Life Sciences | 518 | 575 | 57 | 11% | 1.83 | \$131,614 |
| 541711 | Research and Development in Biotechnology | 437 | 406 | (31) | (7%) | 5.11 | \$134,970 |
| 541712 | Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) | 81 | 169 | 88 | 109% | 0.72 | \$123,530 |
| Total | | 700 | 720 | 20 | 3% | | \$135,725 |

*Includes wages and supplements

Source: EMSI Complete Employment 2015.3

Local Companies

Verastem and Karyopharm Therapeutics are new biotech arrivals in the Corridor, having come from Cambridge and Natick respectively. A research lab for Celldex Therapeutics is in the same complex on Kendrick Street as Verastem. These companies' primary industry identification is "pharmaceutical and medicine manufacturing," although their facilities in Newton and Needham are also headquarters with R&D laboratories.

Beltronics is a medical equipment and supplies manufacturer in Needham, near but not in the Corridor. It may employ about eight

Example Companies

- Verastem
- Karyopharm Therapeutics
- Celldex Therapeutics
- Beltronics
- Abbott Laboratories
- Knoll Environmental
- Miraca Life Sciences

³² EMSI Complete Employment 2015.3. Average earnings include wages, salaries, supplements (additional employee benefits), and proprietor income.

people. Bird's Hill is a compounding pharmacy outside the Corridor in Needham and also falls into this industry category.

Abbott Laboratories, the pharmaceutical, medical advice, and diagnostics company with 73,000 employees worldwide, has a location just a block or two outside the Corridor in Newton, listed under the "R&D in biotechnology" industry.

Miraca Life Sciences is a Texas pathology laboratory and R&D firm with a presence in the Corridor of perhaps between 10-19 employees.

Regional Ecosystem

Massachusetts is home to 6.3% of biotechnology industry firms nationwide, second only to California's 22.6%, and they are concentrated in the Boston metro.³³ The Boston metro earned Jones Lang LaSalle's ranking as the top life sciences cluster nationally.³⁴ It is home to many elite academic and research institutions (including Harvard and MIT) and world-class medical facilities, including the top three NIH-funded hospitals in the U.S.³⁵ There is a Massachusetts Biotechnology Council based in Cambridge with over 650 member organizations that advocates for the cluster.

BIO considers the Boston metro area to have specialized employment concentration in three difference bioscience subsectors—drugs and pharmaceuticals, medical devices and equipment, and research, testing, and medical laboratories. It named Massachusetts as one of the top leading states for academic bioscience research and development expenditures, which totaled over \$1.4 billion in 2012—putting it 8th in the nation, or 3rd in terms of per capital investment. Massachusetts and its significant biomedical research infrastructure has been awarded \$356 in NIH funding per capita, or more than 5 times the national average. And it is second only to California in terms of attracting biotech venture capital, and well outperforms California on a per capita basis. Massachusetts topped the list for bioscience-related patents per capita between 2009 and 2013.³⁶

According to Jones Lang LaSalle's research, Greater Boston is home to the largest concentration of life sciences researchers in the U.S. and has over 3.75 million square feet of requirements. Moreover, it suggests that life science tenants have recognized the added value the suburbs provide, and that "in contrast to older stock available in Cambridge, the suburbs have afforded occupants the opportunity for office-to-lab conversions as well as brand new development projects, at lower cost."³⁷

Biotechnology (General)

Industry Overview for Biotechnology (General)³⁸

Biotechnology is a high-growth industry with a wide array of diverse fields, markets, and applications. For example, major sources of demand for biotechnology products and services include agriculture (e.g. to increase crop yields) and health care (as an aging population requires more pharmaceutical products with biotechnology inputs). The human health technologies segment constitutes the largest share of the biotechnology industry's products and services (65.8%), according to IBISWorld, followed by the agriculture/aquaculture segment (12.8%), industrial segment (9.2%), environmental remediation segment (6.1%), and animal health, marine, and terrestrial

³³ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

³⁴ Jones Lang LaSalle Life Sciences Outlook, United States, 2015.

³⁵ Jones Lang LaSalle Life Sciences Outlook, Boston, 2015.

³⁶ Battelle/BIO State Bioscience Jobs, Investments and Innovation, June 2014.

³⁷ Jones Lang LaSalle Life Sciences Outlook, Boston, 2015.

³⁸ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

microbial technologies segment (6.1%). Over the past five years, industry revenue has grown an annualized rate of 4.0%, and IBISWorld expects that rate to be 8.3% over the next five years.

There is a trend of vertical integration in which biotechnology companies are being acquired by pharmaceutical manufacturers as the latter face patent expirations and seek new cutting-edge drugs, and as the former seek stable resources for R&D endeavors.

Industry Drivers and Performance Factors for Biotechnology (General)³⁹

According to the Biotechnology Innovation Organization (BIO), the global trade association representing biotech organizations, the five conditions required for future industry growth are technology transfer, specialized facilities, venture/discovery funds, bioscience workforce initiatives, support business climate incentives.

Venture capital, federal funding, and R&D tax exemptions are important sources of investment into this industry, which has high start-up costs and R&D requirements. Biotechnology firms are benefitting from the Affordable Care Act, which provides tax breaks for smaller biotech firms and offers long market exclusivity rights that are attractive to potential investors. The Renewable Fuel Standard that requires ethanol to be blended in to the fuel supply is an example of another federal law that heavily impacts the biotechnology industry: With perhaps 40% of the U.S. corn crop now going toward ethanol production, high demand and prices for corn mean there is a premium on biotechnologies that can increase crop yields. Energy Independence and Security Act of 2007 similarly reinforce demand for sustainable energy, some of which can be provided through biotechnology. And the industry will continue to benefit from federal funding for biological defense.

According to IBISWorld's analysis, six major factors work to promote the development of a biotechnology presence in a geographic area:

- "Availability of venture capital and local entrepreneurship;
- Availability of federal and state government funding and the level of industry regulation and taxes;
- Access to research through universities and government agencies;
- Proximity to a pool of highly skilled personnel;
- Proximity to large private enterprises in many related industries; and
- Proximity to subject of research (i.e. rural areas for agricultural studies and oceans for marine and aquatic studies)."

The Massachusetts biotech industry therefore benefits from the state's high concentration of large pharmaceutical and chemical manufacturing companies. But in addition to the Bay Area and San Diego regional biotech clusters in California, it faces competition from emerging hotbeds of biotech activity in Maryland (home to NIH), the Research Triangle area (NC), and Atlanta, home to the U.S. Centers for Disease Control and Prevention and related higher education research assets.

Emerging Technologies and Opportunities for Biotechnology (General)^{40,41}

Substantial advancement in the knowledge of biological processes and systems, enabled by technological progress in imaging, genomics, informatics, nanotechnology and other tools of modern science, continue to create an environment in which bioscience innovation flourishes. Emerging opportunities are vast, especially as

³⁹ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

⁴⁰ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

⁴¹ Battelle/BIO State Bioscience Jobs, Investments and Innovation, June 2014.

biotechnology becomes increasingly able to solve new problems, and as public acceptance of biotechnology solutions grows.

The following are key examples of emerging or fast-evolving opportunity areas for the biotechnology industry. The pace of several of these developments will depend on public attitudes and regulatory regimes where ethical concerns exist.

- Production of sustainable energy through bio-refinery facilities and technologies
- Developments in gene therapy: This potential application of DNA science could be used to treat diseases using normal genes to replace or supplement defective genes. In a precursor to this, biotech researchers are now creating drugs based on gene sequence that target specific sites in the body.
- Pharmacogenomics, the study of how an individual's genetic inheritance affects the body's response to drugs, will enable people to understand, monitor, and respond to their susceptibility to certain diseases, and could enable people to be treated with more powerful medications that are targeted to their illness and are within the limitations proscribed by their genetic profile.
- Genetically modified or biotech crops will continue to be developed, both in the food and non-food (cotton, trees for paper) categories.
- Rapid prototyping has provided a means for accelerated and affordable design and development of complex components and systems within the industry. Together with flexible manufacturing methods and equipment, this could enable the transition to agile manufacturing systems that will facilitate the development of global biotechnology enterprises with components more easily specified and manufactured across the globe.

Wherever technological advancements can address global challenges there is typically a robust economic opportunity. And biotechnology has bearing on a variety of global challenges, from food security to human health to sustainable industrial production to the environment. The growth of the global and domestic bioscience industry reflects this economic reality with dramatic advancements in fundamental biological knowledge and bioscience technologies being applied to the development and production of novel products and innovative services. Since the turn of this century, biotechnology has been a consistent producer of innovation-driven economic growth, generating jobs, income and output growth for those regional economies with key bioscience assets.

The biotech industry's contribution to U.S. innovation is evident in the fact that the industry has experienced a compound annual growth rate in patent activity of 16.9% over the five years from 2009 to 2013—exceeding the overall rate of 11.9%.

The software and computer services sector is increasingly overlapping with biosciences as bioinformatics, big data analysis, image processing, precision agriculture, and other IT and computing-intensive applications facilitate modern bioscience discoveries and uses. This overlap is expected to continue to grow further.

Medical Equipment & Supplies Manufacturing⁴²

This industry primarily researches, develops and produces nonelectronic medical, surgical, dental and veterinary instruments and apparatus, such as syringes, anesthesia apparatus, blood transfusion equipment, catheters,

⁴² IBISWorld Industry Report 33911a: Medical Instrument & Supply Manufacturing in the U.S., November 2015.

surgical clamps and medical thermometers. It is defined as excluding manufacturers of electromedical and electrotherapeutic apparatus, X-ray apparatus, nonmedical thermometers or ophthalmic goods.

General Outlook and Life Cycle Position for Medical Equipment & Supplies Manufacturing

This industry is more mature than many of the other industries associated with the biotechnology and life sciences sector, having grown an annualized rate of 1.1% over the five years to 2015 and undergoing consolidation. However it is, like the others studied here, being propelled by the ongoing aging of the population and the health care needs associated with longer life expectancy and increased obesity, and is characterized by a high degree of innovation and product development. It is expected to grow at an annualized pace of 5.3% over the next five years.

All medical equipment manufacturing in Newton and Needham is in the category of "surgical and medical instrument manufacturing," the segment that includes surgical dressings, crutches, surgical sutures and prosthetics. Surgical instruments and supplies account for 19.0% of nationwide industry revenue, and the development of next-generation instruments based on new technologies and improved materials will drive segment growth in coming years. Moreover, shortcomings in existing drug therapies will promote the use of surgery in the treatment and management of cardiovascular, neurological, ophthalmic and various other chronic disorders. As demand for surgery increases, so will demand for this segment's products.

Industry Drivers and Performance Factors for Medical Equipment & Supplies Manufacturing

The favorable demographic trends mentioned above are being complemented by healthcare reforms that are expanding access to health insurance coverage, thereby boosting demand for medical supplies. Government and private funding of medical-related research and development is an industry driver. International trade is robust in both directions, and a slight trade deficit might widen as the U.S. dollar gains in relative strength, making U.S. exports more expensive abroad. The future of an excise tax on medical device manufacturing that is part of the Affordable Care Act, but currently suspended, is a threat to profit margins and a strain on firms' drive to innovate, potentially hindering investors' willingness to back start-up companies seeking to commercialize new medical technologies.

Emerging Technologies & Opportunities for Medical Equipment & Supplies Manufacturing

The "surgical and medical instruments" sub-industry is responsible for the largest segment of biomedical patents issued in recent years.⁴³

R&D budgets are expected to remain strong, bringing new products to market that tackle complicated medical needs. Continued industry consolidation will give many smaller manufacturers access to substantial R&D budgets, driving innovation. The expanding home healthcare market is one area that is providing opportunities for new product development. With Massachusetts' strong past performance in bioscience R&D as well as high concentrations of medical devices employment, which cited earlier from the Battelle study, it can be assumed that the Boston area is playing host to substantial portions of this investment and will be the site of related future growth.

⁴³ Battelle/BIO State Bioscience Jobs, Investments and Innovation, June 2014.

Pharmaceutical Manufacturing⁴⁴

Although Camoin's employment data sources do not show employment in the pharmaceutical manufacturing industry, we know that highly innovative local biotech firms like Verastem and Karyopharm are involved in such manufacturing. This may be the case with other biotechnology and medical research companies in Newton and Needham, or with biotech companies that would be appealing industry attraction targets for the N² Corridor.

Camoin Associates has focused its research on the brand name segment of this industry, since it is characterized by patent protection, while generic pharmaceutical manufacturers typically are not significantly engaged in the research and development of new drugs.

General Outlook and Life Cycle Position for Pharmaceutical Manufacturing

This industry grew at an annualized rate of 0.5% from 2010 to 2015, a low growth period that was largely attributed to the "patent cliff." We are in the midst of one of the largest waves of drug patent expirations in history, which greatly intensified intensifying competition and cut into revenue growth as low-price generic drugs were allowed to inundate the market.

However over the next five years to 2020, industry revenue is forecast to grow at an annualized rate of 6.2%. In 2015 alone, revenue was anticipated to grow 3.7%, driven by robust demand for biologic drugs as well as companies' recovery from the patent cliff.

Industry Drivers and Performance Factors for Pharmaceutical Manufacturing

As is the case for the other medical-related industries researched here, the aging U.S. population and the increasing number of people with access to health care are drivers of demand for the pharmaceutical manufacturing industry's goods. Relatedly, Medicare and Medicaid are important facilitators of demand. However, growth from these sources of demand is also shaped by government and private health insurance providers who, concerned with mounting healthcare costs, have attempted to stimulate generic drug use by setting favorable reimbursement rates for generic drugs, threatening overall industry growth. Disease rates and prevalence of chronic illness are also determinants.

R&D investments, since they lead to new drugs being released, are a key ingredient in future growth. In addition to private investment, federal research funding—most of it through the National Institutes of Health—is therefore a driver of the industry's performance.

The U.S. is a net importer of manufactured pharmaceuticals, but foreign demand is an important component of overall demand, accounting for an anticipated \$39.3 billion in sales in 2015. The European Union and Canada are top destinations for U.S.-manufactured pharmaceuticals. According to IBISWorld, location decisions by the industry for clinical trials appear to align more closely with pharmaceutical sales than with available patient populations; strong pharmaceutical sales in the United States have caused many manufacturers to invest in R&D and drug testing domestically.

To cut costs and have the resources necessary to invest in R&D-related expenditures, the industry will continue to consolidate. As a result, the number of industry employees is expected to decline somewhat over the next five years even as the number of operators increases, as small biologic drug makers enter the market.

⁴⁴ IBISWorld Industry Report 32541a: Brand Name Pharmaceutical Manufacturing in the U.S., November 2015.

The recent proliferation of small biotechnology companies suggests that the barriers to entry are falling. These companies benefit from government tax incentives, which target small pharmaceutical manufacturers in particular. Nonetheless, major players control a significant share of high-value global products, and new industry entrants will grapple with matching the level of R&D-related expenditures needed to succeed in this industry. Significant capital investments are required to establish manufacturing plants geared to produce drugs.

The West and Mid-Atlantic regions are the most prominent pharmaceutical and drug manufacturing regions in the United States, comprising 22.4% and 20.5% of total establishments, respectively. Pfizer, Merck and GlaxoSmithKline are all located in the Mid-Atlantic region. Geographic clustering of industry operators yields benefits for pharmaceutical manufacturers in terms of a local specialized workforce, experienced business services, and availability of facilities that are often highly specialized and expensive to build.

Emerging Technologies and Opportunities in Pharmaceutical Manufacturing

The industry relies on advances in medical technology to develop new products that address unmet needs; nevertheless, the pace of development has slowed considerably, while the cost of R&D has risen dramatically. The development of blockbuster drugs has been slowing, making it difficult for research-intensive pharmaceutical companies to recoup their R&D costs with multibillion-dollar products as in the past. Consequently, R&D focus is shifting to less lucrative products or those that occupy niche product segments.

Many brand-name manufacturers have included biotechnology, particularly biologic drugs, in their product portfolio. Biologics are biologics, which develop immunizations and vaccines. Biologics are genetically-engineered proteins derived from human genes—they are “manufactured” in a living system, often using recombinant DNA technology. They often represent the cutting-edge of biomedical research and, in time, may offer the most effective means to treat a variety of medical illnesses and conditions that presently have no other treatments available. Pharmaceutical manufacturers invested R&D resources into biologics during the patent cliff, and they represent a key growth area for the industry; however, over the next five years, patents in that category will begin to expire and open the door for “biosimilars” (their generic counterpart). In anticipation of this, brand-name pharmaceutical manufacturers will move toward including both biologic and biosimilar production in their product portfolio. The timing of market exclusivity regulations will significantly shape this industry’s growth.

Bioinformatics, a branch of biotechnology using information technologies to work with biological data like DNA, is a particularly dynamic new area of work.

Investments in R&D for orphan drugs—pharmaceutical agents developed specifically to treat a rare medical condition—are expected to generate high returns for the industry and constitute an increasing portion of companies’ drug pipelines.

IBISWorld expects that manufacturers will undergo a continued shift in focus toward patients, such as by providing streamlined patient care from drugs to technological applications; an example of this is applications that assist users with blood glucose management.

R&D in the Physical, Engineering, and Life Sciences⁴⁵

This industry only includes companies and organizations whose primary purpose is R&D and excludes players such as pharmaceutical or manufacturing companies that may undertake R&D to support their primary operations. Government entities, though they may contract and fund such research, are also excluded.

Biotechnology is one of the most active fields of research and development (R&D). Investment in R&D promotes new drugs and vaccines, disease-resistant crops, enzymatic manufacturing processes and methods of dealing with hazardous materials.⁴⁶

General Outlook and Life Cycle Position for Physical, Engineering, and Life Sciences R&D

This is a mature industry whose growth is largely tracking the overall economy. In the five years to 2015, industry revenue is estimated to have grown at an average annual rate of 3.0%; it is projected to continue to grow at an average annual rate of 2.8% over the next five.

Industry Drivers for Physical, Engineering, and Life Sciences R&D

Increasing R&D expenditure across the economy generally leads to more business being outsourced to companies in this industry. Federal government funding is a major industry driver; stimulus spending provided several years' boost to the industry, but a reduction in that funding due to sequestration and a decrease in troops stationed overseas (reducing demand for new defense technologies required for military occupation) has hurt industry growth. Private investment is predicted to increasingly fill in this investment gap and enable long-term growth despite weak government funding.

The healthcare sector represents a significant source of demand for industry services. A rapidly aging population and rise in obesity-related chronic illnesses spurs demand for new healthcare and social-assistance products and services.

Low interest rates are an important ingredient for stimulating investment into physical, engineering, and life sciences R&D, as it encourages private investment outside low-yield bank accounts, and makes it cheaper for the industry to borrow. With interest rates expected to rise, this growth factor will be dampened.

Increased R&D expenditure in biotechnology, specifically, encourages new industry biotechnology product development, which in turn boosts overall biotechnology industry revenue. R&D expenditure is expected to increase in 2015, which may present an opportunity to industry operators.⁴⁷

Emerging Technologies & Opportunities for Physical, Engineering, and Life Sciences R&D

In recent years, government funding specifically for biotech R&D has risen, for example on stem-cell research and biofuel initiatives intended to develop alternative energy sources. In general, strong biotechnology growth has led to increased demand for scientific R&D related to biotechnology.

The rise in share of private funding for this industry has led to some fragmentation, with private investors more willing to invest in niche, start-up enterprises than the government.

⁴⁵ IBISWorld Industry Report 54171: Scientific Research & Development in the U.S., November 2015.

⁴⁶ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

⁴⁷ IBISWorld Industry Report NN001: Biotechnology in the U.S., November 2015.

Government funding for environmentally friendly technologies has increased significantly over the past five years and represents a major growth area for the industry. Work in this area includes the development of production techniques and goods that reduce the speed of climate change, as well as the development of renewable energy sources.

Nanotechnology will be one of the most important sectors of research over the next ten years. This technology has the potential to revolutionize a wide array of fields, including medicine and other fields in this R&D category. IBISWorld notes the example of the recent development of the 3D particle tracking microscope, which is facilitating breakthroughs in microbiology and immunology.

Medical diagnostic imaging R&D is another growing field for the industry; related equipment is also linked to bio and nanotechnology research.

The industry's materials-technology segment, which deals with the development of materials that can survive extreme environments, is another emerging opportunity area. Materials-technology R&D also involves developing products that have greater strength-to-weight ratios (e.g. carbon fiber). Energy-saving applications and environmentally beneficial developments often come out of this research and may stimulate substantial funding for the industry in the future.

Priority Industry Real Estate Needs

According to Jones Lang LaSalle's research, technology companies have been responsible for the largest share of leases 20,000 square feet or larger across the U.S. in recent quarters, and 73 percent of those leases represented occupancy growth. It also notes that start-up founders and mature companies alike are increasingly considering the viability secondary and tertiary markets as a business location instead of moving to, for example, East Cambridge, where the average asking rent for 2015 Q3 was \$67.21 per square foot. It cites high rent costs in the hottest tech neighborhoods as the primary driver of this reconsideration.⁴⁸

JLL considers Boston to present both high start-up opportunities (in terms of concentration of innovation, talent, and existing tech) and high costs, putting it in the same quadrant of the JLL "locator matrix" as New York City and Silicon Valley, though not as extreme by either metric.⁴⁹

JLL's research indicates that Greater Boston's life sciences industry has over 3.75 million square feet of requirements. In addition to acknowledging the attractiveness of Cambridge and Boston's downtown, JLL reports that life science tenants have recognized the added value the suburbs provide, and that "in contrast to older stock available in Cambridge, the suburbs have afforded occupants the opportunity for office-to-lab conversions as well as brand new development projects, at lower cost."⁵⁰ Increasingly tight conditions in Kendall Square and the Seaport submarkets are leading smaller tech companies to "stretch the traditional boundaries to find locations to grow as larger, more established companies quickly snap up space."⁵¹

However, JLL's report regarding suburban real estate availability for the life sciences sector is focused on Waltham, Watertown, Bedford, Lexington, Beverly, Woburn, Medford, and Wilmington.⁵²

⁴⁸ Jones Lang LaSalle Technology Office Outlook, United States, 2015.

⁴⁹ Ibid.

⁵⁰ Jones Lang LaSalle Life Sciences Outlook, Boston, 2015.

⁵¹ Jones Lang LaSalle Technology Office Outlook, United States, 2015.

⁵² Jones Lang LaSalle Life Sciences Outlook, Boston, 2015.

Also of note, JLL reports that life sciences firms are trying to foster innovative environments by modifying traditional lab configurations to provide more options for teamwork and collaboration. Firms are also investing in more state-of-the-art lab space to conduct highly specialized biopharma research. JLL reports that the large cost of developing in core markets like the Boston area will inspire firms to rent more space in the future, rather than construct new buildings. It also states that landlords of second-generation and older lab facilities will need to invest in renovations and upgrades to attract tenants and maintain occupancy levels. And as consolidation occurs in the life sciences, with big pharma continuing to acquire small new firms, companies will seek to renovate older facilities to meet the needs of younger employees or seek out new space that does.⁵³

⁵³ Jones Lang LaSalle Life Sciences Outlook, United States, 2015.



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