THE ASPEN INSTITUTE
FUTURE OF WORK INITIATIVE

EXCHANGE: FUTURE OF WORK & MOBILITY

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EXECUTIVE SUMMARY

Rapid technological change is reshaping the way we build, create, and accomplish things across the economy. Autonomous vehicles and drones are two of today's leading examples that demonstrate the many ways that new technologies could impact the work that people do, and in the process, change jobs, occupations, and industries. Some work skills will become more relevant, while others become less so, and we will see the emergence of some new skills and roles that we cannot imagine today.

Currently, there is a disconnect between people who are building technologies that could impact the workforce and those who are designing policies to help manage the impact. In order to help bridge that gap, the Aspen Institute Future of Work Initiative and X (formerly known as Google X), the Moonshot Factory, convened a day-long cross-sector workshop in the spring of 2018 to build a better understanding of the opportunities and challenges of these two developing technologies.

Drawing from and building on that conversation, this workshop report lays out issues at the intersection of the future of work and the future of mobility. First, the paper looks at autonomous vehicles and drones as examples of automation, and considers their impact on work. Second, the paper highlights three policy approaches to associated challenges and opportunities. Specifically, we explore the opportunity to build greater connectivity between technologists, employers, and the education and workforce systems in order to improve signaling around skills likely to be in demand. We look at how we might "disrupt graduation" and adopt a lifelong learning posture to ensure that all workers are prepared for likely technological change. And we highlight the need for cities and states to enhance their own technological capabilities in order to plan for the implementation of these technologies.

This workshop and paper are first steps on a longer journey that will require participation from all sectors. We aim to share our insights on these important topics with others wrestling with similar issues, and inspire others to convene similar conversations. Through careful consideration, we should ensure that any gains from technology will be broadly shared.

Acknowledgements

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The Initiative also thanks X, the Moonshot Factory, for their generous support of the workshop as well as this report.

The Aspen Institute Future of Work Initiative would like to recognize Libby Reder for serving as the workshop facilitator and leading the preparation of this report. While this document draws on insights shared at the workshop, the findings, interpretations, and conclusions expressed in this report are the Initiative's alone.

About the Aspen Institute Future of Work Initiative

The Aspen Institute Future of Work Initiative is a nonpartisan effort to identify concrete ways to address the challenges American workers and businesses face due to the changing nature of work in the 21st century. Several trends are impacting workers and businesses today, and could bring dramatic transformations in the years ahead: the weakening social contract between workers and employers, the increased importance of access to education and skills resulting from new technologies and increased automation, and the pressure to produce short-term profits rather than long-term value. Rather than waiting to react to future disruptions, it is critical to develop solutions that address the changes transforming the U.S. economy. The Initiative focuses on policy ideas at the federal, state, and local level to:

- Improve economic security for both traditional and independent workers
- Expand investment in and access to effective education and training programs
- Reduce pressure on public companies to prioritize short-term profits and encourage investment in long-term value creation

Established in 2015, the Initiative is driven by the leadership of Honorary Co-Chairs Senator Mark R. Warner and Purdue University President and former Governor of Indiana Mitch Daniels, and Co-Chairs John Bridgeland and Bruce Reed. Executive Director Alastair Fitzpayne leads an Aspen Institute staff, based in Washington, DC.

EMERGING TECHNOLOGY AND ITS IMPACT ON WORK

There are many elements of the future of work conversation, but the impact of new technology on jobs seems to dominate people's attention. Whether printed and bound, like Martin Ford's *Rise of the Robots: Technology and the Threat of a Jobless Future*,[1] or in periodical form, like Alexis Madrigal's take in "Automation Could Worsen Racial Inequality,"[2] automation is top of mind for those thinking about how we will create financial value in the future. However, observers have reason to believe that automation, while complex in its effect, is generally a net positive.[3]

In this paper, automation is defined as the implementation of technology within a process to reduce the level of human intervention needed in the completion of a particular task. By reducing the costs of production, automation can lead to productivity gains, lower consumer prices, and improved living standards along with economic and job growth. However, history also shows us that automation can pose significant challenges to workers whose jobs and tasks are affected and communities whose industries are dislocated.[4]

Two technologies that have attracted significant interest as part of the automation conversation are autonomous vehicles and unmanned aerial vehicles or drones. Autonomous vehicles are already being tested[5] and operated[6] on public roads, and drones are already being deployed by various industries, such as agriculture[7] and construction.[8] As a result, we can begin to predict the impacts they may have on individuals and communities in the context of the future of work, and identify areas in which policy and regulatory solutions could help mitigate the negative impacts of these technologies. Exploring both positive and negative impacts of emerging technologies is valuable in itself, and also provides a framework we might apply to other technologies that we cannot yet see around the corner.

Autonomous Vehicles

The self-driving car has captured the imagination perhaps more than any other near-horizon technology. In the future, autonomous vehicle (AV) technology has the potential to dramatically shift labor associated with transportation of people and goods. It could also shift the business model for personal mobility away from ownership and toward a service model, creating new and different types of work. According to a U.S. Department

1 Ford, Martin. 2016. *Rise of the Robots: Technology and the Threat of a Jobless Future.* Basic Books.

2 Madrigal, Alexis. 2018. "How Automation Could Worsen Racial Inequality." *The Atlantic.* January 16. https://www.theatlantic.com/technology/archive/2018/01/black-workers-and-the-driverless-bus/550535/.

3 Chien, YiLi. 2015. "What Drives Long-Run Economic Growth?" Federal Reserve Bank of St. Louis. June 1. https://www.stlouisfed.org/on-the-economy/2015/june/what-drives-long-run-economic-growth.

4 Acemoglu, Daron, and Pascual Restrepo. 2017. "Robots and Jobs: Evidence from US Labor Markets." Working Paper 23285, National Bureau of Economic Research. March. http://www.nber.org/papers/w23285.
See also: http://siteresources.worldbank.org/EXTLACOFFICEOFCE/Resources/870892-1265238560114/PRestrepo_Oct26_2016_PPT.pdf.

5 Peters, Adele. 2018. "The world's first self-driving grocery delivery cars are on roads in San Jose." *Fast Company.* August 27. https://www.fastcompany.com/90227423/the-worlds-first-self-driving-grocery-delivery-cars-are-on-roads-in-san-jose.

6 Krafcik, John. 2018. "Waymo One: The next step on our self-driving journey." *Medium.* December 5. https://medium.com/waymo/waymo-one-the-next-step-on-our-self-driving-journey-6d0c075b0e9b.

7 Patel, Prachi. 2016. "Agriculture Drones Are Finally Cleared for Takeoff." IEEE. October 19. https://spectrum.ieee.org/robotics/drones/agriculture-drones-are-finally-cleared-for-takeoff.

8 Madigan, Nick. 2018. "Need a Quick Inspection of a 58-Story Tower? Send a Drone." New York Times. August 14. https://www.nytimes.com/2018/08/14/business/drones-real-estate-construction.html.

of Commerce report, as of 2015 there were 15.5 million people in driving-related occupations (figure includes both motor vehicle operators, such as truck drivers and taxi drivers, as well as other on-the-job driving occupations, such as police officers and mail carriers).[9] Additionally, there are many jobs that do not themselves include driving but which exist within the current driving ecosystem—such as the work at rental car companies and dealerships, auto body shops, highway rest stops, and motels. As autonomous vehicles are adopted, jobs may shift or be displaced. However, experts project that technology adoption will happen gradually and isn't expected until the late half of the 2020s.[10] There is great interest among business, workers, and policymakers to better understand the potential impacts autonomous vehicle technology might have on the labor market as the technology becomes widely adopted.

The fully-autonomous passenger vehicle—such as that developed by Waymo, the independent self-driving technology company that originated as the Google Self-Driving Car Project—is already testing in more than 25 cities around the country. Waymo, whose mission focuses on building technology that could help reduce traffic fatalities and provide greater access, has been testing since 2009, and the fleet has self-driven more than 10 million miles on public roads as of October 2018.[11] Boston Consulting Group estimated in April 2017 that by 2030, one-quarter of miles driven in the U.S. will be by shared self-driving passenger vehicles[12] and that 15 percent of new cars purchased will be fully autonomous. AVs will change the way people and goods move around communities, which will in turn impact work. However, the rate of adoption will be dependent on a number of factors, including the development of AV technology, the speed and nature of policy and regulatory change in response to AVs, and consumer trust in the safety of the technology.

As fully-autonomous passenger vehicles reach critical mass, we are likely to see a few critical changes that impact jobs and work. First, this technology is likely to cause a significant readjustment in the labor market—from the direct loss of driving jobs, to large changes in demand for adjacent occupations—even as new jobs are created elsewhere. Planning ahead to manage this transition will be necessary to smooth the shift and reduce the number of people who experience it painfully. Second, adoption will likely prompt the creation of a new ecosystem of businesses and offerings built around the design, sale, operation, and enhancement of autonomous mobility solutions; these may create demand for new skills in the labor market and commercial uses of the technology that have not yet been envisioned. Third, adoption of AVs will demand policy innovation from cities and states, including new approaches to urban planning, land use, traffic rules, parking and vehicle-based revenue streams (registration, licensing, traffic and parking enforcement, etc.) and more. These changes will require greater technological expertise within city and state government, and may prompt the creation of new types of jobs in city halls, state agencies, and elsewhere.

9 Beede, David, Regina Powers, and Cassandra Ingram. 2017. "The Employment Impact of Autonomous Vehicles." Economics and Statistics Administration, U.S. Department of Commerce. August 11. https://www.commerce.gov/sites/commerce.gov/files/migrated/reports/Employment%20Impact%20Autonomous%20Vehicles_0.pdf.

10 Yankelevich, Aleksandr, R.V. Rikard, Travis Kadylak, Michael Hall, Elizabeth Mack, John Verboncoeur, and Shelia Cotton. 2018. "Preparing the Workforce for Automated Vehicles." The American Center for Mobility. July. https://ouravfuture.org/wp-content/uploads/2018/08/MSU-TTI-Preparing-Workforce-for-AVs-and-Truck-Platooning-Reports-.pdf.

11 Korosec, Kirsten. 2018. "Waymo's self-driving cars hit 10 million miles." *TechCrunch*. October 10. https://techcrunch.com/2018/10/10/waymos-self-driving-cars-hit-10-million-miles/.

12 Boston Consulting Group. 2017. "By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars." April 10. https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076.

Commercial Drone Delivery

Another technology poised to change the way that we connect people and goods is commercial Unmanned Aerial Vehicles (UAVs), more commonly known as drones. As a technology, UAVs are already in broad commercial use, largely for photography and surveillance purposes, such as insurance companies inspecting assets or agricultural interests monitoring crops.[13] Use is expected to continue to grow. According to analysis by McKinsey & Company, commercial drones—both corporate and consumer applications—will contribute an estimated additional $31 billion to $46 billion to the U.S. GDP by 2026.[14] Drones are envisioned as a way to inspect wind turbines,[15] provide internet service when none is available,[16] and deliver medical supplies[17] or consumer goods on-demand.

One area of expected growth in drone usage is commercial drone delivery, enabled by technology such as that developed by Wing, an independent business of Alphabet, Inc. Some experts believe that drones may offer significant value in last-mile delivery,[18] particularly in suburban and exurban areas where flight paths would be less crowded and landings easier to plot and execute than in urban areas, and the last-mile is currently most expensive. However, even in more densely populated areas, some real estate projects have already begun to plan for drone delivery, with rooftop drop spots and other drone-related infrastructure integrated into new, multi-unit residential projects.[19] This technology has the potential to change delivery work in the U.S., where there are currently at least 1.78 million people in delivery occupations as of 2017.[20] Given the number of people employed in these capacities, understanding the projected uses, rate of adoption, and related policy issues is critical.

As with AVs, UAV adoption will be determined in part by changes to policy and a shift in consumer acceptance. As the drone delivery market becomes more mature, a few issues at the intersection of the future of mobility and the future of work demand particular attention. First, commercial drone delivery may impact those who transport goods for a living, and would benefit from explicit inclusion as part of any consideration of the impacts of the loss of driving jobs and ways to address it. Second, commercial drone delivery has the potential to impact neighborhoods and local commerce in

13 Cohn, Pamela, Alastair Green, Meredith Langstaff, and Melanie Roller. 2017. "Commercial drones are here: The future of unmanned aerial systems." McKinsey & Company. December. https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems.

14 Cohn et al. 2017. "Commercial drones are here: The future of unmanned aerial systems."

15 Dvorak, Paul. 2017. "Self-flying drones and wind turbine blades: Inspections in about 15 minutes." Windpower Engineering & Development. March 1. https://www.windpowerengineering.com/operations-maintenance/tools-and-equipment/self-flying-drones-wind-turbine-blades-inspections-15-minutes/.

16 Metcalfe, Tom. 2018. "This 'pseudo-satellite' drone can fly 70,000 feet up in the sky." NBC News. July 24. https://www.nbcnews.com/mach/science/pseudo-satellite-drone-can-fly-70-000-feet-sky-ncna894071.

17 Stradling, Richard. 2018. "Medical delivery by drone begins with short flight at WakeMed this week." News & Observer. August 27. https://www.newsobserver.com/news/local/article217285105.html.

18 Joerss, Martin, Florian Neuhaus, and Jürgen Schröder. 2016. "How customer demands are reshaping last-mile delivery." McKinsey & Company. October. https://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/how-customer-demands-are-reshaping-last-mile-delivery.

19 Barragan, Bianca. 2015. "South Park Tower Will Have "First-Ever" Drone Landing Pad." Curbed Los Angeles. March 25. https://la.curbed.com/2015/3/25/9976890/condo-drone-landing-pad.

20 Sum of Driver/Sales Workers, Light Truck or Delivery Services Drivers, Couriers and Messengers, and Postal Service Mail Carriers. U.S. Bureau of Labor Statistics data on employment by occupation.
U.S. Bureau of Labor Statistics. "May 2017 National Occupational Employment and Wage Estimates." Last modified March 30, 2018. https://www.bls.gov/oes/current/oes_nat.htm.

multiple ways. Drone delivery from local business holds the potential to expand a brick and mortar store's or restaurant's potential customer base and enable new products and services. This would require that at least some workers in small businesses build proficiency with drones. However, the technology could also open up low-cost delivery from non-neighborhood outlets of drone-suitable products (for example, non-food consumer packaged goods). This would expose local businesses to new competition, potentially changing the entire texture of a neighborhood economy—with inherent impacts on jobs.

Automation and Work

Autonomous passenger vehicles and drones for commercial delivery both automate activities that have historically been performed through human labor: the driving of cars and the delivery of goods. As these technologies are adopted, they are likely to impact the way people and firms organize to get things done. Automation conversations often center around the concept of job loss, though that is just one type of anticipated impact. These technologies are also likely to bring organizational change to existing firms as jobs shift, disappear, or get created. And they are likely to prompt the creation of new jobs, firms, and industries. For example, when aviation was commercialized, the passenger airport was born. Job categories in baggage handling, aircraft maintenance, in-airport hospitality services, and others were created or expanded. In a recent paper, MIT's David Autor and Anna Salomons of Utrecht University found that the net effects of total factor productivity growth, of which automation is a significant component, amounted to an 18 percent increase in overall employment from 1970 through 2007, using data from 28 industries across 19 countries.[21] We expect that automation technologies on the horizon today will both create new jobs and expand existing job categories in ways we cannot yet anticipate. Indeed technological progress is the single largest driver of GDP growth per capita,[22] in part through automation.[23]

From a simplified economic perspective, as tasks are automated, productivity increases because it frees up labor—and, by extension, capital—to be deployed elsewhere. Generally speaking, automation can impact jobs in two ways: by replacing human labor or by augmenting it. In some cases, technology can automate an entire job or function. For example, retailers are increasingly implementing self-checkout systems, eliminating a role that a human worker has historically performed. However, the McKinsey Global Institute estimated in its 2017 report, "A Future That Works," that fewer than five percent of occupations in the U.S. are fully automatable given demonstrated technology.[24] In the case of autonomous vehicles, one can imagine the taxi driver being replaced.

To the extent that automation replaces human labor, it historically has not tended to replace whole jobs. Rather, automation replaces human tasks—

21 Autor, David, and Anna Salomons. 2018. "Is Automation Labor Share–Displacing? Productivity Growth, Employment, and the Labor Share." Brookings Papers on Economic Activity. March. https://www.brookings.edu/wp-content/uploads/2018/03/AutorSalomons_Text.pdf.

22 Chien, YiLi. 2015. "What Drives Long-Run Economic Growth?" Federal Reserve Bank of St. Louis. June 1. https://www.stlouisfed.org/on-the-economy/2015/june/what-drives-long-run-economic-growth.

23 Executive Office of the President. 2016. "Artificial Intelligence, Automation, and the Economy." December. https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/Artificial-Intelligence-Automation-Economy.PDF.

24 Manyika, James, Michael Chui, Mehdi Miremadi, Jacques Bughin, Katy George, Paul Willmott, and Martin Dewhurst. 2017. "A Future That Works: Automation, Employment, and Productivity." McKinsey Global Institute. January. https://www.mckinsey.com/featured-insights/digital-disruption/harnessing-automation-for-a-future-that-works.

and every "job" is made up of a series of different tasks. For example, voice recognition technology has not eliminated call center work; rather it has taken over simple requests, freeing up people to tackle more complex questions. Similarly, AVs and UAVs have the potential to change the task makeup of jobs that previously involved driving and/or delivery. In the case of delivery work, the car may drive itself, but the job may still require a person to transport an item from curb to doorstep. Automation can take over tasks that are dull, dirty, or dangerous, resulting in improved safety outcomes and general well-being.

However, from the perspective of an individual worker, automation may not be a positive experience; indeed, it may present significant hardship. Realistically, automation will eliminate some jobs. For instance, over the past several decades, the introduction of robotics technology to automate production tasks in the manufacturing industry has had profound impacts on workers and regions with large shares of manufacturing employment. In looking at data from 1990 through 2007, Daron Acemoglu of MIT and Pascual Restrepo of Boston University found that for every additional industrial robot introduced into a local labor market, 6.2 workers lost their jobs.[25] Over this period, manufacturing output increased more than 60 percent[26] even as employment fell more than 20 percent.[27] In addition, increased digitalization will demand that workers acquire new skills.[28] And automation may make a person's job less rewarding in terms of what they do, with what or whom they collaborate, and how much they are paid for their work. Indeed, interventions by the private sector, government, and social sector have historically been necessary to address disruptions caused by technology during periods of rapid change. For example, as we transitioned from an agricultural economy to an industrial one, we made secondary education universal in order to ensure that the workforce had the training required.[29] Intervention efforts can help ensure that technological change does not increase inequality or further polarize wages, and that the economic benefits of automation are broadly shared.

25 Acemoglu, Daron, and Pascual Restrepo. 2017. "Robots and Jobs: Evidence from US Labor Markets." Working Paper 23285, National Bureau of Economic Research. March. http://www.nber.org/papers/w23285.
See also: http://siteresources.worldbank.org/EXTLACOFFICEOFCE/Resources/870892-1265238560114/PRestrepo_Oct26_2016_PPT.pdf.

26 U.S. Bureau of Labor Statistics. "Manufacturing Sector: Real Output [OUTMS]." Retrieved from FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/OUTMS.

27 U.S. Bureau of Labor Statistics. "All Employees: Manufacturing [MANEMP]." Retrieved from FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/MANEMP.

28 Muro, Mark, Sifan Liu, Jacob Whiton, and Siddharth Kulkarni. 2017. "Digitalization and the American workforce." Brookings Institution. November. https://www.brookings.edu/research/digitalization-and-the-american-workforce/.

29 Selingo, Jeffrey. 2018. "The Third Education Revolution." *The Atlantic*. March 22. https://www.theatlantic.com/education/archive/2018/03/the-third-education-revolution/556091/.

CONVENING CONTEXT AND DISCUSSION

Background and Rationale

Autonomous vehicles and drones are developing quickly and raising important questions about how society should react or adapt. The issues at the intersection of the future of work and the future of mobility—namely, how these technologies will impact the labor market and what the public and private sectors can do to prepare—have been relatively unexplored. To the extent that these issues are being considered, it is primarily at the problem level (for example, how many jobs might be lost due to these technologies), with discussion about solutions still relatively nascent. These issues are increasingly timely as we prepare for the effects of automation on workers in several ways—by creating reskilling, reemployment, and other supports to assist workers who may face mid-career displacement; by ensuring current workers can upskill as the task makeup of affected jobs and industries shift; and by preparing students entering the workforce for the jobs of tomorrow through traditional and new education pathways. These efforts are complicated by the fact that signaling between sectors—business, education, government, and nonprofit—is currently inefficient and imprecise. Because of the scope and nature of these questions, and because solutions will necessarily require work across sectors, it is critical to convene stakeholders across sectors to discuss both challenges and solutions.

The Workshop

In March 2018, the Aspen Institute Future of Work Initiative and X (formerly known as Google X), the Moonshot Factory, convened a one-day workshop on the Future of Work and the Future of Mobility. Participants represented a vibrant mix of professionals from the private sector, nonprofits, and government from across the United States, with varying levels of expertise on AVs, UAVs, and potential policy solutions.

During the workshop, participants explored three topics. First, we explored a landscape map for work related to autonomous passenger vehicles. This map was developed by the Aspen Institute Future of Work Initiative in early 2018 as a conversation tool in order to explore the types of skills likely to be required by the new work ecosystem of AVs; given the constant evolution in the space, the landscape is likely to change.

Mapping Exercise: Driverless Vehicle Job/Function Ecosystem Today

This graphic captures an interactive exercise from the workshop that asked attendees to think through jobs that could be associated with autonomous vehicles. It is not intended to be comprehensive, but to illustrate how jobs may change.

CATEGORY		BUSINESS AND FUNCTIONAL NEEDS
DESIGN		Understand Human Experience | Experience Design
ENGINEER & TEST	Engineering	Software | Vehicle | Systems | Safety | Sensors | Security | Computer | Machine Learning
	Testing	Public Roads | Simulation | Closed Course
	High-Res Mapping	Development | Maintenance
BUILD & SELL	Manufacturing	Base Vehicles | Sensors | Specialized Components | Completed Self-Driving Vehicles | Retrofitting Cars
	Distribution	Fleet Uses | Leasing | Sales | Renting | Fleetwide Models
OPERATE & MAINTAIN	Maintenance, Upgrades & Repairs	Vehicles | Sensors (LiDAR, Radar, Cameras, Ultrasonic) | Inspection | Cleaning & Care
	Customer Support	Fleetwide | Individual Vehicle Owner | Business | Passenger
	Parking & Storage	Real Estate | Charging
ENHANCE & ADD VALUE	In-Vehicle Services & Experiences	Advertising | Car as Locker | Personal Services | Entertainment (Music, Video, Audio) | Connectivity | Vending & Point of Sale | Interaction with Other Technologies | Public Health | Education | Making/Creative Projects
	Delivery	Goods | People | Sensors
	Partnership Development & Implementation	
CIVIC POLICY & INFRASTRUCTURE		Curb allocation | Traffic control | Congestion Pricing | Data | IT | Infrastructure | Land Use Planning | Vehicle Permitting | Smart Tolls | Policing | Mapping | Cybersecurity | Integration with Mass Transit
POTENTIAL JOB SHIFTS & FLOWS		Drivers | Auto Insurance | Rest Stops | Parking Lots | Parking Enforcement | Creative Industry | Motels | Car Dealers | Travel & Leisure | Policing

By discussing the ways in which autonomous vehicle technology is likely to impact existing tasks, jobs, occupations, firms, and industries—and by exploring what new tasks, jobs, occupations, firms, and industries may be created as a result—participants generated the type of output that the education and workforce system could use to adapt how we learn, what we learn and when we learn it. For example, participants discussed the increase in the civic work of reimagining the urban environment—which may demand a different hiring approach by cities—and the likely proliferation of new business models around fleet management and AV maintenance—which could be a source of jobs in a variety of functions at a variety of income levels.

For UAVs, participants explored McKinsey & Company's 2017 framework for UAV use and adoption, included below, as a jumping off point to consider community impacts of the technology.

By discussing the ways in which commercial drone delivery might impact cities and neighborhoods, participants anticipated some of the local policy questions that may be on the horizon as drone advocates pursue regulatory change. For example, policymakers will need to consider some of the tradeoffs inherent in this technology—such as speed/cost/convenience of delivery contrasted against privacy considerations and the audio/visual nuisance of drone flight.

Finally, participants explored specific solutions and ideas to address the challenges and opportunities presented by AVs and UAVs.

Unmanned-Aerial-System Applications Fall into Five General Categories

Uses		Description of use	Estimated time to maturity,[1] years	Impact[2]
1 Surveillance	1a Short-range surveillance	Conducting short-range surveillance, image capture, and analytics	Already mature	■
	1b Long-range surveillance	Conducting long-range surveillance, image capture, and analytics	2-5	■
	1c Photo/video	Using photo and video applications without analytics	Already mature	□
2 Operations		Facilitating labor-intensive or difficult tasks	Already mature	■
3 Entertainment/advertising		Leveraging drones to entertain or advertise	Already mature	□
4 Signal emission		Providing multimedia bandwidth by emitting signal/video/sound	1-3	□
5 Movement	5a Transportation	Moving people	10-15	■
	5b Delivery	Moving objects	5-10	■

1 Based on expert industry interviews, with maturity defined as the point when public acceptance, economic drivers, technological advances, regulation, and infrastructure enable the majority of uses.

2 Based on expert industry interviews, where impact, in relative terms, refers to the magnitude of the economic effect on an industry.

■ High ■ Medium □ Low

Adapted from McKinsey & Company. 2017. "Commercial drones are here: The future of unmanned aerial systems." https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems.

IDEAS EXPLORED

Discussion at the workshop—mirroring discussion on this topic in public discourse—generally focused more on questions than answers. Some questions are broad: How can we ensure that wealth created by technology is shared broadly? Other questions fall closer to the intersection of the future of work and mobility: How can we retrofit, reform, or re-think existing workforce systems to accommodate anticipated labor need created by AVs and drones?

There are a number of policies and ideas that have been proposed to address the opportunities and challenges that UAVs and AVs—and automation in general—present for the workforce. Exploring specific ideas was important to ensure a more solution- and action-oriented conversation that helped to identify and draw out shared interests and barriers across sectors. UAV and AVs will likely result in policy shifts at the local, state, and federal levels. Some concepts will be especially valuable when thinking about how these technologies interact and impact workers. In an effort to offer concrete ideas, this paper presents three big ideas that generated interest during the workshop, but they are by no means intended to represent a complete policy agenda.

> *"As a matter of equity and economic competitiveness, the private and public sectors must be aligned on prioritizing investment in education and training for the most vulnerable people in today's workforce. We will yield an enormous shared benefit and do a tremendous justice if we increase the earning capacity in disenfranchised communities by preparing people for the future of work."*
>
> ***- WILLIAM ROGERS***
> *President and CEO, Goodwill of San Francisco, San Mateo and Marin counties*

Concept One: Create tools and opportunities for employers and technology creators to anticipate and signal future labor needs

Roundtable participants identified a lack of connectivity between technologists, employers, and the education and workforce systems as a key challenge in preparing for technology-driven changes to the labor market in the United States. Currently, these stakeholders have limited systems or networks to develop a shared understanding of what skills or credentials are likely to be in demand. Technology creators and employers have not been in a habit of deep engagement with educators to drive increased supply of certain skills because the scale and magnitude of any existing skills gaps has been manageable and has, for the most part, corrected with time. In the meantime, workers must rely on imprecise or indirect signals—like what they read in the news—to get a sense for the most valuable ways to update their skills in order to prepare for the future of work.

With a period of rapid technological change expected, including broad adoption of autonomous vehicles and commercial drone delivery, we need to make the connection between technology creators, technology employers, and the workforce and education systems stronger and more effective. We need more ways for these sectors to interact, both in-person and through scalable, transparent systems. Improved signaling of future skill demand will help both the education and workforce systems provide a more valuable service, will ensure an adequate supply of skilled workers for critical jobs, and will help reduce the pain of any technological transition by reducing the number of people who will be vulnerable mid-career.

All Sectors Have a Role to Play in Preparing for Future Labor Shifts

EMPLOYERS... should gain clarity on what skills and credentials will be needed in what combinations for the jobs of the future, and will need to take responsibility for sharing that with educators and workforce organizations—and sharing the cost of building the programs that will build their pipeline.

TECHNOLOGY CREATORS... should take responsibility for ensuring that educators and workforce efforts are up to date on the labor demands of new technology and the associated skills and credentials required.

WORKERS... should be more proactive in seeking information on the relevance of their skills and credentials, and logical areas for skills upgrades throughout their careers.

EDUCATION & WORKFORCE SYSTEMS... should bring new expertise into schools and organizations, and adapt to demand that is likely to change more quickly than usual.

POLICYMAKERS... should identify contemporary, real-time ways to collect the data necessary for decision-making, and create incentives for parties to work together to build connectivity.

Efforts such as Skillful have begun to implement programs aligned with this model that could support better signaling during a technology transition driven in part by AVs and UAVs. Skillful is an initiative of the Markle Foundation piloted in Colorado in partnership with Microsoft, LinkedIn, the state of Colorado, and local partners.[30] Skillful brings together businesses, state government, nonprofits, and educators to a shared, evidence-based understanding of how to align the labor force with labor demand. Using data and technology tools, Skillful seeks to provide transparency around the value of educational and training programs, give educators a clearer picture of which skills are in demand in their area, and give businesses a better sense of which skills are available in their applicant pool. Focusing on skills, rather than job categories, creates an opportunity for workers to move across industries with greater ease and flexibility, and gives employers a way to explore a more diverse and dynamic candidate pool.

Another approach discussed at the workshop brings businesses and educational institutions together to co-design the degrees that employers will most value. Miami Dade College presents a compelling example of a direct partnership: all of the programs created in the last ten years were as a result of close cooperation with business.[31] A new bachelor's degree in data analytics was introduced in close partnership with Siemens, NextEra, and Google. In a similar effort that connects more businesses with educational institutions, 2018 saw the launch of the Capital CoLAB,[32] a collective of 13 universities and 10 major employers in the Baltimore/Washington, DC area focused on the development of unique, region-wide credentials in the area of digital technology.

30 To learn more about Skillful, visit http://www.skillful.com/.

31 Padrón, Eduardo, and Edward Alden. 2018. "Report: Americans are finding work, but the better-paying jobs require a college degree." *Miami Herald*. June 1. https://www.miamiherald.com/opinion/op-ed/article212395614.html.

32 Greater Washington Partnership. 2018. Greater Washington Partnership Announces New Milestone In Regional Collaboration." June 22. http://www.greaterwashingtonpartnership.com/wp-content/uploads/2018/06/201806-GWP_Press-Release_Capital-CoLAB.pdf.

"As jobs change and new jobs are created in response to emerging technologies, we must build systems for workers that facilitate upskilling, while recognizing that technical skills are not enough. We must also make greater investments to develop the soft, and inherently human, skills that will be required regardless of job category. These soft skills are likely to become even more important in the face of automation."

- JAY BANFIELD
Chief Officer of Innovation & Scale and Managing Director, California, Year Up

Employers also have incentive to understand and address future skill needs internally. For example, AT&T discovered that nearly half of its 250,000 person workforce was ill-equipped for the likely technological evolution of their jobs. In order to stay competitive, the company is investing $1 billion in training and upskilling its workforce.[33] AT&T says that, as of early 2018, more than half of its employees have completed 2.7 million online courses to improve their technical skills. In an international context, Evian Water made a similar investment in the workforce at a bottling plant that underwent an automation transformation. The project cost the company considered and approved included both the cost of technology as well as a program to retrain nearly half of the 1,200 workers at the plant through more than 30,000 total hours of training.[34]

More specifically, technology, in the hands of an actor from any sector or through a partnership across sectors, could also be brought to bear to help solve this problem. AI and machine learning could be used to analyze public job descriptions or other data to understand and project skills required for certain industries, occupations, or regions—including those that may be experiencing change as part of a transition to an autonomous vehicle future both on the road and in the air. Indeed, some entities are already connecting these dots—for example, job search/recruiting websites like ZipRecruiter are using AI to provide prioritized lists of matched jobs or candidates to their users.[35] LinkedIn has created an Economic Graph to map the global economy based on 560 million members, 50 thousand skills, 20 million companies, 15 million open jobs, and 60 thousand schools.[36] Using this data in partnership with governments and other organizations, the company is able to spot and help respond to talent migration, hiring rates, and in-demand skills by region. A model effort would collect similar data from across occupations and sectors, and would be used by the workforce system and educational institutions to engage relevant expertise and tailor program and course offerings.

Finally, one factor influencing workforce training (and associated funding) is the U.S. Bureau of Labor Statistics (BLS) occupational projections. Currently, every two years, the BLS produces a 10-year occupational projection for the United States. The agency's methodology is comprehensive and rigorous, but there is some question as to whether it could be made more useful in light of the likely magnitude of and uncertainty about the rate and

33 Caminiti, Susan. 2018. "AT&T's $1 billion gambit: Retraining nearly half its workforce for jobs of the future." *CNBC*. March 13. https://www.cnbc.com/2018/03/13/atts-1-billion-gambit-retraining-nearly-half-its-workforce.html.

34 Mazzoni, Mary. 2017. "How Evian Automated Its Factory Without Laying Off Workers." *Triple Pundit*. September 20. https://www.triplepundit.com/2017/09/evian-modernized-factory-automation-employees/.

35 ZipRecruiter. 2018. "Candidate Calibration is Our Newest Feature for Employers." June 14. https://www.ziprecruiter.com/blog/candidate-calibration-feature/.

36 LinkedIn. 2018. "The Economic Graph." https://economicgraph.linkedin.com/.

impact of the adoption of automation technology.[37] For example, the BLS projections show no real disruption to the trucking industry in the next ten years, but experts believe that technology adoption could begin during that period.[38] In order to build flexibility around technology adoption assumptions into the projections, the standard projections could be accompanied by some scenario modeling with sensitivity analyses based on a few different adoption curves for certain technologies, informed by technology creators. Additionally, recent research from the McKinsey Global Institute,[39] the OECD,[40] and others have taken new and informative approaches to projecting the potential impact of automation on the labor market by studying discrete tasks rather than whole jobs, given automation's tendency to change the task-makeup of jobs rather than fully replace them. BLS could incorporate some of these methodologies into their projections to provide a more detailed picture of how technology might impact work, including a more granular assessment of within-occupation shifts in tasks and skill needs. Alternatively, the agency's projection model and data could be made publicly available so that other researchers could engage in independent analysis along these lines.

Improving the signaling between technology creators, employers, government, workers, educators, and workforce training entities will go a long way toward ensuring that workers tomorrow have the skills necessary to propel our economy through the 21st century.

Concept Two: Disrupt graduation and adopt a lifelong learning posture

In the post-World War II era, many workers could expect a stable career at a single company that would assume responsibility for investing in the workers' skills over time. This stability has given way to careers consisting of multiple jobs in potentially different occupations and industries.[41] At the same time, people are working more frequently with and alongside a rapidly changing mix of hardware and software in a "digitalization" of work, resulting in a fast evolving set of technological skill needs on the job. In a recent report, "Digitalization and the American Workforce," Brookings found that between 2002 and 2016, the percent of jobs that required high digital skills rose from 5 to 23 percent, and the jobs for which workers needed only a low level of digital skill fell from 56 to 30 percent.[42] In a future of AVs and UAVs, this shift seems poised to continue. For example, long-haul truckers may spend more time

37 Casselman, Ben. 2017. "A Peek at Future Jobs Shows Growing Economic Divides." New York Times. October 24. https://www.nytimes.com/2017/10/24/business/economy/future-jobs.html.

38 International Transport Forum. 2017. "Managing the Transition to Driverless Road Freight Transport." OECD. May 31. https://www.itf-oecd.org/managing-transition-driverless-road-freight-transport.

39 Manyika, James, Susan Lund, Michael Chui, Jacques Bughin, Jonathan Woetzel, Parul Batra, Ryan Ko, and Saurabh Sanghvi. 2017. "Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation." McKinsey Global Institute. December. https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages.

40 Nedelkoska, Ljubica, and Glenda Quintini. 2018. "Automation, skills use and training." OECD Social, Employment and Migration Working Papers, No. 202. March 14. https://www.oecd-ilibrary.org/fr/employment/automation-skills-use-and-training_2e2f4eea-en?mlang=en.

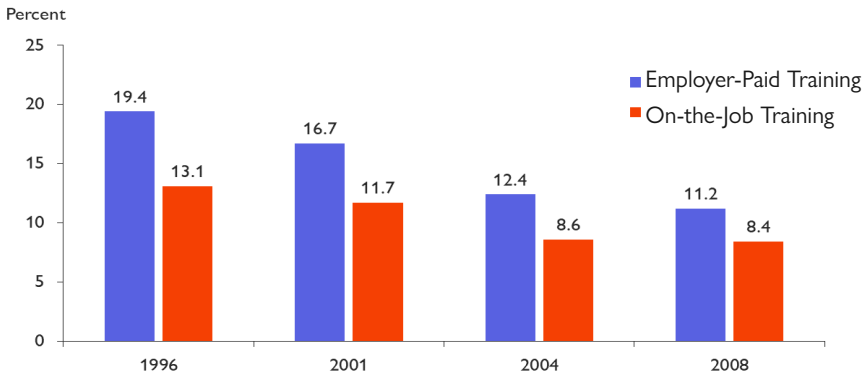
41 For example, Hunt Lambert, Dean of Harvard's Division of Continuing Education and University Extension, estimates that a college graduate today should expect to have 30 different jobs and three separate careers over their 60-year working lives. Future U Podcast. 2018. "Episode 13: Innovation in Continuing Education: The 60-Year Curriculum." May 15. https://futureupodcast.wordpress.com/2018/05/15/episode-13-maintaining-academic-rigor-in-open-enrollment-courses/.

42 Muro, Mark, Sifan Liu, Jacob Whiton, and Siddharth Kulkarni. 2017. "Digitalization and the American workforce." Brookings Institution. November. https://www.brookings.edu/research/digitalization-and-the-american-workforce/.

as a passenger managing logistics on a laptop and less time in the driver's seat. Delivery professionals may need to learn how to pilot a drone rather than driving a package to a customer.

As a result, we will need new ways for workers to continuously update their skills and acquire new skills throughout their careers. Part of the solution is correcting for declining corporate investment in workforce training; data suggests employer training has declined over the last few decades,[43] as employers look for ways to cut costs, and over concerns that workers might leave the company and take their new skills to a competitor.[44] But individuals and the public sector will also have to take some responsibility to ensure a smooth transition.

Percent of Workers Receiving Employer-Sponsored or On-the-Job Training



Note: Fraction of workers ages 18-65 receiving training of any duration in the last year.
Source: Census Bureau, Survey of Income and Program Participation (Employment and Training Topical Module); CEA calculations. Council of Economic Advisers. 2015. "Economic Report of the President."

This environment demands a disruption of the concept of graduation and a cultural shift to a lifelong learning posture. In some cases, individuals who have earned a four-year degree will need to continue to learn and train beyond their receipt of a diploma. Others may find that alternative educational pathways give them more flexibility to participate in the workforce sooner and update their skills as needed along the way. Reorienting the education and training sectors will take significant work by actors across sectors. In addition, it will require a rethink not only of what to educate and train for, but how the efforts are funded.

First, a lifelong learning approach presents a range of alternative options for post-secondary education. Career technical education and vocational schools and programs provide an educational foundation for occupations projected to be stable or growing, such as health care and engineering. For example, Delaware's Pathways to Prosperity program gets students started on a credential pathway while in

43 Council of Economic Advisers. 2015. "Economic Report of the President." February. https://obamawhitehouse.archives.gov/sites/default/files/docs/cea_2015_erp_complete.pdf.

44 Lynch, Lisa. 2004. "Development Intermediaries and the Training of Low-Wage Workers." National Bureau of Economic Research. December. https://www.nber.org/chapters/c9959.pdf.

high school.[45] The nation-leading program is part of a multi-sector commitment to increase the proportion of Delaware residents with college degrees or postsecondary credentials from 40 to 65 percent by 2025, and currently serves more than 9,000 students.

Community colleges also take on a greater role under a lifelong learning approach. Community colleges are more affordable than other options, and often provide schedules that accommodate students' existing jobs.[46] In the U.S., community colleges already serve 10 million students each year, and provide demonstrated economic return for students who complete degrees.[47] In recognition of their importance in preparing the workforce of the future, California's Community Colleges recently held a series of Future of Work MeetUps[48] and conducted a survey to understand the needs of employers and prospective workers. That process resulted in the proposal of an online-only learning environment that students can engage with around the other elements of their life, often including work and family. These types of solutions could support pre-career training for individuals who might have gone into a driving job but who might now require additional skills.

Second, because many workers do not have the financial flexibility to forego income, models that enable workers to learn while they earn are worth particular consideration. One concept that seems to be having a renaissance is the apprenticeship, earning praise from policymakers on both sides of the aisle. In Germany, nearly two thirds of students emerge from secondary school to participate in an apprenticeship in fields ranging from advanced manufacturing to banking to hospitality. In the United States, apprenticeships make up only 0.3 percent of the labor force, far below Canada (2.2 percent), Britain (2.7 percent), Australia (3.7 percent), and Germany (3.7 percent).[49]

Experts attribute this low participation rate to a variety of factors. First, there is a lack of awareness about the breadth and nature of these opportunities as well as social stigma about post-secondary education options outside of the traditional college track.[50] Second, there are simply not enough businesses offering apprenticeships, leading to a consistent over-enrollment in existing apprenticeship programs.[51] And finally, the federal role is fairly minimal: to oversee the system that certifies apprenticeship programs as "registered apprenticeships" if they are in compliance with the regulations concerning program design, worker protections, and other criteria. While there are benefits to registration—it can be an important quality signal to prospective students, and registered apprenticeships are an eligible use of funds for several education and workforce programs—the federal role is focused largely on ensuring the quality of existing apprenticeships rather than encouraging more apprenticeships. Some states are taking a more active role: South Carolina expanded its apprenticeship enrollment from roughly 800 in 2007

45 Jobs for the Future. 2017. "Delaware a National Leader in Career Pathways, Case Study Finds." October 24. https://www.jff.org/points-of-view/delaware-national-leader-career-pathways-case-study-finds/.

46 The College Board. 2018. "Trends in College Pricing." https://trends.collegeboard.org/sites/default/files/2018-trends-in-college-pricing.pdf.

47 Community College Research Center. "Community College FAQs." Teachers College at Columbia University. https://ccrc.tc.columbia.edu/Community-College-FAQs.html.

48 To learn more about California's regional Future of Work MeetUps, visit https://doingwhatmatters.cccco.edu/FullyOnlineCommunityCollege/Events.aspx#meetups.

49 Lerman, Robert. 2014. "Expanding Apprenticeship Opportunities in the United States." The Hamilton Project at the Brookings Institution. June 19. https://www.brookings.edu/research/expanding-apprenticeship-opportunities-in-the-united-states/.

50 Rabasca Roepe, Lisa. 2017. "Why Apprenticeships Are Taking Off." CityLab. February 1. https://www.citylab.com/life/2017/02/why-apprenticeships-are-taking-off/514977/.

51 Lerman. 2014. "Expanding Apprenticeship Opportunities in the United States."

to nearly 30,000 in 2018 through a combination of tax credits, apprenticeship consultants that work with businesses to facilitate the registration process, and an engaged community college system.[52]

Even in the absence of significant federal financial incentives, some companies—many of them, notably, German companies operating in the U.S.—have created strong apprenticeship programs. For instance, Siemens' facility in North Carolina offers an apprenticeship that combines on-the-job learning with an associate degree from a nearby community college, preparing candidates for a guaranteed job that earns a living wage without any student debt. It is important to note that apprenticeships can vary in quality and it is critical that safeguards are put in place to ensure that the experience is valuable for both apprentices and employers.[53] These models could support those whose careers may be disrupted due to the introduction of autonomous vehicle or commercial drone technology.

In the United States, some employers are providing opportunities for workers to learn and acquire new skills and credentials while employed, including those not necessarily in fields related to their concurrent employment. For example, Starbucks offers its coffee shop workers the opportunity to complete a college degree through Arizona State Online in any one of 49 different areas of study with no out-of-pocket tuition cost.[54] Similarly, Amazon's CareerChoice program offers Amazon employees the chance to earn a range of degrees and certificates, with many classes taking place in dedicated classrooms at Amazon facilities/workplaces and the company footing up to 95 percent of the bill.[55]

Finally, innovative funding mechanisms can make programs such as those described above more viable. In 2015, Singapore introduced SkillsFuture, a $500 use-it-or-lose-it upskilling grant for all Singaporeans 25 and older.[56] Policymakers hope that this program will address skills mismatch in the labor market and change attitudes about lifelong learning. In the United States, some policymakers have proposed Lifelong Learning and Training Accounts.[57] These individual accounts could pool funds contributed by employers and the government, as well as personal funds, for use toward an individual's training or development. Others are looking at ways for the government to provide safety net funds to individuals or areas where technology has disrupted work. Some have proposed an expansion of Trade Adjustment Assistance, originally implemented to support workers who lose a job due to trade with other countries, to include those who have experienced job loss due to automation.[58] Another proposal involves Workforce Opportunity and Innovation Act (WIOA) reform that would make training funds more counter-cyclical in order to

52 Moore, Thad. 2017. "South Carolina's apprenticeship initiative cracks growth milestone as new U.S. labor secretary advocates for on-the-job training." *Post and Courier*. May 18. https://www.postandcourier.com/business/south-carolina-s-apprenticeship-initiative-cracks-growth-milestone-as-new/article_72157c86-3c05-11e7-9514-7bb6c3409ac9.html.

53 Hanks, Angela. 2018. "The Administration and Congress Should Not Undermine Registered Apprenticeships." Center for American Progress. January 11. https://www.americanprogress.org/issues/education-postsecondary/reports/2018/01/11/444829/administration-congress-not-undermine-registered-apprenticeships/.

54 Blumenstyk, Goldie. 2014. "Starbucks Will Send Thousands of Employees to Arizona State for Degrees." The Chronicle of Higher Education. June 15. https://www.chronicle.com/article/Starbucks-Will-Send-Thousands/147151.

55 Fall, Jaime. 2016. "Five Questions for Amazon's Global Leader for Career Advancement, Juan Garcia." UpSkill America, Aspen Institute Economic Opportunities Program. August 2. https://www.aspeninstitute.org/blog-posts/five-questions-amazons-global-leader-career-advancement-juan-garcia/.

56 To learn more about Singapore's SkillsFuture program, visit http://www.skillsfuture.sg/.

57 To learn more, see the Aspen Institute Future of Work Initiative's issue brief, Lifelong Learning and Training Accounts: Helping Workers Adapt and Succeed in a Changing Economy, at https://www.aspeninstitute.org/publications/lifelong-learning-and-training-accounts-2018/.

58 Stettner, Andrew. 2018. " Mounting a Response to Technological Unemployment." The Century Foundation. April 26. https://tcf.org/content/report/mounting-response-technological-unemployment/.

ensure that the workforce system is able to meet increased demand associated with the introduction of new technologies, such as AVs and drones.

In order to both prepare workers for newly created jobs and support those whose occupations are disrupted with the adoption of technologies such as AVs and UAVs, it is essential that we value and resource a range of post-secondary education options, ensure that our infrastructure for mid-career retraining is prepared for the number and needs of people who might require it, and that we encourage employers to take an active role in training and educating their workforce.

Concept Three: Bring tech expertise into state/local governments to prepare for impacts of new technologies

The adoption of AVs and UAVs has the potential to impact state and local government workers and staffing needs. In some cases, these technologies will impact government jobs—in much the same way that they are forecast to do in the private sector. For example, the availability of AVs may prompt cities to rethink public transit, especially last mile transportation, which could impact transit jobs. UAVs may take over for U.S. Postal Service letter carriers on some routes or for some mail/package types.[59] As a result, government workers may require additional training for new jobs related to these technologies—from the city or from the public workforce training system. In addition, adoption of these technologies may change the economics of certain city or state programs, such as the Department of Motor Vehicles, parking enforcement, and others. For example, if individual vehicle ownership decreases, parking revenues will likely decrease. Understanding and planning for the impacts of these technologies will require new skills and capabilities among government staffers to design new revenue models. Both the labor force impacts and the economic impacts demand expertise on these technologies inside city halls and state capitals.

Bringing tech expertise into government holds promise for—and requires commitment from—all stakeholder groups. Policymakers gain a deep, current understanding of technologies to inform work and plan ahead, but they must be ready to change. Business stands to benefit from the infusion of tech expertise in government because it allows policymakers to take a nuanced approach to regulation.

Existing models provide a useful frame of reference. In some cities, mayors' offices have created Entrepreneur-In-Residence or Fellowship programs that create a formal way for tech talent to contribute to city government operations over a short term. For example, the city of Los Angeles created a technology advisor fellowship at Los Angeles Department of Transportation (LADOT).[60] Made possible by a grant from a locally-focused foundation, the technology advisor was tasked with the creation of a citywide strategy and a policy plan for the City to ensure a safe, mobile, sustainable future for Los Angeles. Other cities have established formal offices of Innovation and Technology. For example, in New York City, the Mayor is advised by a Chief Technology Officer whose mission is to create a more inclusive and equitable tech ecosystem for city residents.[61] Any of these approaches would create a temporary mechanism to address the change in the nature of the work of the city government.

59 U.S. Government Publishing Office. 2017. "Accomplishing Postal Reform In The 115th Congress – H.R. 756, The Postal Service Reform Act of 2017." Hearing Before the Committee on Oversight and Government Reform, U.S. House of Representatives. February 7. https://www.gpo.gov/fdsys/pkg/CHRG-115hhrg26360/pdf/CHRG-115hhrg26360.pdf.

60 To learn more about the City of Los Angeles's Urban Mobility fellowship, visit http://www.urbanmobilityla.com/fellowship/.

61 To learn more about the City of New York's Chief Technology Officer, visit https://tech.cityofnewyork.us/.

Third-party nonprofits also match private sector talent with public sector opportunities to bring specific expertise into government service. For example, FUSE Corps is a national nonprofit based in San Francisco that works with cities to scope year-long assignments for executive fellows.[62] At the federal level, the Partnership for Public Service also helps to recruit relevant talent and train career public servants in an effort to create a more effective government generally,[63] and TechCongress places technologists in a one-year fellowship with members of Congress and congressional committees.[64]

In addition, the creation of a commission, advisory committee, or task force could provide valuable insight. The State of Oregon recently passed legislation to create a Task Force on Autonomous Vehicles that has already begun to look at how AVs intersect with issues including licensing and registration, insurance and liability, law enforcement and accident reporting, and cybersecurity.[65] Other states that have established similar bodies include Delaware, Idaho, Maine, Massachusetts, Minnesota, Ohio, and Wisconsin.[66] Bringing leaders together across city and state lines, the National Conference of Mayors has an Automation Task Force that is exploring, among other things, "the impact and opportunity of automated systems for city-as-enterprise."[67] Where these task forces are underway or under consideration, policymakers should explore explicit inclusion of economic and workforce issues—both for residents and the jurisdiction itself.

"In San Jose, we recognize that as the Capital of Silicon Valley, our residents expect their government to be as efficient and intuitive as their user experience with any tech platform. They expect their city government to be innovative and willing to take measured risks that leverage the expertise of their residents and the Valley. However, it's hard for city government to compete with the private sector for the necessary talent. In response, we are developing partnerships and fellowship programs for experts, executives, researchers and students to infuse the city with current technologies and trends."

- KHANH DUY RUSSO

Senior Policy Advisor & Director of the Office of Strategic Partnerships and Performance, Mayor's Office for the City of San Jose, CA

Appreciating that the best approach may differ between jurisdictions, any of these approaches could help bring essential understanding of emerging mobility technologies into policymaking contexts, enabling more strategic planning and increased engagement with the private sector for better public results.

62 To learn more about FUSE Corps, visit https://fusecorps.org/.

63 To learn more about the Partnership for Public Service, visit https://ourpublicservice.org/.

64 To learn more about TechCongress, visit https://www.techcongress.io/.

65 To learn more about the State of Oregon's Task Force on Autonomous Vehicles, visit https://www.oregon.gov/ODOT/Get-Involved/Pages/Task-Force-on-Autonomous-Vehicles.aspx.

66 National Conference of State Legislatures. "Autonomous Vehicles: Self-driving Vehicles Enacted Legislation." Last updated November 7, 2018. http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx.

67 Office of Mayor Pete Buttigieg. 2018. "South Bend to Host U.S. Conference of Mayors Automation Task Force." July 25. https://southbendin.gov/2018/07/25/south-bend-to-host-u-s-conference-of-mayors-automation-task-force/.
To learn more about all U.S. Conference of Mayors Task Forces, visit https://www.usmayors.org/the-conference/committees-and-task-forces/.

CONCLUSION

The introduction of AVs and UAVs into the economy will undoubtedly have impacts on work and workers in the United States. To maintain a competitive labor force, we will need to improve the connectivity between sectors to speed up and clarify signaling about in-demand skills. To ensure that we can keep our economy strong as technology changes jobs, we need to create more options and more opportunities for all people to learn throughout their careers. And cities and states will need to hire or otherwise engage expertise to help plan for the implementation of AVs and UAVs. These three concepts—improving signaling between sectors to identify and train for in-demand skills, disrupting the idea of graduation in favor of a lifelong approach to learning, and strengthening technological capability in city halls and state houses—represent promising approaches to help us plan for the changes that these technologies are likely to bring. But this list is just a start—in part because we cannot yet anticipate how these technologies will create jobs, change them, or cause them to disappear. Bringing together stakeholders across sectors is essential to develop a shared sense for what we know and what remains uncertain in forecasting some of these changes, so that we can all anticipate and drive best possible outcomes together.

While the future is uncertain, we have the opportunity to embrace technological innovation and the responsibility to manage the transition, minimizing disruption and giving all Americans the opportunity to succeed. Technology holds the potential to change society for the better, but we must manage its impacts to create the society we want. Ultimately, we will have the opportunity to ensure that any jobs created in the AV and UAV ecosystems will be quality jobs with pathways accessible to all who seek work. After all, these technologies will only have realized their full potential if they result in gains that are shared broadly.