

Executive Summary

Given that computer-operated systems are taking over most repetitive and labor-intensive tasks of the 21st Century, it is imperative that we begin to closely investigate automation and how it affects society. This project tackles the field of automation using historical analysis and various case studies on the current state of automation and proposes recommendations for adapting to it.

To begin, the expansive automation that occurred in the medieval era is assessed. The start of automation in this era was motivated by three distinct factors including; the influx of new immigrants, foreign influences from the East, and a small workforce, which was the most prominent factor. A shortage in the production of food made way for the first automation in the form of horse drawn plows. Consequently, the benefits of increased food production led to more automation, varying from fulling stocks to the clock. Automation had positive effects on the health and social structure of society, but also brought an obsession we still see today; profit-centered automation rather than human-centered.

The next key period was the Industrial Revolution which occurred twice between Europe and North America, and introduced a period of significant technological change underpinned by several inventions ranging from steam engines to the introduction of electricity. Industrial job creation and concentration led to the rise of the first cities and economic prosperity – a large step towards full scale automation, practically free of human input. Although this era had many positive impacts, its negative impacts were felt strongly. Child labour, poor living conditions, disease, pollution among many other problems were prevalent, impairing quality of life. While some may argue these problems weren't foreseeable, now that we have historical precedent, should we expect similar issues going forward as automation advances? Questions like this need answering before real problems begin to emerge.

The first case study examined was autonomous driving. The origins of automation in driving can be traced back to cruise control first introduced by Wilson-Pilcher in 1901, followed by driving assistance technologies like adaptive cruise control that have existed since the late 1990s. These technologies sought to assist drivers, with no intention of fully replacing the driver. In 2012, Waymo became the first project that aimed to achieve completely autonomous driving. Fast forward to 2019, several companies in addition to Waymo such as Toyota and Tesla have begun projects to develop completely autonomous driving technologies. Given the rapid pace of development, this report presents potential social impacts of autonomous vehicles including the displacement of over four million driving jobs in the USA alone, congestion issues resulting from increased vehicle ownership, regulatory and quality concerns of autonomous driving technologies and privacy concerns related to mass data collection and storage.

The second case study examined the hospitality industry, where automation comes in the form of kiosks, robots and Artificial Intelligence (AI). The hospitality industry is a crowded place with many brands fighting for consumer loyalties. The name of the game is customer service, and innovations in automation allow companies to offer personalized experiences. These automations are currently being employed at various levels of sophistication in trial hotels around the world, e.g. Alibaba's FlyZoo hotel. Though automation in this industry will result in the loss of jobs, it

will create others in the cybersecurity industry due to the increased security threat. It is also worth noting that automation has allowed for more energy efficient and customer personalized hotel operations.

The third case study surveys the field of medicine. Medicine is a field that dates back to as early as almost 5000 B.C.E and is a field that has changed tremendously over the years. The integration of automation in medicine has altered various practices in a positive manner, including radiology, ophthalmology and cardiology. Automation has allowed machines to take control of works that are beyond human limitations, such as advanced surgeries, and the management of large data sets that could otherwise not be reviewed effectively by humans. This is just the start for automation in medicine, but over time the integration will only increase, and automation will become more and more prevalent in your doctor's office.

The fourth case study on 3D printing highlighted the inherent benefits of increased, cheaper production of prosthetic limbs, low-cost homes, quick and painless construction in war-torn or disaster-prone areas without the loss of human life. Drawbacks to this type of automation include illegal commercial printing of weapons due to the relative simplicity of the technology. These findings show that while the automation of everything will disrupt society, it will also improve the quality of human life and take on tasks far beyond physical limitations of humans. The relatively new process of Building Information modelling was also discussed and highlights the ease with which construction companies can now collaborate because of automation in that sector. The drawbacks were touted as a Luddite fallacy because history shows that groups of employers are more likely to train skilled staff to use new technology than lay them off in favor of machines.

The final case study was the manufacturing industry. Economically speaking, manufacturing plays an important role for several nations in providing GDP and supporting millions of jobs. Countless products used daily are the result of a manufacturing process. Although there is evidence that shows current automation isn't necessarily replacing jobs, whether this will be the case in the future is unclear. Regardless, the benefits of automation are clear as it promises increased productivity at reduced costs. The question is if we are willing to accept eliminating the industry and the millions of jobs it supports in pursuit of profits. This will only be answered over time as automation evolves and further increases its presence in manufacturing.

It is evident that the integration of automation will certainly create some form of disruption in society. However, this disruption will not be all and bad. On one hand, it has the potential to improve product efficiency, productivity, reliability and safety, as well as complete tasks that are far beyond human capability. On the other hand, countless jobs will be eliminated, leaving a fair number of individuals jobless and privacy is also a concern. To combat these problems, various approaches are suggested. For one, automation should be advanced at a controllable pace, allowing humans to carefully monitor and regulate its development. Two, a multi-disciplinary committee should be created (IEEE, CSCE, etc.) to monitor the progression of automation in the various fields of engineering. Furthermore, relevant companies should have an *automation team* responsible for considering automation-related issues and a *tenureship*-style role for those in the field of engineering which allow engineers take on more social responsibility without the fear of reprisal. Overall, the intent is to smoothen the eventual transition to a largely automated world.