Chapter 3

Digital Disruption in Production, Governance, and Management

In the previous chapter, we saw the areas in which digital disruption is already blurring the lines between the physical, digital, and biological spheres. In this chapter, we will examine what kind of transformations today's digital technologies are enabling in production, management, and governance and discuss how those changes, disruptions, and transformations may impact libraries.

Fundamental Changes in Production

Platform Businesses and Network Effects

Today's World Wide Web is a platform for almost all types of human activities, ranging from broadcasting and education to gaming, dating, and so on, and commerce is a big part of those activities. As e-commerce matures over the years, a "platform" business has emerged as a new and successful business model. The term *platform business* may sound unfamiliar, but examples of platform businesses can be seen all around us. Uber, eBay, Airbnb, Alibaba, Amazon, and Facebook are all examples of platform businesses.

A platform business enables value-creating interactions between external producers and consumers, provides an infrastructure for those interactions, and sets governance conditions for them in order to find matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants.[1] The core activity of a platform business is enabling interactions between providers and consumers and facilitating value exchange between those two parties.[2] Digital technology and the World Wide Web have been key to the success of platform businesses. In contrast to traditional businesses, platform businesses' most crucial infrastructure is digital. Their technology infrastructure enables them not only to reach a large number of people at many different locations but also to rapidly scale up their operations over a short period of time.

Many of today's platform businesses thrive because they succeeded at realizing what economists call *network effects*. Hal Varian, the chief economist at Google, describes network effects as follows: "A good exhibits network effects if the value to a new user from adopting the good is increasing in the number of users who have already adopted it. This generates a positive feedback loop: the more users who adopt the good, the more valuable it becomes to potential adopters. This positive feedback loop also works in reverse: if adoption fails to reach a critical mass of users, the good or service may fall into a 'death spiral' and ultimately disappear."[3]

A good example of positive network effects is the World Wide Web.[4] When it was first created, there were only a small number of web pages and users. The value of those web pages and of the World Wide Web was accordingly small. However, as more people access the Web, use the content, and engage in activities with one another on the Web, the value of the content and businesses on the Web increases to new users. This draws more people to the Web, thereby driving its growth and drawing even more users. The network effects apply to today's platform companies. The more users join and use platform businesses such as Facebook and Twitter, the more value their services have for new users. Note that network effects can also be negative. In the case of negative network effects, the value of a good or service mediated by the platform business decreases as more users adopt the good or service.

Varian distinguishes "network effects" from "increasing returns to scale" on the grounds that

network effects are a demand-side phenomenon while the latter is a supply-side phenomenon.[5] What he means by this is that network effects have to do with value increasing with the number of units sold, while increasing returns to scale have to do with the cost declining or the quality improving with the number of units produced. In platforms that achieve positive network effects, the value of adopting a service to an incremental user is larger when more users have already adopted the service. Here, value rises based upon how widely the service is already shared.

Platform businesses benefit from both (a) "increasing returns to scale" and (b) "learning by doing."

a. Airbnb and Uber present an opportunity to generate new revenue with very little up-front cost for those who have spare bedrooms and cars that are underused. With those providers on board, Airbnb and Uber can increase the number of new accommodation and ride options for consumers. The more suppliers join these platform businesses, the more value consumers get to derive from booking accommodations and rides through those businesses. That is, platform businesses increase their returns as they scale up their operations.
b. These businesses also improve their performance and lower the business cost by learning and applying new strategies, such as predictive analytics and machine learning algorithms. Airbnb, for example, makes use of deep learning techniques to enhance search ranking, listing categories, and amenities detection.[6] Uber relies on artificial intelligence (AI) for many things such as fraud detection, risk assessment, safety processes, marketing spend and allocation, matching drivers and riders, route optimization, and driver onboarding.[7] Just like any other type of business, platform businesses improve their productivity through practice and innovation over time, that is, learning by doing.

Connections as a Means to Generate New Value

New online platform businesses certainly follow a different business model than the traditional one. Almost all successful traditional businesses own and maintain large physical infrastructure and assets to process raw materials, produce goods or services, and hire a number of employees. Today's platform businesses, however, do not produce particular goods or services. They may not own any physical assets to operate. Unlike the more traditional linear type, platform businesses do not own the means of production. Rather, they create and maintain the means of connection.[8]

For example, Airbnb facilitates people's lodging arrangements by connecting those who are willing to rent their rooms or houses with those who are looking to stay at such places while traveling. Airbnb has over four million property listings in 6,500 cities across 191 countries. It is valued at approximately $30 billion, the third most valuable private business in the world.[9] But Airbnb does not own or maintain any of the real estate properties that it lists. It simply acts as a broker of the lodging arrangement transactions and makes money from charging transaction fees.

Platform businesses produce connections at an unprecedentedly large scale with the help of digital technologies. This is the kind of change that digital disruption is bringing to the area of production. The idea of platform businesses is not new. Marketplaces and shopping malls played a similar role in the past, albeit in the brick-and-mortar form. What distinguishes today's platform businesses is the fact that their activities take place more quickly with greater precision at a global scale, meaning they connect providers and consumers beyond the restrictions of time and space with more details factored into final transactions. All of us have had the experience of buying something on Amazon to later find out that its seller is shipping the item from a country on the other side of the globe, such as China and India. Amazon and other online platform businesses enable and facilitate such global-scale matches in astronomical volume. eBay, for example, enables interactions between over 170 million buyers and 25 million sellers all over the world.[10]

Artificial Intelligence as a Tool for Production

I showed above how digital technologies are bringing disruption in the world of business, where a traditional company's core activities are producing and delivering goods and services directly to its customers. Unlike those traditional businesses, platform businesses generate value by brokering connections between suppliers and consumers at a large scale and achieving positive network effects. Brokering the match between suppliers and consumers is one way in which digital technologies generate value. But digital technologies can also be used for the production of goods and services in a more direct way.

Artificial intelligence (AI) is the technology behind the new phenomenon of machine-generated content and services. AI is a discipline pioneered by British mathematician Alan Turing. Its goal is to create an artificial being that is as intelligent as a human, whether it is a piece of computer software or a machine.[11] John McCarthy, professor emeritus of computer science at Stanford University, came up with the term *artificial intelligence* to describe the topic of the Dartmouth Conference in 1956.[12]

The early AI systems followed the symbolic AI approach, which attempted to approximate human intelligence by mapping rules and programming

logic into AI applications. The symbolic AI approach produced many expert systems. An expert system is a computer program that mimics a human expert's decision-making process by following explicit rules and instructions that were fully understood and articulated by humans in advance. The impact of the so-called expert system in the early 1970s was mostly confined to academia. By contrast, recent breakthroughs in AI are changing the world. Those breakthroughs were enabled by the adoption of machine learning techniques, particularly deep learning, a subfield of machine learning that uses a neural network with many layers.[13]

Unlike an expert system, a machine learning system is not built with a comprehensive set of rules. Instead, it is given a large amount of data and a preliminary mathematical formula, which allow the machine learning system to gradually learn to classify or analyze that data in order to make accurate predictions over time through training. Deep learning, a subfield of machine learning, utilizes an artificial neural network (ANN) with multiple hidden layers between the input and the output layers, which refines and produces a learning algorithm that best represents the result in the output. Computer vision, facial and speech recognition, natural language processing, machine translation, and customized recommendations are all areas where the application of deep learning produced impressive results. This novel machine learning approach enabled AI researchers to build programs whose performance is close to or even exceeds that of humans. Research in machine learning and deep learning is continuing to advance at a rapid pace. In 2016, AlphaGo, an AI program designed with deep learning techniques to play Go, a very complex strategy game, won four out of five Go matches against the eighteen-time world champion Sedol Lee.[14] And this formidable AlphaGo was defeated by another AI program, AlphaGo Zero, only one year later.[15]

The greatest difference between a symbolic AI system and a machine learning AI system is that while the former is deterministic, the latter is not. In comparison to past AI systems that followed the symbolic approach, machine learning AI systems showed huge improvements in their performance. But they also present the new problem of opacity, which is often referred to as the "black-box AI" problem.[16] A machine learning system develops its own rules based upon a massive amount of data, and those rules often involve a very large number of parameters, ranging from hundreds to thousands or more. This makes it difficult for even the developers of such machine learning programs to tell exactly how those programs produce particular outputs or to fully explain the process. For example, AlphaGo learned how to play Go by playing millions of Go games against itself, and Deep Face, a deep learning facial recognition system developed by Facebook, operates with more than 120 million parameters.[17] Clearly, the level of complexity commonly seen in deep learning applications makes the use of advanced AI algorithms controversial, particularly in areas where transparency and accountability are of critical importance, such as in court.[18]

Nevertheless, the impressive results of machine learning and deep learning prompted many industries to adopt AI in areas traditionally viewed as exclusively human domains. Journalism is one such area. The *Washington Post, USA Today,* Reuters, and BuzzFeed are all experimenting with AI technology in news writing.[19] Heliograf, the *Washington Post*'s AI-powered software, produced news stories about the Olympics and elections based upon given narrative templates and a set of structured data provided. Wibbitz, the AI software of *USA Today,* creates short news videos that condense news articles. Bloomberg News uses similar AI technology to produce as much as a third of the content that it publishes.[20] Its AI tool, Cyborg, helps reporters produce thousands of articles on the quarterly earnings reports of businesses. AI applications are also used to generate many news articles on baseball, football, and earthquakes at the Associated Press, the *Washington Post,* and the *Los Angeles Times,* respectively.[21]

That computer programs are creating content for humans to read sounds like a sci-fi story, but it is most certainly happening now. By generating news content with AI, media companies can lower the cost of content creation and target many small audiences on local or niche topics with a much larger number of stories quickly created, at the same time.

The subfield of AI that deals with language is referred to as natural language processing (NLP). AI is not used only to produce news articles and other types of stories but also to perform translation. Google has been long applying machine learning and deep learning techniques to improve the performance of Google Translate.[22] In 2017, it released the Pixel Buds, a pair of wireless earphones that provide real-time translation for forty different languages by connecting to Google Translate. Google has introduced this real-time translation feature to Google Assistant-enabled Android and iOS phones in December 2019.[23] In 2018, Google also announced a new feature of Google Assistant called "duplex." With this duplex feature, Google demoed Google Assistant successfully making a restaurant reservation by carrying out a phone call with a person at the other end of the line.[24] These developments indicate that more language-involving tasks will be automated by AI to a significant degree in the near future. There is even a company that provides the service of AI in design, which many consider to be an area reserved for human creativity.[25]

News creation, translation, and a personal intelligent assistant are not the only new services whose

production is being led by digital technologies, specifically AI. Autonomous driving technology pursued by Apple, Google, Tesla, Uber, General Motors, Mercedes-Benz, Ford, and many other companies is another example of such machine-produced services to come.[26] From new ways to generate value in e-commerce through brokering connections at a massive scale to partly or fully machine-created services and content, digital technologies are certainly disrupting the area of production. In the next section, we will take a look at what kind of transformative changes digital technologies are ushering into the area of governance.

Challenges to Governance

Digital Technologies and Governance

Today's digital technologies are suggesting new ways of governance that rely less on traditional third-party authorities. *Governance* refers to establishing, monitoring, and implementing the rules and procedures for an organization to properly function. An organization is often run by people with conflicting interests who support different decisions. Governance activities manage such situations of disagreement and conflict by following a set of rules and procedures and steer the organization to adopt a decision that helps its prosperity in the long run. A government is the most prominent example of a governing agency; its operation is dedicated to governing an area or a country. What kind of role do digital technologies play in governance?

Digital technologies excel at connecting a large number of people on the Web and facilitating activities or transactions among them. This ability of digital technologies creates the potential to decentralize the governance role of a third-party authority or even eliminate it altogether. Blockchain is the technology that is in the center of this new possibility.

Blockchain

Blockchain refers to the distributed ledger technology. While it was originally developed for Bitcoin, the cryptocurrency that debuted in January 2009, blockchain can be used not just for financial but for any type of record keeping. What distinguishes blockchain from other record-keeping methods is its capability to encrypt a record of a transaction in a secure and tamperproof manner. Entries in a blockchain ledger are created by a distributed network of computers that participate in the blockchain-mining process, which makes the resulting records immutable and irreversible. Due to the security and the speed of the transaction it offers and its fully decentralized nature, blockchain is an exciting development for a wide array of industries, such as finance, insurance, digital content providers, supply chain management, and venture capital, as well as charities and even humanitarian NGOs.

How does blockchain manage to create and keep records tamperproof? This requires some explanation. Blockchain is basically a ledger, a list of transaction records, similar to a spreadsheet or a database. However, a blockchain database is distributed and decentralized. This means that a copy of each blockchain database resides in every single node of a network of computers. Each blockchain database in those nodes is identical, and all of them are kept in sync. The fact that there are so many copies makes it very difficult to forge a blockchain record. It is easy to forge a transaction record when there is only one database. It is much harder to do so when there are hundreds of thousands of them. Furthermore, in blockchain, each record is stored in a particular block, and each block is chained to the previous and the next block. If one changes a record in one block, it will make the entire block invalid because that particular instance of the block will now no longer match those blocks in other copies of the blockchain kept in other nodes of the network. This is how blockchain keeps its records immutable and irreversible.

The key components of blockchain technology are public key cryptography, hashing, nonce, and mining. Let's take a look at these one by one. First, public key cryptography works with the public and the private key pair. The public key is like one's address for a mailbox. The public key is given to others, so that they can find and send things. Once one receives something in the mailbox, the private key is used to unlock the mailbox.[27] The next component is a hash. A hash is data of a fixed size created by a mathematical algorithm. Each record in the Bitcoin blockchain, for example, is kept as a hash encrypted with the algorithm called SHA-256. For a hash function to work effectively in cryptography, it should be quick and easy to transform data to a hash, and at the same time nearly impossible to break the hash back into the original data. If a hash function takes too long to encrypt data or is easily decrypted, it is not practically useful.

Each block in a blockchain ledger includes multiple transactions. In the Bitcoin blockchain, for example, one block is capped at 1 MB, which contains approximately 1,400 Bitcoin transactions.[28] Each block includes the block header, nonce, the hash of the Merkle tree containing transaction records, the current time stamp, and the current block version number.[29] The block header includes the hash of the previous block. Nonce is a random string that satisfies the difficulty level set for the block to be accepted in the blockchain.[30] Finding the right nonce value is what is called "mining." Mining is a process of solving the mathematical puzzle of finding the needed nonce by

the brute-force trial-and-error process. A transaction gets recorded into a blockchain through the following process.[31] Transactions in the block go through a hash function and get encrypted. The resulting hash values from those transactions are combined into what is called a Merkle Tree, which makes it easy for one to look up a transaction in a blockchain ledger.[32] Then, the hash of the Merkle Tree, combined with the hash of the previous block, nonce, the current time stamp, and the current block version number go through the hashing process again. Any change to any of this block data will make the block hash completely different.

With all these components together, the process from the creation of a new record to the recordation of that record into a blockchain can be summarized as follows.

1. A transaction is transformed into a hash.
2. The hash of a whole block is created.
3. A nonce is appended to the hash and hashed again.
4. The resulting hash is compared to the difficulty level required by a blockchain.
5. If it is less than the required difficulty level, other nodes on the network check and confirm the solution and update their instances of the blockchain. Otherwise, the nonce is changed and the trial-and-error process repeats until it finds the satisfactory nonce.
6. The hash of the header becomes the new block's identifying string, and the addition is propagated through the network. That block is now part of the ledger.
7. The miners responsible for this are rewarded (if there is a reward associated with mining).

Since the blockchain's recording process takes place in a distributed network of many computers—that is, nodes—it is not possible to predict when and which node will get to find the right nonce. It is also not possible to predict which nodes will check and confirm the block, thereby lengthening the chain. And by each block referring back to the previous block and the previous block referring back to the one before, this chaining mechanism makes each block and the records in it irreversible and immutable—that is, tamperproof. This feature makes blockchain a very promising new technology with the potential of great disruption.

Technology as a Trust Protocol

Traditionally, a third-party authority is brought into important transactions, such as fund transfer, real estate purchase and sales, insurance, and any type of credentialing, from school graduation to marriage certification. The role of a third-party authority in those cases is to guarantee the authenticity of the transaction and the integrity of the recordation process. However, the technological implementation of blockchain can now provide such a guarantee without relying on any outside party with existing authority. In this sense, blockchain is a trust protocol that enables transactions on the Web to be validated, authorized, and recorded in a secure manner using the distributed network and the hashing process only. This capability of blockchain can make the authorizing and recording role of a third party obsolete.

As a trust protocol, blockchain provides privacy and transparency. It can be used for a wide range of purposes, such as recording and confirming ownership, provenance, credentials, identity, or a financial transaction, separately or in combination. Without the need for a mediating third party, a transaction becomes immediate, and its cost becomes much lower, while it still remains secure. Imagine one does not need to go through a bank for a financial transaction or a county clerk's office to officially record the purchase or the sale of a piece of real estate. You can imagine the scale and the impact of the blockchain technology when fully implemented.

While certainly experimental, blockchain is already being adopted in many areas. The Washoe County Recorder's Office in Nevada recently announced that it will make marriage certificates recorded on the Ethereum blockchain platform.[33] Officially recording a marriage and getting an official copy of the marriage certificate usually takes a week or longer. But if the blockchain technology is used, the certification can be done almost immediately. In addition, making a false claim about any marriage will be detected much more quickly. Blockchain is also being used for humanitarian aid. The World Food Programme (WFP), the UN's food-assistance branch and the world's largest humanitarian organization, set up a program called Building Blocks in early 2017 in order to distribute its cash-for-food aid to over 100,000 Syrian refugees in Jordan. Before this program, transferring money to refugees who needed food required working with local banks in the affected area. This incurred large transaction fees that can be as high as 30 percent of the total food aid fund. The adoption of blockchain resulted in a 98 percent reduction in those fees.[34] It was estimated that by the end of 2018, the Building Blocks program would cover all 500,000 refugees in Jordan. [35] In the future, blockchain may be used for providing not only food aid for refugees, but also proof of their identities, thereby allowing refugees to start new lives in a place to which they are completely new with less friction.[36]

In Estonia, a country that gained independence from the former Soviet Union in 1991, there exists a national blockchain that registers every Estonian citizen's identity. Estonia has been using blockchain since

2012 for national data registries such as the national health, judicial, legislative, security, and commercial code systems. Estonia backs up its data in other countries for further security, and this is called *digital embassy*.[37] Estonia also incentivizes entrepreneurs through its E-Residency program.[38] This program helps people from other countries to establish an EU company based in Estonia. Since all government services in Estonia are fully online, a business's residency in Estonia can be fully established via the Internet. As of November 2019, Estonia has over 60,000 e-residents from more than 160 countries.[39]

Since blockchain is a set of code, other code can be embedded to trigger certain actions in a blockchain database. This is called a *smart contract*. It is how blockchain can not only fully automate but also go beyond the governance role of a third-party authority. As a piece of code, a smart contract is executed when specific conditions are met in a blockchain. It is a self-executing if-then statement on a blockchain and enables a transaction to be automatically performed without the mediation of a third party.

A smart contract adds to the disruptive potential of blockchain as it can provide more security than a conventional contract and lower the costs associated with the transaction. Perhaps to take advantage of those benefits, Arizona and Tennessee legally recognized smart contracts in 2018.[40] More examples of blockchain and smart contracts in use include Everledger, which stores information about over one million diamonds; Horizon State, a secure blockchain voting system; Augur, a prediction market platform for trading; EventChain, a blockchain-secured event ticketing system; and Livepeer, a peer-to-peer live-streaming platform.[41] Currently, most smart contracts take place in Ethereum, a prominent smart contract framework. Ethereum is an open software platform for decentralized blockchain applications.[42]

It is to be noted that issues remain in current blockchain technology. It is slow due to its decentralized nature, lacks standards, and for that reason has interoperability issues. The blockchain mining process consumes a huge amount of energy.[43] There is also a potential security risk, such as the *51% attack*. The 51% attack is a scenario in which someone gets control of more than 50 percent of the nodes of a blockchain ledger. If this happens, the attacker can reverse a transaction and also prevent any new transaction from being recorded into the blockchain.[44]

In spite of these issues, blockchain is expected to spread to many industries due to its unique benefits. As it is adopted more widely, it will have an impact on governance activities in all types of organizations from businesses to governments.

Technology Model of Employment

Changes in the Way We Work

So far, we have examined what kind of transformations are taking place in production and governance with today's digital technologies. Now, let's take a look at how digital technologies are changing the way we work as well as the way businesses manage their employees' work. In recent years, remote work away from physical offices has become a popular trend. Due to the increasing volatility in the labor market, freelancing has also become quite common. According to the report "Freelancing in America 2019" by the Freelancers Union and Upwork, an online freelancing platform company, 57 million Americans, approximately 35 percent of the US workforce, freelanced in 2019, and the share of full-time freelancers increased from 17 percent in 2014 to 28 percent in 2019.[45]

Jobs in today's economy no longer follow the pattern of steady growth. Due to the growing automation enabled by technology, many jobs that involve not just mechanical and manual but also more skilled work are at the risk of disappearing. In the previous section, we saw that advanced AI applications can generate news articles, for example. Autonomous vehicles can also take away a great number of driver jobs once they are fully developed. While it is uncertain when and at what level autonomous vehicles will be put to wide use, autonomous vehicles are already being tested on public roads in several countries at a large scale.[46] Imagine the day in which UPS and FedEx own fleets of self-driving trucks. There will be a drastic drop in the number of long-distance truck drivers needed in the shipping industry. What kind of workers will be retained by these companies, and what type of tasks will they be performing at that point? And how will those companies be managing their employees?

Earlier, we discussed blockchain as an example of how the third-party authority's governance role may be disrupted by digital technologies. Sony developed a blockchain technology that stores educational records such as test scores, degrees, and diplomas and filed a patent application for it in 2017.[47] Suppose that this new system is widely adopted, and schools and colleges all start storing their students' educational records in a blockchain ledger. Technologically, it is entirely possible to have such a system to handle on its own the payment of any associated fees and the instant delivery of transcripts and other educational records to those who request them. This means that schools and colleges will no longer need the staff to manage those processes. This type of increasing automation will add further volatility and uncertainty to the labor market and bring significant changes in the way businesses manage their workers.

The Sharing Economy

The term *sharing economy* is often used to capture the character of the new type of economic activities that grew out of online platform businesses such as Uber and Airbnb. It refers to an economic model defined as a peer-to-peer activity of acquiring, providing, or sharing access to goods and services facilitated by those online platform businesses.[48] The sharing economy has certainly brought benefits and opportunities to people. It created flexible and short-term work options (also known as "gigs") and presented new ways for individuals to monetize their idle or underused assets by selling their short-term use-right to others. It also significantly lowered barriers to sales and purchase activities through online platforms.

The sale and purchase of services and goods between individuals are age-old activities. What is interesting about online platform businesses, however, is that they describe these age-old activities as "sharing" rather than "selling and buying." But this so-called sharing in *sharing economy* means short-term leasing or renting rather than sharing. And as such, it stands more in contrast with owning. A good example of this is buying and owning one's own car versus using the Zipcar service whenever one needs a car.

Sharing in its proper sense is something that takes place among friends and family with established connections. Such usual sharing activities do not involve monetary transactions, and their primary purpose lies in fostering connections and relationships, rather than making money or obtaining needed goods or services. By contrast, what is called "sharing" in the sharing economy is simply another type of market transaction for the short-term access to goods and services. For this reason, some have argued that a better term for this new type of market transaction is "the access economy."[49] Platform businesses in the sharing economy found a new way to create those short-term access offerings with more convenience and at a lower price point by mediating transactions online and attracting individuals rather than established businesses to provide services and goods.

Workers Reclassified as Consumers and Entrepreneurs

By enabling direct peer-to-peer (P2P) market transactions with technology, online platform businesses introduced much disruption to the established roles of a business as an employer and of a worker as an employee. In the traditional economic model, businesses hire employees to work for them and pay wages. Managing and supervising these workers is the responsibility of a business. While being placed under supervision for proper work performance, employees are entitled to fair labor practices from their employers. Employers are also to provide a level of support and direction for employees when disputes arise in their interactions with customers.

Online platform companies practically broke all of the well-established conventions in the employer-employee relationship. They claim to be technology companies that are no more than brokers in P2P transactions between individuals. This way, online platform businesses can distance themselves from their obligations as employers. For example, Uber does not regard its drivers as employees. Instead, it calls Uber drivers "Uber entrepreneurs."[50] It also argues that Uber entrepreneurs are the consumers of its platform.[51] With this new and confusing usage of the term *consumer*, Uber obscures the distinctly different roles of drivers and riders. Online platform companies prefer to conflate workers and consumers as simply "users" of their platform services and members of their so-called "community." But no matter which term is used, the role of one who works on a platform such as Uber to make a living is not so different from that of a traditional worker. Just like traditional workers, Uber drivers are also essential to Uber generating its revenue.

Let's take Uber drivers further as an example. Uber drivers can work on a flexible schedule. They also work on their own without a supervisor. These facts often count as the advantages of driving for Uber. But in comparison to the employees in a traditional company, Uber drivers also encounter disadvantages. Because Uber drivers are required to have a certain level of ratings, they are dependent on the ratings of their service by passengers even when those ratings are not fair or accurate. Since they have no formal supervisors or physical offices, they do not have a way to resolve these issues promptly, even when those ratings directly affect their earning.[52] Even in case of harassment or violence from passengers, which negatively affects their workplace conditions, Uber drivers can expect little meaningful support from the management.[53] Uber explicitly adopts a model of customer service communications in managing drivers and offshores and automates its main communications with them, which means that even urgent or important issues reported by Uber drivers that require a timely resolution will be often met with automated email replies.[54]

Uber drivers may be free from supervision by a human manager. But they are instead subject to surveillance-level algorithmic supervision by the Uber app, which they must use during their working hours. The app monitors drivers' performance in detail through the phone's accelerometer, GPS, and gyroscope and tracks each driver's ride acceptance and cancellation rates, hours spent logged in to the app, trips completed, and so on.[55] With its access to all drivers' real-time data, Uber has a huge advantage in morphing Uber drivers' behavior in the direction it

needs at any moment. By contrast, Uber drivers have to rely on whatever information the Uber app supplies. For example, Uber uses a surge pricing notification to keep drivers working at locations where there is a high demand for rides. But when drivers get to those surge areas, they often find that the demand has already disappeared.[56] Unlike an ordinary employer, Uber does not provide drivers with explicit rules that apply to the important details of their work in advance because they are subject to constant change.[57] For example, pay rates for Uber drivers continually shift, and so do other policies and incentives.[58] Needless to say, working in an unstable workplace environment like this is likely to generate much stress.

It is apparent to many that Uber, Lyft, and other ride-sharing businesses are a new type of taxi-service company. As a matter of fact, these ride-sharing businesses, with their rating systems and the data they collect through the apps, actually hold much more power over individual drivers than any traditional taxi companies ever did. And yet, they use the rhetoric of "sharing" to refer to paid work and call their drivers "partners" and "entrepreneurs." This clearly does not match the reality experienced by those who drive for these ride-sharing services for a living. Alex Rosenblat, the author of the book, *Uberland*, observed that the sharing economy popularized wider changes to work culture by conflating work with altruistic contributions, bringing into question the identity of workers, and devaluing paid work itself and that Uber brought to light the power that technology platforms wield to disadvantage their workers even as the platforms shield themselves with the rhetoric of neutrality.[59]

Libraries in the Era of the Fourth Industrial Revolution

In this chapter, we looked at how today's digital technologies are disrupting and driving transformative changes in production, governance, and management with examples. I hope that these examples have shown that there are enough grounds in the claim that the fourth industrial revolution is well underway and digital technologies are now bringing much more rapid and comprehensive changes than in the past to the way we live, work, and interact with one another, disrupting almost every industry in every corner of the world and transforming entire systems of production, management, and governance.[60]

How do all these relate to libraries? Clearly, libraries are not online platform businesses. AI and blockchain are being discussed with interest by many library professionals, but they are not close to mainstream adoption yet.[61] Given this, one may dismiss the impact on libraries of these new technologies and the transformative changes that they are driving in the areas of production, governance, and management as less than significant. But this would be a mistake.

The success of online platform businesses demonstrates that in today's economy, digital connections themselves generate value. It also signals that we will be using and interacting with more and more technology platforms to obtain connections that we need for our personal and work lives. What do such technology platforms do well and not so well? Are there things that libraries can emulate in what those technology platform businesses do well? What are some of the things that technology platforms do poorly but libraries can do with excellence? In a way, today's libraries lead a double life, one as a physical building and the other as a digital platform of e-books and many other types of online resources. If well leveraged, this unique combination of the physical and the digital can become a point of strength for libraries.

There is no doubt that in order to adapt to and succeed in the times of digital disruption, libraries must continue to explore and evaluate emerging technologies and adopt them appropriately. AI may feel like a distant phenomenon to many library professionals right now. But it will bring fundamental changes to the information and knowledge industry as its capacity approaches the level of generating content and services whose value equals or surpasses that of those produced by humans. It will also most certainly have an impact on people's information-seeking, learning, and teaching activities. AI has the potential to automate the labor- and time-intensive cataloguing, abstracting, and indexing processes; improve information discovery and retrieval;[62] extract key information from a large number of documents;[63] and detect certain features from visual materials such as historical maps.[64] These are the aspects of AI particularly relevant to libraries.

Blockchain is still an experimental technology and has several drawbacks in its current stage, as noted earlier. But the immutable and tamperproof record keeping that it offers can benefit a certain set of data and records that libraries need to store and preserve exactly the way they were created. Libraries may also apply blockchain to securing information that is at great risk of being altered or compromised by changing circumstances.[65] Other ideas for utilizing blockchain for libraries currently under consideration include a library patron card and a library currency for interlibrary loan.[66] But blockchain implementation would be beneficial to libraries when it can serve as not only a novel but also a cost-effective solution.

Even if libraries do not get to make use of blockchain for their collections or services in the near future, blockchain and smart contracts are likely to present interesting and unique opportunities for libraries. For example, how may blockchain help

with advancing the open science or the open access agenda that many libraries are strongly advocating?[67] Can blockchain be used to make the peer-review process in scholarly publishing more transparent?[68] How would these experiments relate to the overall trend of the role of governance and authority by a third party being challenged and replaced by technology, which I described earlier?

Lastly, libraries play a significant role in workforce development, helping with people's job searches and facilitating their job-related continuing education.[69] We have seen that digital technologies are likely to displace more jobs in the future. With their data-driven algorithmic supervision and management practices and the rhetoric of being a neutral broker, today's platform companies are already disrupting the traditional employment model while shunning their responsibility as employers. The clear understanding of how the platform economy redefines and reorganizes work and how technology enables this can help libraries best serve patrons who need help navigating the changing economy and the challenging job market.

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