

The Effect of Autonomous Vehicles on Education

Abstract

The evolution of autonomous vehicles (AVs) is a major innovation that will have a profound impact on the economy, contributing to both the loss of existing jobs and the creation of new ones. With each level of innovation and adoption of these vehicles, there will be an increased loss of jobs within the economy across many different connected segments. Although this loss will be gradual over the next several decades, the estimated number of jobs that could be lost is substantial. The jobs created related to autonomous vehicles during this period of time are unlikely to outnumber those lost, and will require entirely different skill sets. Education will undoubtedly be affected with this shift in the economy; however, analysis of the predicted job loss reveals that most jobs lost due to the increase of autonomous vehicles have minimal education requirements, and the development of AVs is projected to create a number of jobs that require a bachelor's degree or higher.

Snapshot of Key Findings

- By 2030, an estimated 15% of all car sales will be self-driving vehicles.
- The adoption of AVs may cause the loss of more than four and half million jobs and \$168 billion dollars in annual wages. While some industries will be directly impacted, AV technologies will also create new jobs.
- In addition to the transformation that the transportation sector will experience, other indirect, but connected, industries will also be affected, including insurance, smart signals, location-based or GPS dependent sectors, hospitality and municipalities.
- Higher education institutions have an opportunity to enhance their existing curricula in the areas of specific value to the AV and related industries.

Brief History

While autonomous vehicle development has evolved dramatically in the last several years, the widespread adoption of fully self-driving vehicles is predicted to still be decades away. The current state of the market is what is regarded by McKinsey as AVs' first era: AVs are still in development and cars currently being sold offer no or limited automation capabilities. The market is expected to remain in this era until 2020. Little job loss is expected in the automotive or related industries during this time and jobs associated with the development of AVs such as programmers and engineers will be added to the economy.

AVs' second era is projected to take place from 2020 to 2035. This is where the effect of AVs on the economy will truly begin. Consumers will begin to adopt AVs so that by 2030, an estimated 15% of all car sales will be self-driving vehicles. Many of the early adopters of this technology will be major personal transportation companies such as Uber and Yellow Cab. Additionally, industries like trucking may begin to adopt the technology resulting in job loss in these industries.

The third and final era will begin in 2035 and go to 2050. During this period, AVs will have their largest impact. During this era, it is predicted that all major taxi companies, trucking companies, and delivery services will have adopted AV technology, resulting in major job loss for drivers in those sectors. For consumers, AVs will have become the primary means of transportation, opening up many opportunities since consumers will not spend the daily average of 50 minutes in a vehicle. Additionally, this will be when the job loss extends beyond the automotive industry. Job creation associated with the development of AVs will likely still occur. However, vehicles at this point will be further developed and job creation may slow.¹

Figure 1: The Three Eras of Autonomous Vehicles¹



¹ <http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world>

Occupational Outlook

When factoring in the occupations directly affected by the rise of autonomous vehicles, the U.S. economy alone is looking at a loss of more than four and half million jobs and \$168 billion dollars of annual wages. Notably, the automation of tractor trailers has the largest direct impact on the economy. There are nearly nine times as many truck drivers as taxi drivers and it is the most common job in 29 states.²

Table 1: Direct Job Loss from Autonomous Vehicles³

Occupation	Average Annual Wage	Number of Jobs (2016)	Total Annual Wages
Taxi Drivers & Chauffeurs	\$25,690	278,949	\$7,166,199,810
Bus Drivers - Transit & Intercity	\$39,410	175,107	\$6,900,966,870
Driver/Sales Workers (Delivery)	\$27,720	445,189	\$12,340,639,080
Bus Drivers - School or Special Client	\$29,910	495,953	\$14,833,954,230
Postal Service Mail Carriers	\$51,790	314,155	\$16,270,087,450
Light Truck or Delivery Services Drivers	\$33,870	898,687	\$30,438,528,690
Heavy and Tractor Trailer Truck Drivers	\$41,930	1,910,673	\$80,114,518,890
Total	\$35,760	4,518,713	\$168,064,895,020

Beyond the direct impact on the loss of drivers, there are a number of other hypothesized sources of job loss due to this technology. A major feature of self-driving vehicles is their ability to drive back and forth between locations with no passengers. This may allow families that have two cars to switch to owning only one. Additionally, companies like Uber may expand to completely fulfill certain areas of transportation needs allowing some consumers to not even own a car. Decreased demand in the number of vehicles may result in a decrease in car manufacturing jobs.

With human error being the cause of 90% of accidents on the road, the mass adoption of self-driving vehicles will play a substantial role in reducing the worldwide 1.5 million annual fatalities and 50 million injuries related to car accidents. The increased safety of vehicles will reduce damage to vehicles and traffic violations. This will likely have an impact in the reduction of emergency care, auto body repair shops, auto insurance companies, and traffic police.⁴

² http://www.huffingtonpost.com/sam-tracy/autonomous-vehicles-will-_b_7556660.html

³ EMSI 2016.4

⁴ <http://www.marketwatch.com/story/driverless-cars-are-coming-to-take-your-job-2016-01-30>

Fewer truckers on the road and more drivers sleeping in autonomous vehicles will impact the hospitality industry through fewer motel stays and eating stops. Additionally, transporting freight via trucking may become cheaper as fewer truck drivers will be employed, which may draw business away from freight trains and pipelines.⁵

It is clear that the development and adoption of AVs will have an effect that ripples across the economy. However, very few of the jobs facing possible loss have advanced education requirements.

Education

Jobs created as a result of autonomous vehicles will be related more to the development and adoption of the new technology. The bulk of this job creation is likely to come before and during the loss of the other jobs in the first and second eras.

Car and technology companies are in need of many employees to make the potential of AVs become a reality. A large focus of the hiring will be on programmers and engineers. Programmers are needed to design the code that allows the AVs to take in all of the sensory data the car is observing and reacting to while navigating roads. Engineers and designers will be needed to help develop the next generation of vehicles that contain all of the necessary technology and sensors. They will also need to focus on designing the new vehicles' manufacturing processes. Additionally, they may need to develop car types that have never existed before such as a compartmentalized car to be used by services like Uber during peak commuting times when users may need to share vehicles.

Outside of car design and technology, the companies developing AVs will need to hire employees to help expedite their adoption by the public at large. This will necessitate the hiring of marketers and lobbyists who can focus attention and resources on the public benefits of AVs. Self-driving vehicles are an entirely new form of technology; simply creating AVs does not guarantee the demand necessary to support the businesses around them. Marketers will be hired with the focus of winning over the population with this new technology in order to drive sales upon launch of the vehicles. Taxi service companies may focus more on a marketing message that says customers do not need to own a vehicle anymore and can rely entirely on their service for all their transportation needs. Lobbyists will also be critical in the adoption of autonomous vehicles. The current laws and regulations in place do not allow for the mass adoption of AVs. The companies producing them need to ensure that the legal frameworks are put into place before the technology is finished being developed.⁶

⁵ http://www.huffingtonpost.com/sam-tracy/autonomous-vehicles-will-_b_7556660.html

⁶ <http://www.cnn.com/2016/02/12/google-self-driving-car-hiring-spreed-36-jobs-listed.html>

Unfortunately, data on the exact number of positions to be created from the development and adoption of AVs are currently unclear. However, that number may end up unlikely to match the jobs lost. Conversely, the demand for workers who have experience and degrees with the aforementioned backgrounds are is likely to increase.

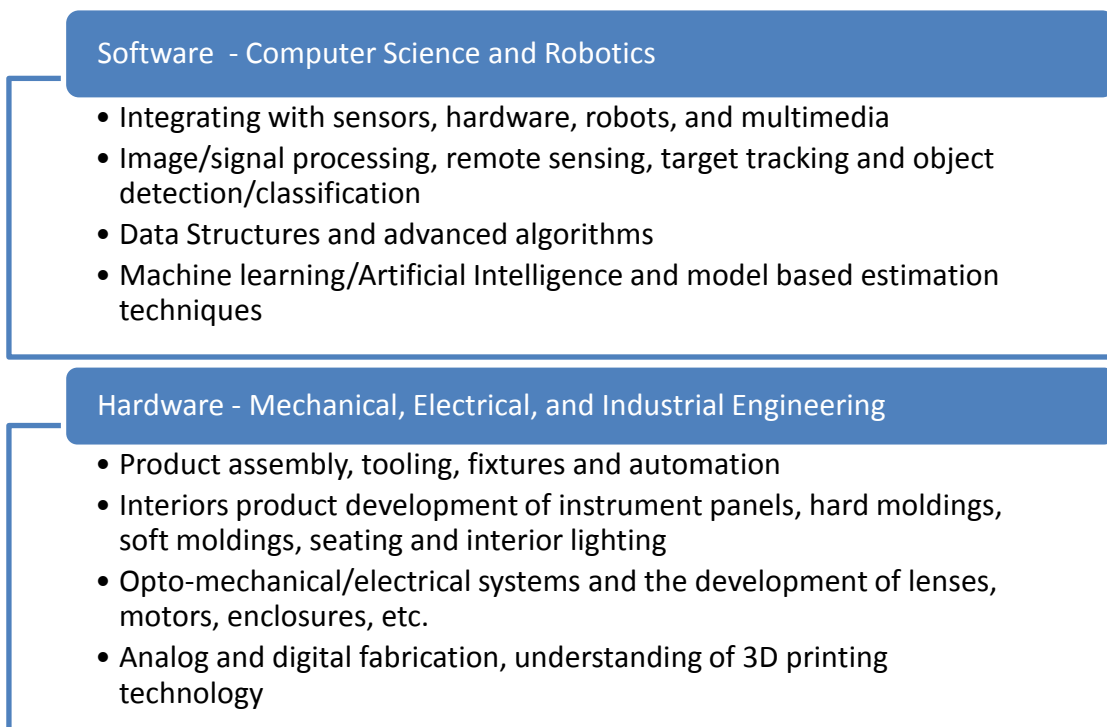
It is likely that autonomous vehicles will have a substantial impact on the job market. The development and adoption of AVs will result in the loss of many blue collar jobs that require little or minimal education. On the plus side, this will also contribute to the development of jobs in multiple professions that require higher education, including experience in programming and engineering as well as marketing and communications. Beginning with the first era of AV development and beyond, programmers and engineers will be needed to facilitate the growth of the industry directly related to the vehicles themselves, but also to related technologies, such as smart signals and location-based services. Many of these positions will require a minimum of a bachelor's degree and many will require a master's degree or higher with additional experience in the field. However, some positions may require a coding or programming background where a certificate or some level of other education may be better suited.

An analysis of the current job postings by Ford and Google's AV divisions revealed that they are trying to recruit programmers and engineers who have a strong interdisciplinary background in science and engineering as well as solid programming skills. AV hardware and software is tightly integrated and these companies are looking for candidates that understand the complexities of both. The basic educational qualification for a position within Ford's AV division is a bachelor of science (B.S.) in electrical engineering, mechanical engineering, aeronautics engineering, physics, mathematics, robotics, or computer science. In addition to a B.S. degree, Ford is also looking for candidates who have five to 10 years of experience in the field. Candidates with master's degrees are expected to have at least two to five years of experience in the field. Candidates who hold a Ph.D. in computer science are especially sought after for very specific high-level machine learning positions.⁷

⁷ <http://corporate.ford.com/jobs>

In order to better prepare students for positions within the AV industry, higher education institutions should consider integrating topics, such as those shown in Figure 2, into their curricula. Opportunities will emerge for institutions to develop partnerships with AV software developers and automobile manufacturers in research, development, teaching, and internships. Students possessing knowledge, skills, and experience directly related to the AV industry are more likely to secure employment upon graduation. At the very least, adding coursework in some of these topics may help reduce the amount of experience required for these positions moving forward.

Figure 2: Recommended Experience for Autonomous Vehicle Development Jobs^{8,9}



⁸<https://www.google.com/about/careers/>

⁹<http://corporate.ford.com/jobs>

As mentioned in the previous section, there will be additional non-technical jobs created to support the emerging AV industry. Figure 3 shows that some of these positions will be consumer facing (marketing, communications, sales, etc.) while others will be government facing (lobbyists, attorneys, regulatory compliance, etc.). Higher education institutions have an opportunity to enhance their existing curricula in the areas of specific value to the AV industry. Interdisciplinary programs for technical majors could be developed as could certificate programs that cover specific topics within the consumer or government facing areas. As with the software and hardware fields, opportunities for partnerships, teaching, research and internships will also present themselves.

Figure 3: Recommended Experience for Autonomous Vehicle Adoption Jobs¹⁰



Universities that integrate these and other applicable topics into their curricula will be better positioned to help their students secure the new jobs that will be created due to the rise of autonomous vehicles. The institutions may consider developing specific courses that combine several of these topics together as a broad overview or they could develop more in depth courses that lead to a minor in an AV-related software or hardware development concentration, or a minor in an AV-specific marketing, public affairs, or communications concentration. These courses and minors would not only apply to the jobs created due to autonomous vehicles but also to many other emerging autonomous technologies that will be created simultaneously.

Autonomous technology will have a profound impact on the economy over the next several decades. Students entering higher education now will be graduating when many more of these jobs will be opening up. Universities must take the appropriate steps to prepare students for this future job landscape.

¹⁰ <https://www.google.com/about/careers/>



About the Authors

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About UPCEA

UPCEA is the leading association for professional, continuing, and online education. Founded in 1915, UPCEA now serves most of the leading public and private colleges and universities in North America. For more than 100 years, the association has served its members through its Center for Research and Marketing Strategy, Center for Online Leadership, innovative conferences, and specialty seminars. The Center for Research and Marketing Strategy is the benchmarking, research and consulting arm of the association, formed to meet the research needs of its members.

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