MassBenchmarks

THE JOURNAL OF THE MASSACHUSETTS ECONOMY


Is Massachusetts’ Economy Losing Its Steam?

Revisiting the Economic Geography of Massachusetts
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Industry leaders anticipate a rapidly emerging mismatch between the skills that workers currently have and the skills that they will need to thrive with disruptive technologies including robotics, blockchain, artificial intelligence, and other transformational factors. In this future, education itself must become increasingly adaptive. It must take the lead in preparing students—tomorrow’s workers—with competencies that allow them to integrate new technologies into their day-to-day jobs. These include competencies with digitalization, data, and interfaces—the latter which entail working firsthand with AI and robots. In addition, higher education must consider credentials that serve the needs of non-traditional students across their professional life span.
INTRODUCTION

Industry workforce needs are rapidly evolving as the future of work unfolds. That future portends that disruptive technologies, such as robotics, blockchain, and artificial intelligence (AI) will alter the structure and nature of work in unprecedented ways. In the next two decades, the economy will witness wide-scale labor displacement across industry sectors from retail to healthcare, from biotech to financial services. No sector will be untouched by this next industrial revolution.

Industry leaders anticipate a rapidly emerging mismatch between the skills that workers currently have and the skills that will be necessary to tackle this new world of work. In response to the pending crisis, policymakers, business leaders, and economists are calling for a ‘reskilling revolution’ to help individuals adapt to the future of work.1 While some large organizations, such as Amazon and IBM, are attempting to meet the call internally, higher education’s role in the reskilling revolution is uncertain.

Historically, higher education has played a key role in helping individuals adapt to industrial and technological revolutions. The Morrill Act supported land grant colleges in the 1800s that subsequently fueled agricultural and engineering education. And after World War II, the GI Bill sent a generation of workers to trade schools and universities. Both of these initiatives fueled unprecedented innovation and economic growth. However, it is unclear whether higher education can meet the needs of the 21st century workforce. Colleges and universities must begin thinking about new, potentially disruptive models that address evolving workforce needs.

DEFINING THE FUTURE OF WORK AND ITS IMPACT

As Figure 1 details, this is not the first ‘future of work’ disruption. Historically, we have seen several other large-scale technological disruptions that have changed the structure and nature of work. Analysts have coined the current disruption Industry 4.0 or the new industrial revolution.2

In the context of such disruption, economists wrestle with the ‘job ledger’—an accounting of whether or not more jobs will be created than destroyed. Past disruptions have created more jobs than have been destroyed—a dynamic referred to as creative destruction. However, in the current disruption, economists are skeptical that such a dynamic will hold. Given the nature of the new technologies, which are likely to replace human workers as opposed to simply augmenting their efforts, the expectation is that Industry 4.0 may destroy more jobs than it creates. Think tanks, universities, and consultancies have offered job loss projections that capture the extent of the potential destruction in the future of work (Figure 2).

Figure 1. Timeline of Future of Work Disruptions

Including Industry 4.0

<table>
<thead>
<tr>
<th>Industry 1.0</th>
<th>Industry 2.0</th>
<th>Industry 3.0</th>
<th>Industry 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>19th Century Industrial Revolution and Rail</td>
<td>Early 20th Century Mass Production</td>
<td>Mid-late 20th Century Information Technology and Telecommunications</td>
<td>21st Century Artificial Intelligence, Automation and Biotechnology</td>
</tr>
</tbody>
</table>

1. While some large organizations, such as Amazon and IBM, are attempting to meet the call internally, higher education’s role in the reskilling revolution is uncertain.

2. Historically, we have seen several other large-scale technological disruptions that have changed the structure and nature of work. Analysts have coined the current disruption Industry 4.0 or the new industrial revolution.
The predictions are fueling several workforce policy concerns. First, is the sheer magnitude of displacement in the U.S. economy in the next two decades, and the fact that anticipated job losses will not be isolated to certain industry sectors. While displacement is already impacting jobs like retail associates, taxi drivers, and warehouse workers, it is expected to spread soon to jobs in knowledge-intensive industries, such as healthcare information technology, information technology, and the life sciences. Displaced workers will need to be reskilled into new jobs, new organizations, and new industries.

Secondly, jobs that are not outright destroyed will be irreversibly altered by technology. Workers fortunate enough to avoid complete displacement by technology will still need to learn to work with these technologies. Recently, an IBM think tank predicted that 120 million people will need training in artificial intelligence and smart automation.

Finally, in addition to concerns specific to job loss and labor transformation, we also need to prepare for jobs that will be created based on these enabling technologies—jobs that we have yet to envision. Analysts predict that 85 percent of the jobs ten years from now have not yet been created. Massachusetts will be ground zero in experiencing these impacts. Automation and artificial intelligence are already beginning to alter the processes that are central to the Commonwealth’s industries. (See Table 1.)

Earlier this year, State Street Corporation, in Boston, laid off 1,500 employees, specifically citing automation as a key driver of that cost-cutting measure. Indeed, this is the tip of the iceberg in financial services—a recent report predicted that close to a quarter of a million jobs will be lost in the next decade. The future of work is here. The worst-case scenario is that disruption will destroy millions of more jobs than it creates; the best-case scenario is that the disruption will create millions of more jobs than it destroys. Regardless, the sheer scale of the change is triggering a reskilling revolution: the recognition that industry, higher education, and government need to formulate a coordinated, multifaceted approach that will help workers adjust and adapt to the future of work.

Source: Author’s analysis

Notes

1. Oxford Study: Based on .47 at risk displacement rate applied to 160 Million U.S. Workforce
2. OECD: High risk of displacement (10%); Significant Risk of displacement (40%)
3. PWC: 38% * 160,000 = 61,000,000
4. McKinsey: 39 million at midpoint adoption; 73 million by rapid adoption
5. Brookings: 25% or 36 million jobs. High risk of automation
6. Forrester: 17% loss by 2026, offset by 10% growth of automation economy
7. Bank of England: Classifies probability of automation for various jobs: high (66% or more), medium (33-66%) or low (less than 33%) and applies to total occupational employment
8. ScienceAlert: Based on MIT Center for Digital Business study—predicted jump of 1.75 robots per 1,000 human workers to 5.25 robots per 1,000 humans by 2025
UNDERSTANDING THE RESKILLING REVOLUTION

The reskilling revolution calls for dramatically different skill sets than those found in the current labor market. But what skills does this entail and how are these skills unique to the future of work? Answering this question is critical to moving forward, especially as we consider the role of higher education. Figure 3 assigns the unique, necessary elements of the reskilling revolution to three areas: technology skills, cognitive skills, and relational skills. As detailed below, this framework focuses specifically on new and emerging skills required for success in the future of work.

Technology Skills

In an age of technological disruption, workers will need competencies adapted to the new technologies themselves. However, this is not the same as the software training of the past. The requisite skills here address the ways that disruptive technologies will affect work on the occupational level; in short, workers must develop a set of competencies that allow them to seamlessly integrate technology into their day-to-day jobs.

• Interface competency
  Interface competency recognizes that every job—large and small—will need to interface, i.e., work with future of work technologies, such as AI, in a symbiotic fashion. For example, radiologists are increasingly working with AI to improve diagnostic accuracy, utility workers are deploying drones to work on power grids, and surgeons are utilizing robots to do surgery across continents. The ability to interface seamlessly with these technologies is central to the future of work, but more importantly, workers will need to negotiate with these active technologies.

• Digitalization competency
  Digitalization is the dynamic that every aspect of work has been integrated through technology at the job level, process level, and value system level. Workers must develop a deep understanding of how the cloud, cybersecurity, and pervasive computing are changing the nature of the job. Fifteen years ago, almost 50 percent of full-time entry-level jobs required medium to advanced digitalization skills; today 90 percent of jobs require strong digitalization skills. There is no better example than the healthcare industry, where electronic medical records have affected every worker—from clinician, to coder, to medical assistant, to office manager.

• Data competency
  Recent Wharton research shows a massive skills shortage relative to data fluency, stating that, “Every worker is a ‘data worker’—not just in offices, but in oil fields, hospitals, schools, and more.” Tomorrow's workforce needs to understand and manage data at every level—from data capture, data cleaning, data integration, and data analytics. Glassdoor recently released its roster of the fastest growing jobs; the overwhelming majority are data-related.

Cognitive Skills

Just as 150 years ago we may have stopped and asked, “How is the railroad going to change commerce?” workers must now consider how this wave of technologies is changing work. Cognitive skills are about just that: developing a big-picture perspective that allows workers

<table>
<thead>
<tr>
<th>Industry</th>
<th>Technology Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare</td>
<td>Various functional areas affected, including artificial intelligence in medical coding and diagnostics, Robotic process automation in patient care working side by side with clinicians</td>
</tr>
<tr>
<td>Financial services</td>
<td>Initial investments in artificial intelligence in customer service, portfolio management</td>
</tr>
<tr>
<td>IT</td>
<td>Programming, system integration</td>
</tr>
<tr>
<td>Hospitality</td>
<td>AI and automation affecting reservations, booking, and housekeeping</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Intelligent automation encroaching at the line level with computer numerical control, as well as design tasks</td>
</tr>
<tr>
<td>Biotech/Pharmaceutical</td>
<td>Organizations utilizing AI to accelerate drug discovery</td>
</tr>
<tr>
<td>Construction</td>
<td>AI used in design, safety and risk management in projects</td>
</tr>
</tbody>
</table>

Source: Author’s analysis
to understand the impact of technology on their organization, industry, and jobs.

- **Systems thinking**
  More and more aspects of our life will be connected through technology platforms (e.g., the Internet of Things, autonomous vehicles, automated delivery systems). As organizations demonstrate a much tighter degree of integration, individuals will need to develop skills in systems thinking—an understanding of the way humans, machines, and data interplay.

- **Critical thinking**
  Organizations will also require workers to utilize the next wave of technologies to improve processes, develop new competencies, and drive new, value-generating business models. As we enter a new industrial revolution, critical thinking will not be a one-off response when problems arise, but rather a skill for working effectively in the future of work. In fact, it continuously ranks as a skill that employers are looking for during this time of transition.

- **Cross-disciplinary thinking**
  Organizational boundaries are breaking down between functional areas more than ever before. Cross-disciplinary thinking pertains to the way individuals understand the interplay of pathbreaking work technologies and systems within and across the organization. For example, one of the fastest growing fields is user design and interface. Workers in these roles need expertise in computer science, design, and human behavior—they need to work across silos.

### Relational Skills

Inevitably, work technologies will alter key relationships in the workplace. Fifty years ago, early stage telecomm technologies, the PC, and the cubicle altered relationships in the workplace. Today, relationships will be altered by AI, smart automation, blockchain, 5G, and AWS. Understanding and managing those relationships will require new relational skills.

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**Figure 3. New and Emerging Skills of the Reskilling Revolution**

- **Technology Skills**
  - Interface competency
  - Digitalization competency
  - Data competency

- **Cognitive Skills**
  - Systems thinking
  - Critical thinking
  - Cross-disciplinary thinking

- **Relational Skills**
  - Collaborative fluency
  - Generational fluency
  - Coordination fluency

- **Flexible**
  - Rapid Reskilling
  - Continuous Learning
• Collaborative fluency
While AI, robots, automation, and other technologies will certainly change jobs themselves, these disruptive technologies will also change the fabric of most organizations. In the very near future, AI and robots will be team members in organizations. Workers will need to develop collaborative fluency to work effectively with an AI team member, to manage AI team members, and, at some point, to potentially work for an AI manager.

• Coordination fluency
Traditional structures and flows for managing processes may no longer work so well in the future of work. The last decade has seen the rise of team-based organizing, virtual collaboration, and flatter organizations. Some statistics suggest that less than 25 percent of large organizations exist in a traditional functional structure. Further changes to work will require workers who can adapt to work flow and processes that go well beyond traditional isolated, cubicle-bound work arrangements. Indeed, the gig economy today represents a third of the U.S. workforce and requires a much different type of worker.16

• Generational fluency
With four generations in the workplace—Baby Boomers, GenX, Millennials, and GenZ—today’s workplace requires that workers gain much greater cultural and demographic understanding.17 The average 20-year-old assimilates technology at work much differently than the average 60-year-old. Not only will working with technology be critical, but we must also understand its conception, integration, and deployment across generations.

How do we get there?
While technology, cognitive, and relational skills are central to the reskilling revolution, we must ask: How do we get there? First, the revolution requires a much faster cycle of knowledge and skill development than in the past—the former often referred to as real time or rapid reskilling. Second, industry needs workers to adopt continuous learning or lifelong learning.18 Industry needs workers who don’t view education as a static undertaking, but rather as a dynamic, evolving central part of their professional path. The U.S. Bureau of Labor Statistics predicts that the average college-age student will have 10 jobs by their 40th birthday. That requires consistent evaluation and updating of workforce skills. And finally, industry needs a flexible workforce. Increasingly, singular job titles are eroding as job duties change more frequently with the ebb and flow of company needs. Zappos, the online shoe retailer, requires its workers to span different jobs regardless of title. This is the new reality in the future of work.

HIGHER EDUCATION’S CENTRAL ROLE IN THE RESKILLING REVOLUTION
Given the rapidly evolving skill sets required in the future of work, the larger question is whether or not higher education still adequately prepares people for jobs. It is unreasonable to believe that businesses or individuals can address the larger workforce changes by themselves. Yet, to play its part in the reskilling revolution, higher education must itself undergo much-needed disruption. It needs to bring the bachelor’s degree into the 21st century as well as broaden the scope of its credentials to meet the needs of lifelong learners and non-traditional students. Accordingly, we offer three strategic imperatives:

Ensuring bachelor’s degree credentialing that adequately prepares early-stage careers for the future of work
The bachelor’s degree will continue to be the foundation for lifelong learning. However, as the average graduate leaves college with $30,000 in debt,19 colleges and universities must provide the necessary skills to enter the workforce.

• Improving the pace of completion
The average completion time for a bachelor’s degree is five years. Consider a computer science major entering college this fall and graduating in 2024, when researchers expect AI to be capable of coding in computer languages like Python. By the time the student graduates, not only will she be competing against humans for jobs, she’ll be going up against a more efficient and cheaper AI bot.

• Ensuring technical literacy in core disciplines
No college student should leave an institution without taking a course in artificial intelligence, automation, big data, etc., regardless of their discipline. Technical skills will touch every job, across every organization, every industry. Students don’t need to program an AI bot, but they do need technical literacy that enables them to understand how such technologies will affect work.

• Committing to more responsive program development
As the future of work unfolds, the next decade should be a time of exciting and innovative program development on college campuses. Yet, it often takes years for new programs to be approved. If as predicted 85 percent of the next decade’s jobs haven’t been realized, then higher education needs to be more responsive by offering new, innovative programs.
Adopting flexibility and open path options
In an era of choice, students are still hamstrung in customizing their degrees, as well as pursuing nonlinear paths. For example, the University of New Haven and the Ohio State University offer degrees in eSports, a growing field in information technology and entertainment. Institutions need to make it easier for students to develop tailored degrees, pursue experiential learning outside the classroom, and work across disciplines.

Practicing big picture thinking
Bachelor’s degrees must incorporate a higher degree of germane cognitive skills, especially critical thinking and systems thinking. Whether it be the humanities, professional schools, or the sciences, young adults must be prepared to answer the big questions associated with the broader societal implications that will accompany rapid changes in technology. The core of critical thinking skills entails bringing wisdom to the machines. Tomorrow’s workers should continuously ask, Why? when it comes to emerging paradigms in the future of work. This is consistent with a recent survey by the Association of American Colleges and Universities, the primary liberal arts advocacy organization.

None of preceding recommendations poses different agendas between liberal arts and professional schools, regardless of discipline. All students need to prepare for the technological disruption represented by the future of work. For example, artificial intelligence ethicist is an emerging career path.

As institutions alter the bachelor’s degree, they also need to consider the following recommendations:

Develop modular, competency-based credentialing as the basis of lifelong learning
Higher education needs to assist individuals with lifelong learning. As currently structured, colleges and universities tend to be career front-loaded in their training: the average undergraduate and graduate degrees are awarded to students in their early 20s and early 30s. While the bachelor’s degree, if properly structured, will continue to get students ‘out of the gate’, the master’s degree as the next and final stop in skill development is antiquated. That is especially relevant when you consider that the average 18 year old may work 60 years.

The notion of a 60-year curriculum is emerging, based on lifelong, constant learning, which requires updating skills, competencies, and perspectives—not just at two points, i.e., bachelor’s and master’s programs. To deliver lifelong learning based on a 60-year curriculum, colleges and universities are beginning to experiment with modular, competency-based programs. These initiatives entail traditional or shorter courses that offer explicitly detailed skills represented by badges or micro-credentials. These milestones are then bundled, comprising larger competencies. The competencies can then contribute to a larger degree.

Figure 4 offers an example in which students earn badges or microcredentials in specific skills, such as feedback theory, control systems, integration design, and user interfaces. These build to a competency-based credential in embedded system design.

Figure 4. A Modular, Competency-Based Credentialing Model

<table>
<thead>
<tr>
<th>Badges or Microcredentials</th>
<th>Credential</th>
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<tbody>
<tr>
<td>Feedback theory</td>
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<td>Control systems</td>
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<td>Integration design</td>
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<tr>
<td>User interface</td>
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<td>Embedded system design</td>
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<td>Interpersonal relationships</td>
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<td>Conflict resolution</td>
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<td>Motivation theory</td>
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<td>Compensation design</td>
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<td>Team leadership</td>
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<td>Economic modeling</td>
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their career progresses and they are promoted into management, they pursue badges, i.e., skills, toward a recognized competency-based credential in team leadership. Depending on the institution, field, and accreditation, other competencies in project management, economic modeling, and strategic thinking could build towards a larger degree, as depicted in Figure 4.

Boston University, in fact, just launched a new online, competency-based MBA. The program provides the timely, innovative credentialing that will improve employee adaptability and market value later in their careers.

Increase and assess educational options for non-traditional students through certificate pathways

Degree-based credentialing can seem insurmountable to non-traditional students, such as mid- and late-career-displaced workers, veterans, first-generation students, and workers without a college education. As the future of work intensifies, and large-scale displacement occurs, we need options for disaffected workers to return to the workforce.

Certificate pathways based on skills required in specific industries, technologies, or trades offer such an option. Certificates have been shown to address the needs of non-traditional learners. And individuals with certificates can meet or exceed earnings and mobility compared with their counterparts with partial college degrees.22 Certificates are no longer exclusive to trade schools, community colleges, and adult education. Top tier institutions, such as Harvard and MIT, now offer certificates in cutting-edge topics, such as AI in strategy. And certificate pathways offer rapid reskilling that will prove central to the entire workforce.

Figure 5 offers a mock pathway for cybersecurity; initial skills help secure employment and could be the basis for future skill development.

THE FUTURE OF WORK IS AN OPPORTUNITY FOR HIGHER EDUCATION

Every aspect of our daily lives has changed in the last quarter century. The way we make phone calls, pursue relationships, watch movies, find jobs, buy homes, use automobiles, order food, rent cars, walk pets, socialize with friends, and vacation has been disrupted. Yet, higher education has largely remained immune from such disruption, appearing much the same as it did 100 years ago. Online education, while innovative a decade ago, to a large degree has not changed the nature or structure of higher education—it still revolves around traditional degrees.

Figure 5. A Stackable Certificate Pathway Model
Example in Cybersecurity
While declining enrollments and student debt are fueling a higher education bubble, the largest driver of change will likely be industry’s increasing disillusionment that higher education fails to meet industry’s evolving workforce needs. Earlier this year, Amazon announced that it was retraining 100,000 workers in STEM disciplines; one of the more telling aspects of its announcement was that it plans to use its own programs to retrain employees, such as Amazon Technical Academy and Machine Learning University. It didn’t partner with higher education. Similarly, Google, IBM, Microsoft, and other major companies have also announced reskilling initiatives, either internally or with new, higher-education companies. IBM’s planned initiative on ‘new collar’ jobs focuses on skills, not degrees.23 Such market signals should be of concern to higher education leaders. If as predicted, the future of work displaces tens of millions of workers over the next decade, higher education should consider alternative structures and innovative approaches that allow individuals to engage in learning at various career stages. Many higher education leaders will view the future of work as a crisis. Given the imperative for massive reskilling, it should be viewed as an opportunity.

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Endnotes


22.) Anthony P. Carnevale et al., “Certificates: Gateway to Gainful Employment and College Degrees”, Center on Education and the Workforce, McCourt School of Public Policy, Georgetown University, June 5, 2019. Retrieved from https://cew.georgetown.edu/cew-reports/certificates/#exec-summary