



CORRIDORS AND TECH REGIONS: INTERNATIONAL CASE STUDIES



ROUTE 128 BOSTON, MASSACHUSETTS

ROUTE 128 BOSTON, MASSACHUSETTS: TECHNOLOGY, INNOVATION AND DIVERSITY WITH INTEGRATED REGIONAL PLANNING

The Boston / Route 128 / Route 495 area is one of the leading high-tech areas in the world. Known for its leading universities (there are 114 colleges and universities in Massachusetts, including Harvard and MIT), it has the second largest concentration of venture capital companies in the United States. Worth over \$360 billion, the Greater Boston metropolitan area has the sixth-largest economy in the US and 12th-largest in the world.

Technology and innovation leadership has been built up over 100 years, and has proved adaptable to changes in market preferences and industrial trends. Boston has a world-class set of research institutions, pushing the frontiers of knowledge in a variety of fields including cancer research, cloud storage, robotics, and nanotechnology. Its eight research universities are all less than 10 miles from downtown Boston.

Diversity, entrepreneurship and innovation – backed by capital. What constitutes 'high tech' has grown more diverse throughout the region. Research, development, and manufacturing related to biotechnology, pharmaceuticals, and medical equipment has grown. Internet-related companies are also well represented. Crucially, the region remains a vital and active source of innovation and start-ups. Massachusetts ranks first amongst U.S. states for venture capital investment as a percentage of Gross State Product.

Boston is emerging as a leading global innovation biotechnology cluster. The Boston area boasts nearly 30,000 scientists and other workers directly involved in biotechnology, pharmaceutical and clinical research – the highest concentration of life-science research workers in the U.S., according to the U.S. Bureau of Labor Statistics.

Boston has been a financial services centre for more than 300 years, and as a result there is a plentiful supply of venture capital, with both the city's technology and biotechnology clusters benefiting from strong links to investors. This ability to commercialise scientific ideas and research has been the city's biggest advantage in biotechnology and life sciences.

Metro- and regional – level strategy, planning and delivery. There is significant collaboration in the provision of infrastructure, land and area-based initiatives such as Innovation Districts. Economic development is integrated with land-use planning. Although there are many challenges of growth (such as income inequality, ageing transport infrastructure, housing shortages and workforce development) – the integrated regional approach means that Boston/Route 128 are better placed than most to understand and plan for them.



ROUTE 128 BOSTON, MASSACHUSETTS: TECHNOLOGY, INNOVATION AND DIVERSITY WITH INTEGRATED REGIONAL PLANNING

INTRODUCTION

After World War II, the Route 128 highway became the locus of high-tech development in the area and, in what became known as the 'Massachusetts Miracle.' The Boston region entered the 20th century as a manufacturing hub for shoes and textiles and emerged at the century's end as a global node of financial services and high tech innovation. After World War II, the Route 128 highway became the locus of high-tech development in the area. Defence contracting and emergent micro-computing combined with Boston's traditionally strong base of skills and research brought sudden growth and prosperity to the area.

Despite suffering decline in the late 1980s/early 1990s, the Boston region has since re-emerged as a global hotbed for technology, R&D and entrepreneurship. Even though the area's three critical industries began to struggle simultaneously (defence research contracts dried up, the finance bubble ended, and the micro computing industry collapsed), the Boston region has made a very successful transition.

The Boston / Route 128 / Route 495 area is one of the leading high-tech areas in the world. It is known for its leading universities (there are 114 colleges and universities in Massachusetts, including Harvard and MIT). It has the second largest concentration of venture capital companies in the United States. Massachusetts ranked overall #1 in the US in the State Tech and Science Index (Milken Institute). It ranked #1 for percentage of population with a Bachelors Degree or higher, #2 for Academic & also Industry R&D dollars per capita, #2 for patents issued per 100,000 people, and #1 for venture capital investment as a percent of Gross State Product. It has been estimated that tech sector generated US\$91 billion in total value added, with a direct employment in Tech., Clean Energy, and Bio-Pharma equaling 440,000 persons, 13 percent of Massachusetts employment (MassTLC 2014, and 2015 reports). Boston area start-ups have raised more than US\$38 billion in capital over the last several years.





The founding of the 'Massachusetts Miracle'

Route 128 embraces the Greater Boston area in Massachusetts. The expansion of the high tech industry along the Route 128 highway surrounding Boston and Cambridge has led to the term 'Route 128' meaning more than the road itself, but the technology area as a whole. Based on the research strengths of the region's universities as well as a diverse, mature, and entrepreneurial industrial base, the world's first high-tech industrial cluster began during and just after the Second World War.

Massachusetts has had a long history of technological innovation. The state could claim to be the birthplace of numerous industries. In the early 1900s, many area scientists, inventors, businessmen, and investors were focusing on the new field of electrical sciences. Research labs at Harvard and the Massachusetts Institute of Technology (MIT) pioneered technologies using electrical currents, magnetic fields, and advanced circuitry.

When World War II started, the unique academic and research infrastructure in eastern Massachusetts was leveraged in national defence. The area became the centre for research in microwaves for radar. This research resulted in the first practical digital computer, and sowed the early seeds of the US computer industry.

Following World War II, the Route 128 highway was built around Boston, providing the transportation infrastructure to support the coming economic growth. The finished expressway provided a way for drivers to circumvent Boston traffic. But Route 128 turned out to be much more than a convenience for motorists; it quickly evolved into the nation's first high tech corridor. The area's economy was going through a profound transformation at this time. Light industry, garment, leather and machinery were being outsourced to areas rich in energy resources and cheaper labour. High-tech industry was still in its infancy and new industries driven by science and technology were seeking space for development.

Realising that the Route 128 corridor would be a perfect place for growing companies to locate, real estate developers began to build the first modern industrial parks. In addition to being affordable and easily accessible by car, the parks were close to university labs and to each other. The Massachusetts Institute of Technology's and Harvard's strong research capabilities attracted new industries and R&D bases to settle in their vicinity. The areas along Route 128 possessed not only open space and inexpensive land, but also a large pool of unemployed workers with technical proficiency – left behind with the migration of traditional industries. Soon there was a critical mass of researchers, entrepreneurs, and investors.

Between 1950 and 1957, Route 128 attracted a total of nearly \$100 million capital investment. In 1955, there were 53 businesses along Route 128. The figure soared to 223 in 1959 and 729 in 1967, with 66,000 employed workers. The land price also increased from the initial \$450 per acre to \$5,000 per acre by 1957. Rapid growth ensued in the 1960s, by which time the Route 128 corridor was becoming one of the nation's major technology centres.

However, from the end of World War II until the 1970s Boston was in decline. During this period, the city's population crashed - from more than three quarters of a million to barely half a million, and



industry stagnated. The mid 1970s were especially bleak. Boston gained a reputation for decline, deindustrialisation, financial crisis, urban strife, racial tension, and white flight.

In the 1970s, the cluster effects of the high-tech industries along Route 128 began to gradually manifest themselves. Between 1975 and 1980, 225,000 new manufacturing jobs were created, mostly in high-technology industries. It was at this time that Boston became the epicentre of the minicomputer revolution. The rapid growth in commercial demand for minicomputers created new local tech giants, including Digital Equipment Corporation, Wang, Prime Computer, Data General, and Apollo. This growth also spawned numerous spinoffs that helped solidify the transition of the local economy from its manufacturing base.

Minicomputer research and development fuelled such growth in the state's economy that the media and politicians referred to 'the Massachusetts Miracle'. As the area moved further away from its traditional reliance on heavy industry, Boston boomed, bucking the national recession of the early 1980s on the back of increased Cold War spending, the rise of new financial services and the emerging importance of technology. The growth of microcomputer manufacturing began a trend towards the building of new knowledge-intensive industries in Boston. By 1990, Massachusetts contained over 3,000 high-technology firms. Boston suddenly became "an entrepreneur's haven where in one case 39 new businesses span out from one major electronics firm¹." The boom saw a leap in incomes from below the national average to 20 per cent above it, a fall in unemployment from 15 to 3.5 per cent, and a tripling of local property prices.

THE 'MIRACLE' OF ROUTE 128 HAS BEEN ITS ABILITY TO RESPOND AND ADAPT TO DOWNTURNS AND CHANGING MARKET CONDITIONS

But this 'miracle' (as developed in the 1960s and 1970s) was short-lived as Boston's three critical industries began to struggle simultaneously. Defence research contracts dried up at the end of the Cold War. Boston's financiers, who had pioneered mutual funds, money-market funds, and stock-transfer services, all suffered as the 1980s financial services bubble ended. But perhaps most importantly, the micro computing industry collapsed due to the inability of minicomputer manufacturers to respond to the personal computer – while Silicon Valley sped ahead with innovation across a diversifying range of components and systems. Overbuilding, speculation in real estate, and generally deteriorating economic conditions added to the downturn. The city lost 350,000 jobs in the following recession. Many start-ups and a few well-established companies failed. In a three-year period, minicomputer manufacturers lost over 40,000 jobs. The state ended the 1980s having lost its position as the most prominent high-tech region in the US.

In the early 1990s, Massachusetts, like most of the North East, was much more severely affected by the early 1990s recession than the country as whole, with unemployment reaching almost 9 per cent by the summer of 1992. However, Massachusetts recovered from the recession faster than the rest of the North East, helped by the nationwide tech-boom of 1990s. The latter half of the 1990s were marked by tight

¹ The Christian Science Monitor, April 19, 1989, P8, Is the Massachusetts Miracle Fading?



labour markets and fast growth fuelled once again by the knowledge intensive technology and financial services sectors. From 1990 to 2000, the Boston region's innovation economy grew and diversified, with job gains of 313,000 shared across nearly every major industry. By the end of the decade the unemployment rate fell below 3 per cent and the city's population was growing again.

However, the city was about to receive a further knock as the area's technology industries suffered during the nationwide recession from 2000 to 2003, with technology manufacturing in the region taking a particular hit. From 2000-2010, two recessions erased many of the gains made during the previous decade, with a loss of 113,000 jobs. Over the decade, Education & Health Services and Professional & Business Services and Leisure & Hospitality added jobs. These sectors contracted: Manufacturing; Professional & Business Services; Information; Financial Activities; and Wholesale and Retail Trade.

However, the diversity of the area's economy by this stage meant that it did not repeat the damaging effects of its reliance on three major industries during the late 1980s. Recently, with the development of new fields of technology – especially software, biotechnology and fiberoptics – the state's high tech sector has recovered. What constitutes 'high tech' has grown more diverse throughout the region. Research, development, and manufacturing related to biotechnology, pharmaceuticals, and medical equipment has grown. Internet-related companies are also well represented. Crucially, the region remains a vital and active source of innovation and start-ups.

And after decades of declining and then slow population growth, the 2010 Census showed a rebound, with Boston's population exceeding 600,000 for the first time since 1970. Population growth has reflected an influx of newcomer immigrants, young adults, families with children, and downsizing Baby Boomers.

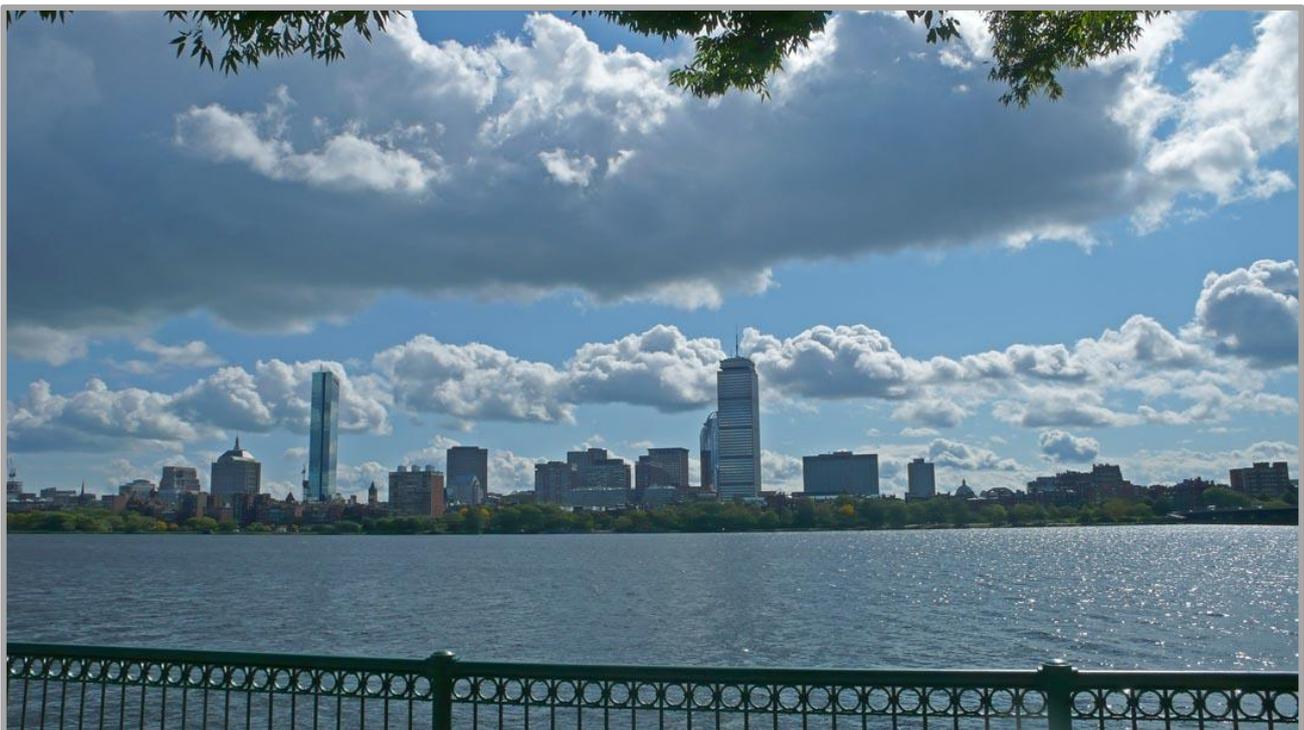


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THE ECONOMY AND RATIONALE FOR SPATIAL INTEGRATION

Scale and nature of the Route 128 economy

Worth over \$360 billion, the Greater Boston metropolitan area has the sixth-largest economy in the US and 12th-largest in the world. With about 10 per cent of Massachusetts's population, Boston accounts for 18 per cent of the state's jobs.

The Greater Boston economy is increasingly knowledge-based. Employment in high-skill jobs requiring at least a college degree, as a share of total regional employment, has grown steadily over the last decade, from 23 per cent of total jobs in 2004 to 32 per cent in 2012. The region's highly educated workforce and ready capital have attracted and helped to expand such 'new economy' clusters as insurance and financial services, computer hardware and software, medical care and life sciences, high tech manufacturing, technical and business services, materials development and clean-tech energy. These sectors, often in partnership with the public sector, have generated multiplier effects such as job growth across other industries, from real estate to hospitality. Boston and Cambridge are the region's most concentrated locus of talent, expertise and innovation, with renowned institutions for higher education, culture and medicine.

Greater Boston's economy has thrived on the ability of entrepreneurs to innovate, which has resulted in a high rate of new patentable technologies. In the last decade, patents issued to Boston residents have grown by 8.3 percent per year. The Boston metropolitan area has accounted for more than a quarter of all patents issued in Massachusetts in the last decade. The top classifications for patents issued to Boston residents are medicine and computing.

The region's economy was relatively resilient during the Great Recession due to its leadership and innovation in science and technology development. From the Great Recession's trough in 2009 through to 2010, the Metro Boston economy grew by 4.8 per cent – the highest rate among all large US metros. Since the end of the recession in mid-2009, Boston has experienced a period of strong growth, with the high tech sector increasing employment by around 9 per cent per year, adding 9,319 jobs. High-tech employment in Boston grew from 4.6 per cent to 6.0 per cent, as a proportion of total employment, from 2010 to 2014.

Strong growth has been particularly concentrated in two sectors: Computer Systems Design and Software Publishing. Computer Systems Design has seen employment more than double since 2010, adding 6,145 jobs. Software Publishing has added another 1,527 workers, increasing its size by 158 per cent over the four-year period. Other large area tech industries have continued their strong presence in Boston. Scientific Research & Development and Architectural & Engineering Services combine to make up 44 per cent of Boston's high tech sector.



High rankings reveal the extent of economic leadership and successful performance

Greater Boston and the wider Massachusetts area rank highly on a number of economic indicators.

Metro Boston ranks:

4th highest of the nation's largest metros in the percentage of adults aged 25 years or older with a BA or higher at 43 per cent;

4th globally in patent filings, accounting for 7.2 per cent of all patents filed in the US and 2.5 per cent of all patents filed worldwide;

4th largest cybercity in the United States with almost 200,000 high-tech jobs;

5th in the nation in clean-tech industry growth (SustainLane);

3rd highest of the top 25 metros for its labour force participation rate.

In 2011, Boston was also ranked the top 'global innovation city' by 2thinknow, and was listed by Mercer as third to Honolulu and to San Francisco among US cities and 36th worldwide in its quality of life. In a study reported on in The Atlantic, Richard Florida ranked Boston 6th among the top 25 most economically powerful cities in the world – ahead of Beijing, Hong Kong and Sao Paulo. The study was based on gross regional product, the region's banking and financial institutions and its innovation index. 2014 marked the 20th consecutive year that Boston received the most National Institutes of Health (NIH) funding of any U.S. city.

Among all US states, Massachusetts ranks:

1st on the State Technology and Science Index (2014, Milken Institute);

2nd for technology employment as a percentage of total employment (2013, National Science Foundation);

2nd for bachelor's degree holders in the workforce (2011, National Science Foundation);

6th in total R&D funding, with nearly \$2.5 billion, and 3rd in per capita R&D funding with \$373 per capita (2009).



Major firms

Companies along or inside I-95 (Route 128), not including Boston:

Akamai Technologies, in Cambridge (HQ)
 AstraZeneca, in Waltham (R&D)
 BBN Technologies, in Cambridge (HQ)
 Biocell Center, in Medford (North American HQ)
 Biogen Idec, in Weston (North American HQ)
 Carl Zeiss SMT, in Peabody (North American HQ)
 Constant Contact, in Waltham
 Dunkin' Brands, in Canton (HQ)
 Facebook, in Cambridge
 Genzyme Corporation, in Cambridge (HQ)
 Genzyme Corporation, in Waltham (R&D)
 General Electric Aviation, in Lynn
 Google Inc., in Cambridge
 Haemonetics, in Braintree
 IBM, in Waltham, Cambridge and Littleton
 InterSystems Corporation, in Cambridge (HQ)
 iRobot Corporation, in Burlington (HQ)
 Keurig, in Reading (HQ)
 Mediatech, in Westwood (HQ)
 Microsoft Corporation, in Cambridge
 Millennium Pharmaceuticals, in Cambridge
 National Amusements (Parent company of CBS and Viacom), in Dedham (HQ)
 National Grid, in Waltham (US HQ)
 NetApp Inc, in Waltham
 Nokia, in Burlington
 Novartis AG, Inc, in Cambridge (Research HQ)
 Novell, Inc., in Waltham
 Nuance Communications, in Burlington
 Oracle Corporation in Burlington
 Osram Sylvania in Danvers (HQ)
 Parametric Technology Corporation in Needham (HQ)
 Philips Lighting in Burlington
 Progress Software in Bedford (HQ)
 Raytheon, in Waltham (HQ)
 Reebok, in Canton (U.S. HQ)
 SunSetter Products, LP, in Malden (HQ)
 Teradyne, in North Reading (HQ)
 Thermo Fisher Scientific, in Waltham (HQ)
 TripAdvisor, LLC, in Needham (HQ)
 Twitter, in Cambridge
 Vistaprint, in Lexington (North American HQ).

Major companies inside Boston:

American Tower (HQ)
 Au Bon Pain (HQ)
 Bain & Company (HQ)
 Bentley Motors (U.S. HQ)
 Blue Cross Blue Shield of Massachusetts (HQ)
 Boston Consulting Group (HQ)
 Fidelity Investments (HQ)
 The Gillette Company, now owned by Procter & Gamble (HQ)
 Houghton Mifflin Harcourt (HQ)
 John Hancock Financial Services, Inc, now the United States division of Canada's Manulife
 Financial Liberty Mutual (HQ)
 LogMeIn (HQ)
 LPL Financial (HQ)
 New Balance Athletic Shoe, Inc. (HQ)
 Putnam Investments (HQ)
 Sapien Corporation (HQ)
 Sonesta International Hotels Corp. (HQ)
 State Street Corporation (HQ)
 Steward Health Care System (HQ)
 Vertex Pharmaceuticals (HQ)
 Wayfair (HQ)
 Wellington Management Company (HQ)
 Zipcar (HQ).



REASONS FOR SUCCESS

The triple helix

The underlying premise of Route 128 is that the long term success of the Massachusetts economy has been the result of the close association between academia, the federal government and private industry – leading to a cluster of high technology-based firms in the area, new fields of research, novel inventions, spin-off companies, entire new industries, new academic disciplines and innovative federal agencies such as the National Science Foundation.

Boston has a world-class set of research institutions, pushing the frontiers of knowledge in a variety of fields including cancer research, cloud storage, robotics, and nanotechnology. Eight research universities – Boston College, Boston University, Brandeis, Harvard, MIT, Northeastern, Tufts and the University of Massachusetts Boston – are all less than 10 miles from downtown Boston. The city is also home to four medical schools and 16 teaching hospitals. These permanent institutions attract a wide range of talent, employ thousands of people and provide a significant source of local investment.

Boston's colleges and universities have a significant impact on the regional economy. Boston attracts more than 350,000 college students from around the world, who contribute more than \$4.8 billion annually to the city's economy. The area's schools are major employers and attract industries to the city and surrounding region. The universities also employed more than 50,000 and conduct \$1.5 billion in research every year. Massachusetts receives more Government research investment per capita than any other state in the US. In 2014, Boston received the most NIH funding of any U.S. city for the 20th consecutive year. Forty-six Boston institutions received 3,521 NIH awards for more than \$1.7 billion in funding. Cambridge institutions also received 565 NIH awards for \$331 million in funding.

The area is home to leading technology companies. A 2001 Brookings Institution study examined 14 American technological hubs and found Boston to be one of only three American cities that have “large high-tech complexes”. The city was also one of only three cities to have higher than average employment in four critical high-tech sectors: computer manufacturing, software publishing, data processing and computer system design. The report noted that while most high-tech cities specialise in one area, these three cities managed to develop various different technology clusters.

More recently, a 2014 report by Jones Lang LaSalle ranked Greater Boston the second-largest tech industry in the nation behind Silicon Valley. The firm's 'High-Technology Office Outlook', revealed a 4.3 per cent annual increase in the number of technology jobs in Boston, amounting to 146,000 tech jobs. By contrast, Silicon Valley's market in California grew 5.2 percent, leaving the area with a total of 214,000 tech jobs. Google, Amazon and TripAdvisor contributed the most to Boston's high-tech growth in 2014.

Boston's has a number of homegrown technology companies such as iRobot, Akamai, PTC, Constant Contact, EMC, and HubSpot. Others have moved to the area, including Facebook, Amazon, Oracle, Google, and Microsoft. In the past five years, major companies have opened or expanded their research centres, including Amazon, Dassault Systemes, Facebook, Google, IBM, Johnson & Johnson, Microsoft, Paypal, and Verizon.



Boston is emerging as a leading global innovation biotechnology cluster. The Boston area boasts nearly 30,000 scientists and other workers directly involved in biotechnology, pharmaceutical and clinical research – the highest concentration of life-science research workers in the U.S., according to the U.S. Bureau of Labor Statistics. The robust life sciences industry across Greater Boston is sustained by its skilled workforce, access to leading universities, established innovative research and development districts, the proximity of major research hospitals, and the presence of venture capital resources.

Life sciences sectors in Boston and San Francisco usually come out first and second interchangeably on Global industry rankings. In 2012, Jones Lang Le Salle Global Cluster report ranked Boston's life sciences sector as the premier R&D cluster in the world for the second year running, with more than 74,000 life sciences employees; five of the top eight NIH-funded hospitals in the country; and \$1.32bn in venture capital funding.

Financial Services. Boston has been a financial services centre for more than 300 years, and these services remain a significant part of the area's economy, especially mutual funds and insurance. Boston-based Fidelity Investments – the second largest mutual fund and financial services group in the world – helped popularise the mutual fund in the 1980s and has made Boston one of the top financial cities in the United States. The city is home to the headquarters of Santander Bank, and Boston is a centre for venture capital firms. State Street Corporation, which specialises in asset management and custody services, is also based in the city.

A major benefit of Boston's financial services sector is a plentiful supply of venture capital, with both the city's technology and biotechnology clusters benefiting from strong links to investors. This ability to commercialise scientific ideas and research has been the city's biggest advantage in biotechnology and life sciences.

Emerging sub-sectors. Within the above established industries, there are a number of specific emerging industry subsets including photonics (life sciences), digital IT, robotics, cyber-security, and big data. Universities in particular are helping to drive the growth of these subsets, e.g. Boston University has a 15,000 square foot Photonics Center that provides companies with access to fully permitted laboratories, equipment, and other resources to ensure the success of growing companies in the field. There are also a number of universities that offer robotics R&D programs including the Harvard Robotics Lab, MIT, and Tufts University. Some of the largest cyber security companies are also located within the region. In a 2013 report, the MA Tech Leadership Council (MassTLC) identified nearly 100 companies in the Boston area currently engaged in Big Data technologies with around 20 start-ups. At that point in time, MassTLC estimates that these Big Data vendors employed about 12,000 people in Massachusetts. They also estimated an additional 58,000 people employed as data scientists and data savvy managers in industries like healthcare, financial services, life sciences, consumer products, and on-line media. The projection was that this industry could add 50,000 jobs and bring the total across the state to as many as 120,000 Big Data jobs.



ENABLING ASSETS, INFRASTRUCTURE AND POLICIES

Enabling assets

Human capital: Boston's success in high tech industries is based on its highly educated workforce which provides a pool of talent to fuel the area's High-Tech Economy. Among comparable metropolitan areas, residents of the Boston metropolitan area rank fourth in the nation for the percentage of the population with at least a Bachelor's degree at 43.4 per cent. The labour force that works in Boston has an even higher level of educational attainment – 55.4 per cent of people who work in Boston have at least a Bachelor's degree and 24.5 per cent have a Master's degree or higher. Almost a quarter of Boston area residents with a Bachelor's degree majored in a STEM field directly relevant to high-tech employment.

High concentration of research institutions: Boston has a high concentration of universities, teaching hospitals and scientific research facilities, which not only retain jobs within the city but also attract other firms who need to locate nearby.

Economic diversity: A 2003 analysis by Pingkang David Yu, an economist at the Federal Reserve Bank of Boston, found that Boston's "more diversified job base" allowed the area to "generate a large enough stream of high-tech jobs to remain on par with its West Coast counterpart." Yu also suggested that the city's strength in technology services, rather than manufacturing, "may fuel future economic growth by introducing new technologies across industries and building channels for cross-fertilization," rather than simply building strength in one area. Indeed, economic diversity was credited with helping Boston suffer less than its Californian counterparts during the dot-com bust.

Supply of venture capital: The Greater Boston venture capital (VC) community continues to be among the nation's leaders in financing investment in high tech firms. This strong financing presence meant that 68 per cent of Massachusetts' seed rounds over the period 2010–2013 were able to find local financing. Entrepreneur.com includes 17 Boston firms in their 'VC 100' list of top early stage venture capital firms, including Boston-based Spark Capital in their top 25. Within the area, suburban hubs along Route 128 such as Waltham and Burlington continue to attract substantial investment, but the biggest investments are made in Boston and Cambridge. The number of VC deals completed by companies within the city of Boston rose from 66 to 97 between 2012 and 2013, and then again to 103 in 2014.

Innovation districts: The Boston region is home to a number of innovation districts, which facilitate new connections and ideas, accelerate the commercialisation of those ideas, and create jobs. Established and growing innovation districts in the Boston area include Kendall Square/MIT and the Seaport District. Dudley Square is another area that has recently seen public investment and is being considered by the City of Boston as a potential hub for technology innovation. The Boston region has significant potential to develop additional innovation clusters as there are many dense, walkable mixed use areas throughout the region in both urban and suburban areas.



Enabling infrastructure

In the last two decades, Massachusetts has undertaken a generation's worth of major highway and transit projects, of which the Central Artery/Tunnel Project, or 'Big Dig' and its associated MBTA improvements are the largest. Logan Airport and the Port of Boston have also experienced dramatic improvements.

Road transport: The metropolitan Boston highway system connects the streets of every downtown, neighbourhood business district, and industrial park to the interstate highway system. In a sixty-year span, two iconic highway investments helped redefine the socio-economic fabric of Greater Boston and its role in the national economy:

- **Route 128 - the partial beltway around Boston** – fuelled the rise of high technology and the diffusion of commercial, industrial, and residential capital to what were once the outer edges of the region. In 2010, the highway carried over 200,000 vehicles per day.
- **The Central Artery/Tunnel Project**, or 'Big Dig', was a megaproject in Boston that rerouted the Central Artery (Interstate 93) – the main highway through the heart of the city – into the 3.5-mile (5.6 km) Thomas P. O'Neill Jr. Tunnel. The project also included the construction of the Ted Williams Tunnel (extending Interstate 90 to Logan International Airport), the Leonard P. Zakim Bunker Hill Memorial Bridge over the Charles River, and the Rose Kennedy Greenway in the space vacated by the previous I-93 elevated roadway. The construction work was carried out between 1991 and 2006 and was the most expensive highway project in the US.

Public transport: Compared to most other US cities, Boston has a relatively good public transportation system serving the core city area of Boston/Cambridge/Newton, which enables businesses to access a diverse workforce. The Massachusetts Bay Transportation Authority (MBTA) is the public operator of most bus, subway, commuter rail, and ferry routes in Greater Boston. Institutionally, metropolitan Boston is well served by the fact that a single authority owns and operates the entire multi-modal regional transit system. Since 1988, the MBTA has been the fastest expanding transit system in the country. In 2010, the MBTA was the fifth largest transit system in the US, when measured by the total annual number of unlinked passenger trips. The MBTA bus system is the seventh-busiest in the country, with over 182 routes throughout the region.

Boston has two discrete rail networks. One of these is normally called the T and includes elements of light rail and streetcar operation as well as traditional subway technology. (The Red, Orange, Blue, and Green Lines have no physical rail interconnections with each other, though they are all operated by the MBTA and exchange passengers in shared stations.) The second network forms the Boston area portion of the national common user railroad network, and provides commuter rail, intercity passenger rail and freight rail services.

The MBTA's rapid transit system serves 124 stations deployed along 131 miles of revenue track and another 60 miles of yard and service track; the Green Line is the busiest light rail system in the US. The north and south commuter rail systems serve 123 stations.



The MBTA commuter rail system services the outlying Boston suburbs and brings people from as far away as Worcester and Providence (Rhode Island) into Boston. There are approximately 125,000 one-way trips on the commuter rail each day, making it the fifth-busiest commuter rail system in the country, outranked only by the various systems serving New York and Chicago suburbs.

Boston is also served by four intercity rail services, all operated by Amtrak. The Acela Express and Northeast Regional services both operate on the Northeast Corridor to and from New York City and Washington. A branch of the Lake Shore Limited service operates to and from Chicago. The Downeaster service operates to and from Portland, Maine.

Air Transport: Logan International Airport is located partly in East Boston and partly in the town of Winthrop, on Boston Harbor, and is operated by Massport. It covers 2,384 acres, has six runways, and employs an estimated 16,000 people. It is the 18th busiest airport in the United States, with 31.6 million total passengers in 2014. The airport has frequent services to destinations throughout North America, Latin America, the Caribbean and the Mid-Atlantic, as well as the Middle East, Europe and Asia. Logan has gained many major international airlines since 2012, especially to Asia and the Middle East. This expansion has resulted in a relatively large increase in passengers, which has soared to over 30 million annually since 2013.

Logan International Airport was rated 'Easiest Airport to Get To' in a 2007 article on aviation.com because of the variety of options to/from the airport, including cars, taxis, the MBTA Blue and Silver lines, regional bus services, shared ride vans, ferries, limousines and the Logan Express bus service. The airport is within commuting reach of four regional international airports in New Hampshire, New York, Connecticut, and Rhode Island.

To help address overcrowding at Logan Airport, Massport operates two other airports in eastern Massachusetts: L.G. Hanscom Field and Worcester Regional Airport: In addition, Massport has designated two out of state regional airports (which are administered independently) as reliever airports: T. F. Green Airport in Providence, Rhode Island, and Manchester-Boston Regional Airport in Manchester, New Hampshire.

ENABLING POLICIES

Public investment and support

According to the Work Foundation, the Federal Government has been hugely important in Boston's turnaround – particularly in terms of providing government funding. The city's economy has traditionally benefitted from defence research contracts and continues to attract significant federal research funding. Equally, the Federal Government played a significant role in funding Boston's 'Big Dig' project to revitalise the downtown area.

More locally, the Massachusetts Biotechnology Council attributes Greater Boston's success in high tech industries to supportive city and state policies and investment. Expedited permitting policies, by-right zoning, supportive public infrastructure projects, pre-permitted biotech sites, and planned area



developments are examples of the increasingly supportive public policies in Greater Massachusetts municipalities.

One recent example of major investment which is creating opportunities for additional growth and supporting Boston's high tech economy is the creation of the 'Innovation District'. In May 2010, former Boston Mayor, Thomas M. Menino, began an initiative to transform 1,000 acres of the South Boston waterfront into the Innovation District – an urban environment that fosters innovation, collaboration, and entrepreneurship. The Innovation District is nestled between Boston's transportation gateways: abutting historic Boston Harbour, adjacent to Logan International Airport, and at the nexus of two major interstate highways. It contains the largest tract of under-developed land in the city of Boston, and is an area with opportunity for growth, a strong existing knowledge base, and the ideal location for producing new ideas, services and products.

The City's stewardship of this land has allowed the development of the research and technology cluster in the South Boston Waterfront. In the three years since the initiative began, the area has grown rapidly. From 2010-2013, the South Boston Waterfront added about 100 new businesses and 15,000 new jobs. In contrast to the large hospitals and universities in other parts of the city, the South Boston Waterfront is becoming the place for high tech companies to congregate.

Although the Work Foundation in 2006 cited a lack of regional government as an issue facing the area, there have since been good examples of joint working. A report from Harvard's Rappaport Institute for Greater Boston also suggested that localism "in Massachusetts is structured in a way that limits local power and frustrates regionalism." The report argued that in the critical policy areas of housing, tax and education neither did towns have meaningful devolution nor did there exist anything approaching a cohesive 'regional government'. However, since the Work Foundation analysis, there have been good examples of joint working across the Greater Boston region, e.g. the regional Life Sciences Corridor is a regional economic development initiative focused on the life sciences sector. In 2014, the Mayors of Boston, Cambridge, Quincy, Somerville and Braintree announced the creation of the Life Sciences Corridor along the MBTA Red Line. Together, the five cities represent over 460 companies within the life science industry sector. The Life Sciences Corridor will focus on attracting business from outside the region, retaining businesses within the region, and promoting cross collaboration between universities, institutions and businesses across the region. The new Corridor is naturally connected by the MBTA Red Line, which serves as an important and efficient connecting link between the five cities.

The regional planning agency, the Metropolitan Area Planning Council (MAPC) – which covers the 101 cities and towns of Metropolitan Boston – has been praised for its work in regional planning and economic development. The MAPC published its regional plan, MetroFuture, in May 2008. "MetroFuture is a bold and achievable plan to make a Greater Boston Region – to better the lives of the people who live and work in Metropolitan Boston between now and 2030. It capitalizes on the region's most important assets: its diverse people and landscape, a history of innovation, and a commitment to education and civic engagement. It is a plan that will help the region to overcome its challenges and to embrace its future."



The plan is based on an understanding that Metro Boston is an interconnected system: regional trends shape local conditions, and every local decision has a broader impact on regional well-being. It was developed with the extensive participation of residents, municipal officials, state agencies, businesses, community-based organizations, and institutional partners throughout the region. They shared their visions for the future of the region, evaluated alternative scenarios for the future, and had conversations about the region's priorities.

Through this process, MAPC created demographic and economic projections of the region's future, a set of 65 specific goals for the year 2030, and 13 implementation strategies. The implementation strategies include recommendations for cities and towns, state government, residents, institutions, and corporations. To date, the plan has resulted in almost 300 individual projects in regional and local planning, municipal collaboration, and public policy to advance the MetroFuture vision. Roughly two-thirds of these projects are now completed, one-third are still underway, and more are being added. In October 2010, MAPC was also awarded a \$4 million Sustainable Communities Grant from the U.S. Department of Housing and Urban Development. This grant – which ended in 2014 – supported the implementation of MetroFuture, through local planning efforts, state and regional policy work, development of tools and data, and capacity building for local residents and leaders.

The MAPC is also the Economic Development District for Metro Boston. In this capacity, MAPC produces the regional Comprehensive Economic Development Strategy (CEDS). The CEDS 2015-2020 uses MetroFuture as a guiding lens to examine the strategies that the Greater Boston region can pursue to achieve smart and equitable economic development. This plan highlights the current state of the regional economy, discusses strengths and challenges, and outlines strategies that stakeholders working in various sectors and fields can adopt to address challenges and ensure continued economic prosperity across Greater Boston. The strategy identifies that a regional approach to economic development is needed to address broad environmental issues, public health, education, housing, transportation, and infrastructure and manage interconnected labour and housing markets, transportation systems, educational institutions, and cultural and scenic assets.

Previous CEDS successes include the following:

- The CEDS became one of the primary vehicles to demonstrate the value, worth, and contributions of the Life Sciences sector in Greater Boston. Federal officials looking for a temperate and data-based look at local life science industries used the CEDS to inform funding decisions.
- The CEDS played a crucial role in attracting federal funding for the Northeastern University School of Law to implement one program with two very different outcomes. The Community Business Clinic at the School of Law provides high quality, one-to-one business legal services to immigrant entrepreneurs at no cost. Additionally, the data drawn from the Community Business Clinic is informing a ground-breaking longitudinal academic study examining the relationship between entrepreneurship, economic development, and poverty alleviation.
- Projects throughout the region like North Shore InnoVentures, N2, The North Shore Bio-Science Consortium, and Developing a New Marine Economy on Gloucester Harbor, received guidance and



perspective from MAPC that encouraged the creation of region-wide partnerships. These projects were able to leverage the collective strengths of the private sector, local government, universities and colleges, and business umbrella groups to focus on one priority mission.

As detailed in the MAPC's Strategic Plan 2015-2020, stakeholders have identified **regional thinking, convening and facilitating, and interdisciplinary work as MAPC's core competencies**, and have praised MAPC's commitment to regionalisation and the role that the MAPC plays as a thought leader in the region. Internal stakeholders saw their agency as leading by example in maintaining a regional approach and encouraging proactive regional thinking rather than reactive local action. External stakeholders noted that MAPC combines on-the-ground knowledge of local government with big picture regional thinking, enabling the agency to promote ongoing discussion of regional trends in local communities. Furthermore, MAPC is well-positioned to remind municipalities that their decisions have regional implications.

CHALLENGES

In its Comprehensive Economic Development Strategy (CEDS) 2015-2020, the Metropolitan Area Planning Council (MAPC) identified five economic challenges facing the region

1) Income inequality: the Metro Boston region ranks among the worst in the nation in income inequality. There are thousands of households that live below the federal poverty threshold and many more who make incomes above poverty yet still do not have enough income to support themselves or their families, let alone build wealth for their futures. Four metrics that are influential in a household's capacity to build wealth are homeownership, family income, unemployment, and college degree attainment. In Metro Boston, there are racial disparities in each of these metrics that are greater than that of the nation, i.e. the barriers to wealth building for BME families in Metro Boston are greater than they are for BME families nationwide.

2) Ageing infrastructure: The harsh winter of 2015 shut down the area's ageing public transportation system as trains were not able to operate safely in the winter conditions, costing Massachusetts companies over \$1 billion in lost sales and productivity. Some of the issues that the MBTA currently faces include a backlog of maintenance with some Red Line cars that are almost 50 years old and Orange Line cars that date back to the 1980s. Power and signalling systems need major upgrades, but the money that is programmed for this only covers about 8 per cent of total requirements. The agency also has a high debt burden with more than \$5 billion in outstanding debt, some of which remains from expansions and improvements related to the Central Artery project. About a quarter of the T's budget this year will just go to servicing debt overall. Regional urban and suburban areas also have a variety of transportation needs outside of those of the MBTA, including highway interchange improvements and local transit needs such as shuttle routes that will create connections between developments and nearby transit stations.



3) Housing shortage: The region faces a shortage of housing that is affecting affordability – meaning that employees are increasingly unable to work in the region because they cannot afford to live there. MAPC projects that 176,000 new units of housing need to be created across the region in the next five years to meet the expected demand for housing by both current and future residents.

The region is already feeling the effects of high house prices. According to a recent Census Bureau report, people who are moving between states are citing housing as the primary reason why they have chosen to re-locate. According to a recent report by the Massachusetts Housing Partnership, Massachusetts lost 170 innovation workers to Texas, 180 workers to Florida, and 190 workers to Colorado for every 100 workers that it gained from these states. Over the coming decades, the lack of affordable housing will likely have a direct effect on the quality of our labour force. As the Baby Boomers (born between 1945 and 1970) retire, the region will need new younger workers to take their place and fill their positions. If there continues to be a lack of affordable housing, even young people who may be interested in taking these jobs, may not be able to afford to live there.

4) Workforce development: The Metro Boston region needs to continue to attract and retain high-skill and middle-skill jobs. At the same time, it is important to continue to efficiently train workers for the jobs that are currently available. Its highly trained pool of workers is currently one of Metro Boston's greatest assets and although there are currently more highly-skilled workers than high-skill jobs, there are still jobs available for which highly educated job-seekers may not necessarily have the right training or qualifications. The Massachusetts Workforce Board Association cites that the area has an ongoing workforce labour surplus and skills gaps – where available jobs are not aligning well with the skills of those applying for job – along with insufficient basic and technical skills training programs. While steps are being made to more strongly align Massachusetts' 15 community colleges (many of which are located in the Greater Boston region) with employers, this is an issue that the region needs to improve upon.

5) Economic resilience: The ability of the region to respond to major disruptions to its economy (whether they are from climate change impacts, safety threats, social concerns, or downturns in core regional industries) will be a major factor in how well the economy performs in the future. Out of all world coastal cities, Boston is at the eighth greatest risk for damaging floods associated with climate change. The change in relative sea levels in Massachusetts is expected to be among the most rapid in the U.S. with 3 feet of potential sea-level rise by 2050. Social inequity is also a major barrier to economic resilience that needs to be addressed in order to create a stronger, more resilient region. Metro Boston is also heavily reliant on Education and Health Care Services & Professional and Business Services and could do more to diversify the industries on which it depends in order to become more resilient.



The 2012 Boston Indicators report, co-sponsored by The City of Boston and the Metropolitan Area Planning Council (MAPC) identified a number of additional challenges

Rising health care costs: Rising health care costs are crowding out investment in other services, particularly education. In Massachusetts 2001-2011, state funding for health care increased by 75 per cent at the expense of Education, Public Safety, Public Health, Public Higher Education and Environment & Recreation. To balance the 2012 state budget, Universal Pre-Kindergarten was cut by 38 per cent, Workforce Training by 15 per cent and Adult Basic Education by 7 per cent. A 2011 study by the Massachusetts Budget & Policy Center found that all public school districts now spend more on health care than originally budgeted. While high-income school districts absorb these additional costs through tax overrides or outside fundraising, low-income districts are forced to cut back on educational services, thus widening the gaps in educational opportunity. Cuts in state funding for higher education have also been offset by hikes in tuition and fees, fuelling student debt or putting college out of reach altogether.

Economic vulnerabilities: Many pillars of Massachusetts' innovation economy clusters – Health Care Delivery, BioPharma & Medical Devices, and Financial Services – are vulnerable to impending funding cuts and global economic instability and competition, placing thousands of the region's highest-paying industries and jobs at risk.

Export markets: A large proportion of the area's exports go to Europe. Thus, instability due to high levels of sovereign debt in Greece, Ireland, Italy and other EU nations pose a risk to the current configuration of the region's innovation economy. Between 2008 and 2018, statewide employment is projected to decline in Computer & Electronic Product Manufacturing (by more than 13,000 jobs), Semiconductor & Electronic Component Manufacturing (by 5,800 jobs), and in Computer & Peripheral Equipment Manufacturing (by 4,600 jobs).

Defence: In the last decade, Massachusetts has received a disproportionate share of contracts from the US Departments of Defense and Homeland Security, but planned federal budget cuts could affect as many as 25,000 defence-industry jobs statewide.

Finance: Massachusetts and Boston are particularly vulnerable to a decline in the Finance Industry. Between 2008 and 2018, Massachusetts is projected to lose more than 9,000 additional jobs in Finance & Insurance (more than any other industry except Construction and Manufacturing) while Boston is projected to lose nearly 3,500 Finance & Insurance jobs (the most of any industry).

BioPharma & Medical Devices: Massachusetts' BioPharma industry cluster now faces public and private funding cuts as well as global competition. Massachusetts was projected to lose \$670 million in NIH funding in 2013 – a 9 per cent reduction; venture capital funding has reduced; pharmaceutical companies have reduced jobs across the U.S.; biotech is targeted for growth and investment in China; and regulatory requirements have increased.

Demographic change: The region's economy is vulnerable to the coming Baby Boomer exodus, requiring a seamless system of education and training to prepare a more diverse young workforce. By



2020, 48 per cent of Massachusetts' workers aged 25-29 will be from BME backgrounds, many of them the young people who are falling behind in educational achievement today.

LESSONS FOR THE LSCC AREA

Technology and innovation leadership has been built up over 100 years, and has proved adaptable to changes in market preferences and industrial trends. Boston has a world-class set of research institutions, pushing the frontiers of knowledge in a variety of fields including cancer research, cloud storage, robotics, and nanotechnology. Eight research universities – Boston College, Boston University, Brandeis, Harvard, MIT, Northeastern, Tufts and the University of Massachusetts Boston – are all less than 10 miles from downtown Boston. The city is also home to four medical schools and 16 teaching hospitals. These permanent institutions attract a wide range of talent, employ thousands of people and provide a significant source of local investment.

Route 128 provided infrastructure and room for growth. The Route 128 highway around Boston provided the transportation infrastructure to support economic growth as well as access to land. In terms of timing, this came on-stream just as new industries driven by science and technology were seeking space for development.

Flexibility learnt from the hard lessons of industrial restructuring. Boston/Route 128 has gone through two major restructurings: 1) the decline of microcomputing, defence contracts and finance from the 1970s to the 1980s then the 1990s recession; and 2) the recession in 2000-03 and the end of the dot.com industry bubble.

Success due to diversity as well as technological leadership. What constitutes 'high tech' has grown more diverse throughout the region. Research, development, and manufacturing related to biotechnology, pharmaceuticals, and medical equipment has grown. Internet-related companies are also well represented. Crucially, the region remains a vital and active source of innovation and start-ups.

Entrepreneurship and business finance for taking technological innovations successfully to the market. The Greater Boston venture capital (VC) community continues to be among the nation's leaders in financing investment in high tech firms.

Metro- and regional – level strategy, planning and delivery. There is significant collaboration in the provision of infrastructure, land and area-based initiatives such as Innovation Districts. Economic development is integrated with land-use planning.

The strategy of re-configuring undervalued and underused land assets has paid off – with the initiative to transform 1,000 acres of the South Boston waterfront into the Innovation District – an urban environment that fosters innovation, collaboration, and entrepreneurship.

The challenges of growth remain apparent – and they include income inequality, ageing transport infrastructure, housing shortages and workforce development.



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