CHAPTER 8

Work in the Future

A Summary and Conclusion

> *There has never been, nor will there ever be, a technological innovation that moves us away from the essential problems of human nature … When we rely exclusively on computation for answers to complex social issues, we are relying on artificial unintelligence.*
>
> —Brousard, M. (2018). Artificial Unintelligence: How Computers Misunderstand the World. MIT Press.

As we conclude this book, the world is beset by a crisis of historic proportions. COVID-19, the disease caused by the SARS-CoV-2 virus, has rapidly spread throughout the globe, leaving death, sorrow, and economic hardship in its wake. Medical professionals and scientists the world over are trying to use their expertise to help monitor, make sense of, diagnose, prevent, and treat this infection.

The first indications of the epidemic were raised by AI software. Early in the morning on December 31, 2019, BlueDot's outbreak risk software alerted its customers that a cluster of pneumonia cases had been reported in Wuhan, China.[1] Other AI services that quantify the risk of infectious diseases noticed this anomaly as well, for example,

[1] www.wired.com/story/ai-epidemiologist-wuhan-public-health-warnings/.

P. Matthews and S. Greenspan, *Automation and Collaborative Robotics*,
https://doi.org/10.1007/978-1-4842-5964-1_8

HealthMap and Metabiota.[2] These algorithms use natural language processing algorithms to monitor news and government reports and utilize "global air travel patterns around transit hubs, livestock health reports, among other sources to estimate risk."[3]

On January 9, 2020, the World Health Organization issued its first notice, "Chinese authorities have made a preliminary determination of a novel (or new) coronavirus, identified in a hospitalized person with pneumonia in Wuhan."[4] The technology exists to identify clusters of infections, to validate these identifications through additional monitoring and blood tests, to quickly ascertain travel vectors of all of the inhabitants flying from nearby airports, and to monitor the destinations for similar symptoms. The problem is not technology. The issues are public policy, privacy, and cooperation among national and international jurisdictions. The technical issues having to do with data quantity and quality can be reasonably solved; the social issues require international cooperation, political will, trust, and money.

Despite the obstacles, the medical and scientific community have shown great courage and dedication in tracking the epidemic and in providing assistance and advice throughout the world. In addition to detecting and predicting the spread of infection, AI and robotics provide a spectrum of potential applications that could be used to predict, diagnose, and mitigate the impact of infectious diseases and other massive social

[2] www.technologyreview.com/2020/03/12/905352/ai-could-help-with-the-next-pandemicbut-not-with-this-one/

[3] Inn, T. L. (2020). Smart City Technologies Take on COVID-19. *World Health*.

[4] www.who.int/china/news/detail/09-01-2020-who-statement-regarding-cluster-of-pneumonia-cases-in-wuhan-china

disruptions (such as famine).[5] These applications can be roughly classified into five main categories as shown with examples in Table 8-1.[6]

Table 8-1. *Application Categories*

Application Categories	Examples

1. Monitoring, detection, and analytics	• Monitor communication and information flows
	  • Identify and validate useful information and curb the spread of misinformation
	• Monitor news sources and the flow of people and animals
	  • Monitor and predict disease transmission vectors

2. Clinical care	• Diagnosis and screening
	  • Automate the processing and distribution of patient data
	  • Automate blood tests
	• Disease prevention
	  • Decontaminate and clean infected surfaces, clothing and bedding
	• Patient care and disease management
	  • Provide bedside care to hospital and remote patients

(*continued*)

[5]Bullock, J., Pham, K. H., Lam, C. S. N., & Luengo-Oroz, M. (2020). Mapping the Landscape of Artificial Intelligence Applications against COVID-19. *arXiv preprint arXiv:2003.11336*.

[6]Yang, G. Z., Nelson, B. J., Murphy, R. R., Choset, H., Christensen, H., Collins, S. H., ... & Kragic, D. (2020). Combating COVID-19—The role of robotics in managing public health and infectious diseases.

Table 8-1. (*continued*)

Application Categories	Examples

3. Logistics and communication	• Optimize communication flows
	  • Use chatbots and RPA to provide public access to health services and to automate fulfillment of those services
	• Autonomous transport services
	  • Transport infected or possibly infected individuals to care facility
	  • Transport contaminated specimens and wastes

4. Continuity of work and maintenance of socioeconomic functions	• Teleoperation and Automation
	  • Continue manufacturing and utility operations through robots and remote control
	  • Provide automation to order supplies, and robots to delivery and restock them in local stores

Some of the applications such as using social robots to ease social isolation and to automate the processing of new patient data are in use today.[7] The pandemic has fast-tracked the introduction of these technologies. For example, the Connecticut-based Maplewood Senior Living facility has introduced robots to help residents maintain social distancing and isolation, and at the Mater Misericordiae University Hospital in Dublin, a pilot RPA project speeds COVID-19 test results, "enabling staff to quickly put infection prevention and control measures in place where necessary."[8]

[7]Developed by the Dublin unit of UiPath Inc., the robotic software application distribute test results from the on-site lab in minutes, "enabling staff to quickly put infection prevention and control measures in place where necessary." Loten, Angus (April 6 2020). *Wall Street Journal* (Online) [New York, N.Y].

[8]*Ibid.*

However, automating venipuncture and subsequent blood analysis is a research challenge, but a solution is currently under assessment for use with humans.[9] If successful, automated or robotic methods for drawing and then immediately test blood samples would both protect health works and greatly facilitate screening. Applications such as this one may someday transform healthcare and disease control.

The Transformation of Work

With increasing regularity AI, automation and robotic systems are transforming the way we work and play. They are altering our expectations about what humans and machines can achieve. These technologies enable us to discover correlations in data and thereby discover new pharmaceuticals or new uses for existing pharmaceuticals, to conduct thousands of experiments in parallel, to have greater success in search-and-rescue missions, and to explore planets through semi-autonomous rovers and satellites. Its impact on surgery, job screening, and customer care is more complex with both positive and negative outcomes. And, the potential of military robots is frightening.

AI and robotics are the result of deep yearnings within society and humanity for help—someone or something that can provide wise guidance or accomplish tasks that are too difficult, dangerous, or undesirable. We have also long known about the dark side of these yearnings: the danger of a malevolent superintelligence, the damage caused by an out-of-control wish to a Genie, or the slow self-destruction created by too much idleness (because others are doing the work and making the decisions).

[9]See, for example, Leipheimer, J. M., Balter, M. L., Chen, A. I., Pantin, E. J., Davidovich, A. E., Labazzo, K. S., & Yarmush, M. L. (2019). First-in-human evaluation of a hand-held automated venipuncture device for rapid venous blood draws. *Technology*, *7*(03n04), 98-107.

In this book, we have taken the middle path, examining the benefits, disruptions, and misfortunes, but with the conviction that proper diligence and human governance can create a better society in which tasks that are too dangerous, difficult, dull, or dirty are done by robots with human guidance; that by applying ethics-by-design principles, manufacturers can design and develop collaborative robots that operate alongside, symbiotically, with humans.

Artificial Unintelligence

When discussing the potential of robots and automation to transform work and culture, the question of artificial intelligence is often raised: Will machines become as intelligent as we are? Or, more intelligent? Will they take over the world and rule humanity? And how soon?

In this book, we have not focused on ge*neral artificial intelligence*, which is defined as the hypothetical capacity of a machine to learn and reason about any cognitive task, as well as or better than a human. This hypothetical capability can be contrasted with the domain-specific capabilities of current AI systems. These current systems can acquire remarkable skills at playing two-person games or six-person Texas Hold'em, accurately predicting the weather or modeling the shape of a molecule. An algorithm designed to win poker against humans would not likely be able to predict the weather. Each algorithm is tuned to the parameters of its "game."

Discussions about artificial intelligence and its limits often lead to discussions about the Turing test. The Turing test is the iconic test of a machine's intelligence and, in particular, its conversational ability. The test is typically constructed to be "game" in which an AI software contestant attempts to be indistinguishable from a human. As illustrated in Figure 8-1, during the test an interrogator communicates with a machine and a human through text. No one can see the other, and the interrogator

must decide who is the human. The interrogator sends a text message and the machine and human each send their separate replies. From the point of view of the machine and the human, the conversation is dyadic—they only know about their dialogue with the interrogator.

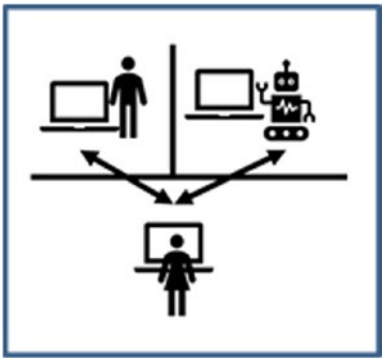

Figure 8-1. *A diagram of the classic Turing test*

As we write this, in March 2020, one of the authors asked Amazon's Alexa, "Alexa, can you talk to more than one person at a time?" Alexa answered, "Sorry I don't know that one." This was followed by, "Alexa, can you pass the Turing test?", to which Alexa replied, "I don't need to. I am not pretending to be a human." Conversational interfaces currently have limited ability to track the conversational flow in complex conversations and they typically cannot recall or make of use of prior conversations. Clearly, the version of Alexa that we accessed cannot pass the Turing test.

The developers of several conversational interfaces have claimed that their software has passed the Turing test, arguing that the Turing test is passed if a computer is mistaken for a human more than 30% of the time.

On June 7, 2014, *Eugene Goostman*, a software program that simulates a 13-year-old Ukrainian boy, was said to have passed the Turing test,

a University of Reading competition.[10] On May 9, 2018, Google's CEO declared in reference to *Duplex*, Google's conversational voice technology, "In the domain of making appointments, it passes the Turing test."[11] The premier demonstration of Duplex was very impressive—it paused before responding, elongated certain vowels as if it were thinking, and inserted "uh" and "um," when appropriate.

Did these conversational interfaces pass the Turing test? We don't think so. As suggested by Harnad in 1992, the Turing test was not intended as a 5-minute game that can be won through clever distractions. The likely intent that was expressed through three variations of the "Imitation Game" was not to propose a 5-minute test of the ability to mimic human reasoning, conversation, or some other form of performance. The intent suggested by Harnad was that the Imitation Game was a thought experiment to demonstrate that the attribution of intelligence (human or otherwise) is not based on any deep intrinsic knowledge of other minds that is available after a short interaction, but is rather built up over many experiences. We cannot read minds, we can only judge behavior.

We bring this up, at the conclusion of this book, for three important reasons:

Firstly, the ability to mimic humans to confuse a judge about who is human and who is machine should not be the goal of collaborative robots or automation. Attempting to fool a human associate might be a serious ethical violation—it should always be clear when a decision or action is solely based on an algorithm; whether its investment advice, the reporting of a newsworthy event, or the far more serious judgment about someone's

[10] *BBC News* (June 9, 2014). Computer AI passes Turing test in "world first." www.bbc.com/news/technology-27762088 [accessed on March 25, 2020].

[11] Richard Nieva (May 10, 2018). Alphabet chairman says Google Duplex passes Turing test in one specific way. *CNET*. www.cnet.com/news/alphabet-chairman-says-google-duplex-passes-turing-test-in-one-specific-way-io-2018

innocence or guilt, it should always be clear to those that are impacted that the decision or action was the result of machine-based decisions.

Secondly, organizations and institutions often err in thinking that a machine intelligence would make better decisions or more objective, less biased decisions. Machine-based decision-making works best when the rules of the game are clear, as in a machine-learning system that plays chess or Go, or as in RPA where a business process is well defined, and each decision point has been considered by the process architect. The immediate danger of AI is not general superintelligence, but that institutions and businesses are "outsourcing" important decisions to machine-learning systems that are biased and limited by the data they process and by the domain-specific, single-purpose algorithms that drive their decision-making.

Thirdly, the algorithms that are hyped because they pass the Turing test often fail on closer inspection. As we worked on this book, it became clear that perceived progress in the domains discussed in the book has been greater than actual progress. This is supported by the research conducted by our colleagues in projects, other researchers around the world, and our own research. According to the media, autonomous vehicles are only a few years away, smart buildings are being constructed at a great rate, business processes are being supported by automation, and we will soon see customer facing and frontline operatives being completely replaced by conversational software robots.

These so-called advances also include medical robots that can replace doctors, robots managing end-to-end supply chains, and robot pickers in agriculture. A parent that one of the authors met described how scared she is for her 5-year-old daughter's future because of all the jobs being lost to robots and automation. Her anxiety was easy to see and appreciate and in part provided some motivation for the book.

Working with Automation and Robots

Work in the future will change for many people and some areas of employment will be radically different over time. We see work being immediately affected by fewer jobs in transport, supply chain, and clerical tasks. This pressure is starting to be felt and will only increase.

Job losses are already being felt in repeatable clerical tasks and the use of tools like RPA is only going to accelerate this trend. One of the reasons for this is that RPA has a low cost of entry that is attractive to small- and medium-sized businesses. Training costs are comparatively low. A process can be automated more easily than a programmer can write a script. RPA is also attractive because of its ability to repeat a process in the same way every time without getting tired or bored and without making a mistake. Looking at literature online, it is clear that RPA has moved out of the lab, through testing, and is now an increasingly mature solution that is being sold to support business processes. In the RPA chapter we also discussed the strategy of keeping the solution either in the IT department or separate from the IT department and this can also have an effect on staffing levels. The pace of change has been accelerated by the COVID-19 pandemic and the work-only-from-home restrictions—hospitals, food distributors, and manufacturers are more willing to start pilot projects that introduce robots and automation.

However, there will also be new jobs created as people are released from menial tasks and are allowed more creative and sophisticated work. Work practices will also change, with a change in the balance of home working and commuting to new purpose-built smart buildings.

Artificial intelligence, machine learning, and deep learning are tools that can develop automation to the next level. Currently RPA can only execute existing processes. According to Serge Mankovski who was interviewed for the RPA chapter, AI tools will come into their own when process automation moves to process optimization. Intelligent automation

should be able to examine both the business processes and their supporting infrastructure and optimize the whole process from end to end. This would cause disruption to the workforce since it would be able to take decisions in a more flexible way.

Successfully integrating robotic systems into the workplace requires careful examination of the goals and attitudes of those impacted by the new processes. Altering a business process may create efficiency in one area of concern but might create other logistical and social problems. When workers work alongside collaborative robots, they must be convinced that cobot is not recording every action and utterance or, if so, that the data will be kept private unless there is an extraordinary and compelling legal reason to analyze and expose it. This applies not only to social cobots that move and directly interact with humans but also to autonomous vehicles and smart buildings, and to robotic software that sifts through emails. Transparency and commitment to ethics is essential to a healthy work environment.

Creating a successful application takes time, patience, and money. It does not happen at "Internet speeds." A good example is self-driving cars and trucks. The expectation that they will be driverless and on the roads in just a year or so has been replaced by the understanding that change takes time. Due to regulation and technical difficulties, they will need a supervisor/driver for some years to come. An entire ecosystem of laws and regulations, of road-service providers, and of containers that are easily managed by mechanical hands needs to be created alongside the machine-learning algorithms.

In this new ecosystem, jobs may be lost, for example, in delivery and supply chain after automation, and robots are fully integrated. The job losses in these domains are frequently offset by productivity boosts and new work opportunities. When driven vehicles are replaced with driverless vehicles, opportunities will open up for more sophisticated servicing and maintenance. Computer engineers will be in demand to fix problems with the technology of the driverless car as well as mechanical engineers to fix

the engine and brakes. Retraining will be an important factor in preparing for a driverless future.

Commuters in the future will have the chance to change their working practices. If you can work in a driverless vehicle, not being affected by motion sickness, you can leave your smart office earlier than normal and work all the way home. Suburbs will be pushed farther out as a long commute is the equivalent of working times. Changing these working practices may well result in better work/life balances and fewer stress-related illnesses as well as a reduction in road rage.

Employee health is a concern in some organizations that have a high rate of sickness absence. Smart buildings can provide personalized environments for workers, reducing the incidence of sick building syndrome. Smart buildings will also be able to remove the stress of parking at work by transmitting parking information to staff who are in driverless vehicles and on their way to work, assuming that the staff need parking information.

Data fusion is one of the tools that will allow all of this technology to deliver an integrated view of the work environment that can be understood by all stakeholders. Progress in high-quality machine learning and real-world models is still in the laboratories, but there are many research organizations working on this problem. The question of how the mix of digital, video, audio, radar, and GPS data can be gathered and fused into a single view is complex and the presentation of data fusion results will also be a challenge. Some of these solutions will take time to develop and commercialize, and the effects will not be felt in the next few years but over a much longer term.

Collaborative robots have the potential to increase the effectiveness of their human collaborators. Awareness of the autonomous entities in a collaborative team by its members will enable collaboration at a distance as well as in the immediate vicinity. For example, a collaborative team of robot and human bartenders and servers in a small space will use the same technology as a search-and-rescue team working over large

distances. Simple robots such as robot vacuum cleaners will evolve to collaborate with human occupants, kitchen appliances, and waste disposal robots to manage a home, an office, or a factory. There are still complex technology problems to solve in maintaining safety and exercising judgment in decision-making. Many of these problems are, again, in the more distant future, but they will be solved. Society will evolve as collaborative robots evolve. In the future we will face as many societal challenges as there are technical challenges.

Final Thought

At talks about machine learning and robotics, we are often asked, "What advice can you give to those who are entering the workforce?" The answer is that work has been transformed by computers, by the Internet, and now by automation and tomorrow by AI-based robots. This does not mean that humans should compete with machines, rather we should be more human—the skills that are needed more than ever by industry from humans are curiosity, sociability, adaptability in thought and perspective, creativity, ethical judgment, and natural intelligence.