# 20 Innovation

## Chapter Overview



The past decade has been a challenging time for banks and other financial institutions. Ultra-low interest rates have squeezed profits. Regulatory requirements and restrictions have significantly increased. Customer preferences and demographics have shifted. New financial technology (Fintech) competitors have emerged, levering technology in new ways and threatening longstanding business models. Now more than ever, banks need to innovate to maintain their position and, more importantly, to continue growing.

Like other industries, financial institutions are under pressure to provide a wider range of products and services with higher quality at lower costs. For many years, competition in the financial services marketplace was driven by innovative financial institutions, such as digital-only banks and discount brokers, that pioneered new business models that removed inefficiencies from basic services, such as retail banking, retail brokerage, and foreign exchange trading. Over time, competitive pressure moved up-market to include other business areas such as payments, lending, and derivatives trading. Competition in these areas came not only from financial institutions, but also from Fintech companies, many of them startups.

Fintech companies have capitalized on opportunities to use technology in ways that banks have been slow to take advantage of or feared to tread, often due to potential cannibalization of their existing lines of business. In many cases, Fintech competitors have been able to better leverage customer information and offer new and improved products and services to customers. They have also taken

advantage of changing expectations and preferences of the Millennial generation. This mobile-oriented and technology-astute part of the market has been more willing to use financial services that were not provided by mainstream institutions.

Banks have struggled to keep up with the pace of change in the technology world. While not so long ago, banks would routinely take 18 months to roll out a new technology solution to customers, today, in many business areas that approach is impractical. During that time, the underlying technology could change substantially, making the solution less relevant by the time it reaches customers. Likewise, if a delivery cycle is too long, Fintech startups could bring competing solutions to market much earlier and capture significant market share. Accordingly, banks have had to rethink how they deliver technology solutions and reimagine how their core businesses can be improved by making better use of technology (Case Study 20-1).

In recent years, many banks have defined new goals related to innovation. After seeing how technology-savvy competitors quickly upended other industries—for example, Amazon displacing brick-and-mortar bookstores and Uber engulfing a large part of taxicabs' business—financial institutions have had little choice but to adapt their strategy to remain relevant. Banks have had to invest in new technologies to stay ahead of the curve, or at least remain with the curve, understanding that not all of those investments will yield major benefits. In a fast-moving environment, it is not possible to determine in advance which innovations will ultimately be winners and losers. However, not all banks have become first movers. Many have chosen to be "fast followers" that invest in and adopt new technologies shortly after their credibility and effectiveness has been established.

Earlier chapters have examined, in the context of specific lines of business, how financial institutions and Fintech companies are using technology to provide new products and services and establish new business models. Chapter 6 reviewed how Fintech competition and new regulations are changing how investment advisory services are provided to customers. Chapter 8 examined how marketplace lenders are encroaching on banks' core lending business. Chapter 9 looked at how a variety of market participants were taking different approaches to make inroads into mobile payments.

## Case Study 20-1

## Changes at Bank of New York Mellon Help Drive Innovation

Bank of New York (BNY) Mellon is over 230 years old and is the one of the ten largest banks in the United States. Part of its strategy for providing competitive services was to function more like a technology company and less like a bank. To support this strategy, three initiatives were pursued: setting up innovation centers, shifting the bank's mentality to become more like that in the Silicon Valley, and encouraging an entrepreneurial way of thinking.

BNY Mellon set up six innovation centers, three in the United States and three overseas. Within the United States, one center was set up in New Jersey to help maintain close alignment and communicate with the bank's corporate headquarters. Another was set up in Silicon Valley to access the Fintech culture and emerging technology practices. The third was set up in Pittsburg, collocated with the bank's technology and operations group that was based there. Overseas, BNY Mellon set up two innovation centers in India, in Chennai and Pune. The last center was set up in London to collaborate on industry problems and solutions with European customers.

Part of shifting the bank toward having more of a Silicon Valley mindset was to move away from a highly structured, project-oriented delivery model, and move toward techniques like continuous delivery and continuous integration*. Using these approaches, products could be delivered to market more quickly,

* Continuous integration is discussed in Chapter 4.

so that customer feedback could be obtained quickly and products could, in a short period of time, be adapted to better address their needs. Another part of the mind-shift was to increase the reuse of software components and actively consider whether it would be more beneficial to use third-party components rather than build components in-house.

To help instill an entrepreneurial mindset, BNY Mellon identified all the IT services that it provided and assigned an internal "owner" to each service. The owner was responsible for understanding the clients who use the service, the costs and risks associated with providing the service, and for developing a strategy to improve the service offering. By focusing service owners and their groups more narrowly on these considerations, BNY Mellon aimed to apply an operating model that was more similar to the ones used by Fintech companies.

With over 12,000 employees, BNY Mellon's information technology (IT) division accounted for a quarter of the bank's overall headcount. Accordingly, to remain competitive, it was critical for BNY Mellon to find ways to help them to become more nimble and adapt to a fast-changing business environment. As shown by this example, in many cases innovation is less about the technology itself and more about people and the approaches they take.

**Questions**

1. Why would banks want to set up separate innovation centers rather than have just have a research and development function within the main IT organization?
2. How could BNY Mellon help ensure that service owners embrace and follow through with their responsibility to make the service successful?
3. What challenges might a financial institution encounter when trying to take advantage of continuous delivery?
4. What other approaches could banks use to help spur technology innovation within the organization?

*Source:* Streeter, Bill, "More Tech Than Bank," *Banking Exchange*, July 2015.

This chapter examines financial institutions' and Fintech companies' strengths and weaknesses and how they approach the process of innovation. Innovation opportunities related to distributed ledgers, i.e., blockchain, will also be reviewed in depth. Then, several other technologies that have disruptive potential within the financial services industry, including artificial intelligence and application programming interfaces, are discussed. Finally, a short conclusion to this book is provided.

## 20.1 BANK INNOVATION

By definition, innovation relates to change, changing something that exists and is already in place. It is also about introducing something new, such as new ideas, methods, or products. Achieving both of these objectives together is often difficult. Things that are established may not change easily and new things can be difficult to move forward.

In financial services, like most industries, innovation is a core principle of competitive strategy. These days, there is an expectation that any bank of considerable size will have a technology innovation function, and large banks will likely have that function located in multiple locations around the world. While much of the focus of banks' management is on operational effectiveness—i.e., efficient utilization of resources and execution of processes—a survey of over 200 CEOs from around the world found that only a quarter of them thought that operational effectiveness was more important than innovation [1].

This is not surprising because growth is a primary goal for most banks, and technology innovation provides the means for providing new products and services that enable growth.

A financial institution's innovation program should have a clear purpose that is aligned with overall technology strategy. For example, if the program's purpose is to facilitate technology transfer, the design of the innovation program will be very different than if the main goal is to achieve cultural transformation. Likewise, it is important to define the area(s) on which innovation is to be focused, e.g., whether the focus is on technology innovation, product innovation, service innovation, process innovation, or business model innovation. Innovation programs should also be well structured and formalized so that the participants in it understand their role and what they are intended to contribute to or get out of it.

To support technology innovation, many larger financial institutions have set up dedicated innovation centers, as discussed in Case Study 20-2. Often a key goal for these centers is to facilitate transfer of new technology into the financial institution. In this capacity, they help serve as a bridge between internal needs and opportunities and new technology and services that are being developed externally, in some cases by Fintech companies. It might seem counterintuitive that banks would want to work with potential Fintech competitors; however, as shown in Figure 20-1, collaboration was identified as a top competitive strategy in a 2016 survey of global banking executives [2]. Having separate innovation centers provides insulation from the day-to-day operational concerns, so that business and technology managers take time out to learn about and focus on new technology. Innovation centers also provide a vehicle for educating staff about new technology and helping to drive collaboration. Furthermore, setting up innovation centers demonstrates to an institution's shareholders that it is taking innovation seriously and is committed to bringing in new technology and ideas.

With regard to technology transfer, to a large extent, innovation functions act as matchmakers. They marry internal needs and goals with external capabilities. The starting point for achieving this is to be in touch with and understand both sides of this equation. The innovation function must maintain an ongoing dialog with internal stakeholders to understand their current challenges and opportunities. It must also engage with external technology providers to identify and narrow down amongst the thousands of potential offerings, which technologies are actually suitable for use within the institution; internal constraints must be taken into consideration. For instance, if the external company providing the technology is not sufficiently established or funded, a bank's vendor management procedures may determine that the company is too risky to depend upon. Alternatively, the potential technology provider may utilize a cloud platform that does not meet a bank's security requirements.

Financial institutions face a number of barriers when pursuing innovation goals. One major challenge is being able to take new technology or ideas and translate them into business solutions

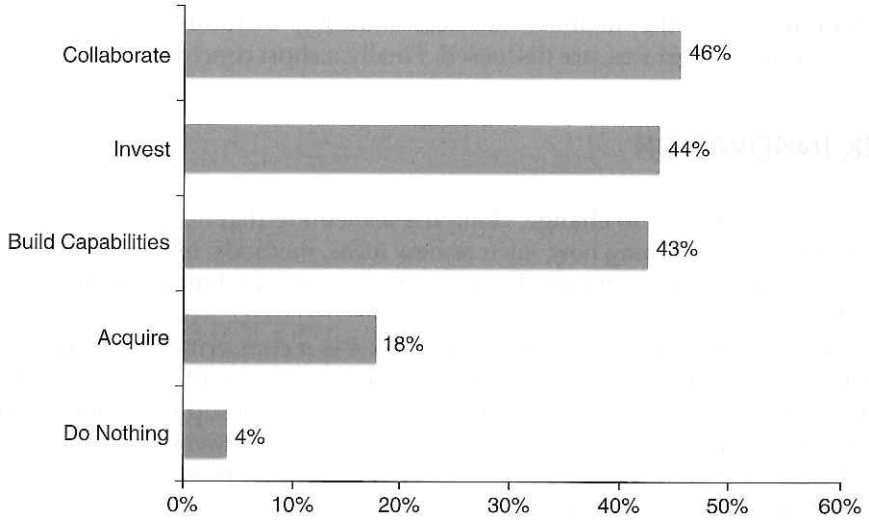


**Figure 20-1 Banks' strategies for competing with Fintechs**

quickly and on a sufficiently large enough scale to produce meaningful benefit. Finding, attracting and retaining people with the aptitude for and orientation toward innovation can also prove to be difficult for banks. The freethinking, break-the-rules attitude that is frequently associated with innovators is in many ways at odds with the structured and controlled environments that characterize banks. Another challenge that banks encounter is being able to break away from the standard operating models and performance assessment approaches that they use for their other business activities; these are often poorly suited for managing and measuring the value of innovation functions.

Quantifying the success of innovation measures and functions is complicated, yet it is essential for determining whether they are effective and are worth the often considerable investment to set up and maintain. In the case of technology transfer, an assessment objective could be rather simply defined as the level of adoption of new external technology. However, a more meaningful measure might be to assess the business benefit that was realized through the adoption of that technology. In some cases, the business benefit might be measured quantitatively, i.e., in terms of additional products

## Case Study 20-2
## Banking on Innovation Centers

Over the past decade, banks have formally embraced the idea of having innovation functions within their organizations, often in the form of separate innovation centers or "labs." Skeptics have suggested this approach is impractical because innovation is something that needs to be ingrained across the entire organization, as opposed to segregated within a single functional area and small number of individuals. However, many banks around the world including Citibank, Wells Fargo, BNY Mellon, Deutsche Bank, Bank of Tokyo-Mitsubishi UFJ, Standard Chartered, and the Development Bank of Singapore (DBS) have moved forward with the strategy of having separate innovation functions.

Some of the common themes that these banks are pursuing include the exploration and use of technology related to artificial intelligence (AI), big data, cloud computing, distributed ledger, and information security. Likewise, most banks' innovation functions are tasked with strengthening relationships with established and startup Fintech companies and becoming more deeply embedded in the innovation ecosystem, to help drive the adoption of new technology throughout the bank. There is also a focus on rapid prototyping and experimentation with new technologies.

Banks have different views on how best to approach innovation. For example, Citibank's Singapore-based innovation lab is focused on collaborating with institutional customers to develop technology solutions. Wells Fargo set up an accelerator where it invests up to $500,000 in startup companies with technology that is relevant to the bank and helps them understand what is necessary to integrate their solutions into the bank's IT environment. BNY Mellon provides an innovation boot camp program for its staff, in conjunction with Carnegie Mellon University. Deutsche Bank's goal is to identify and evaluate 500 Fintech companies per year and, for a select group of them, leverage their technology within the bank and foster their further growth and development. Bank of Tokyo-Mitsubishi UFJ's holding company, MUFG, has used "hackathons" to engage with Fintech startups. Standard Chartered and DBS partnered together with Singapore's Infocomm Development Authority to develop proof-of-concept technology solutions.

Clearly, there are many different strategies that banks are using to promote innovation. The wide range of approaches being used is not surprising though, given banks' diversity of cultures, competencies, and customers.

*Sources:* Citibank, "Citi Launches Innovation Lab in Singapore," http://www.citigroup.com/citi/citiforcities/home_articles/n_singapore.htm; http://accelerator.wellsfargo.com; Broughton, Kristin, "BNY Mellon Opens Silicon Valley Innovation Center," *American Banker*, November 17, 2014, http://www.americanbanker.com/news/bank-technology/bny-mellon-opens-silicon-valley-innovation-center-1071275-1.html; Atkins, Thomas and Andreas Kröner, "Deutsche Bank to Launch Three Tech Startup Labs in 2015," *Reuters*, June 2, 2015, http://www.reuters.com/article/us-deutschebank-tech-idUSKBN0OI28Y20150602; MFUG, "MUFG—Embracing Innovation for Change," http://www.bk.mufg.jp/global/newsroom/featuredarticle/2016_01.html; Standard Chartered, "We've Opened the eXellerator—the Bank's New Innovation Lab," March 23, 2016, https://www.sc.com/en/news-and-media/news/asia/2016-03-23-singapore-opens-the-eXellerator.html.

or services sold. In other cases, benefit could be measured qualitatively, i.e., in terms of customer satisfaction. Alternatively, the time required to deliver externally sourced, innovative technology to market could also be important to banks for assessment purposes. It is unclear even where to start when trying to measure a goal such as cultural transformation. Hence, it can be difficult to define and apply meaningful and consistent measurement standards.

## 20.2 FINTECH INNOVATION

That Fintech companies have been able to outpace banks at innovation should come as no surprise, given that Fintechs have a different operating model and are unencumbered by many of the constraints that banks are bound by. Likewise, typically banks have a formalized approach toward innovation that starts with objectives, which determine strategy, which is translated into an operating model. In contrast, Fintech startups might only have a technology vision and a few eager technologists. Solution developers at financial institutions may be weighed down by regulatory and audit requirements, ongoing operational issues, corporate technology standards, and directives to increase efficiency and productivity. In contrast, developers at Fintech startups have the luxury of focusing more on the underlying business problems and finding the best technology to create solutions. For the most part, Fintechs do not try to govern or measure innovation, other than by demonstrating the success of their technology solutions.

In contrast to banks, which must innovate to maintain their relevance, Fintechs must innovate to become relevant. This leads to a different mindset that helps drive innovation. For instance, in many cases, banks would not demonstrate solutions that are far from being production-ready to customers. In contrast, at startups the idea of waiting to provide a demonstration until a solution was almost ready for production would seem like a substantial waste of time and money; it would be too late to incorporate feedback from the demonstration at such a late stage of the development cycle. Customer expectations drive these attitudes to some extent. While consumers may be willing to put up with a buggy application that provides cutting-edge features from a Fintech startup, they tend to have higher expectations from an application that their main street bank provides.

Another factor that weighs in favor for Fintechs when it comes to innovation is their age and their size. With respect to age, the number of years the company has been operating and the age of its employees are both relevant. While new companies may struggle to get off the ground, they are also not weighed down by legacy systems and distracted by ongoing software maintenance and customer support. Likewise, unlike senior managers at a bank, who are typically in their 50s and 60s, the senior managers in a Fintech startup are commonly in their 20s and 30s. Hence, Fintech firms tend to be better oriented toward the needs and preferences of the Millennial generation, which is often the target audience for innovative solutions. With regard to size, Fintech startups' small size presents limitations, such as lack of resources; however, it also provides benefits that support innovation. Being small means that decisions regarding strategic direction need not be filtered up through layers of management or approved by cross-organizational committees. Rather, they can be agreed upon by a few people in a room and then quickly implemented.

In many ways, financial institutions and Fintech companies are complementary. Banks need to incorporate innovation in their products and services, but are challenged to innovate from within. At the same time, Fintech companies are well positioned to innovate, but need someone to use and fund the technology solutions they create. Hence, the idea of banks' internal innovation functions focusing on transferring technology from Fintech startups into the institution makes perfect sense (Case Study 20-2). However, where this model has broken down in recent years is where Fintech companies have been able to sidestep banks and deliver financial service solutions directly to consumers, becoming competitors to banks in the process.

Historically, with a few exceptions such as Paypal, the threat that Fintech companies have posed to banks has been relatively small. Regulatory restrictions limited the scope of activities that Fintechs

could directly engage in. More recently, this competitive threat has become greater as regulators have shifted their stance to be more supportive of nonbank innovation in the offering of financial services. For example, in the United States toward the end of 2016, the Office of the Comptroller of Currency (OCC), which issues banking licenses, began exploring the issuance of special-purpose national bank charters for Fintech companies. It is likely to be a double-edged sword, enabling Fintechs to provide financial services more easily by no longer having to comply with many different state-level laws and regulations, but also increasing regulatory compliance that is required. In other countries, regulators have begun testing new approaches that provide more regulatory flexibility but still maintain an adequate level of oversight. For instance, the Monetary Authority of Singapore has created a regulatory sandbox that relaxes of some legal and regulatory requirements which allows Fintech companies and financial institutions to experiment with new offerings within a "well-defined space and duration".

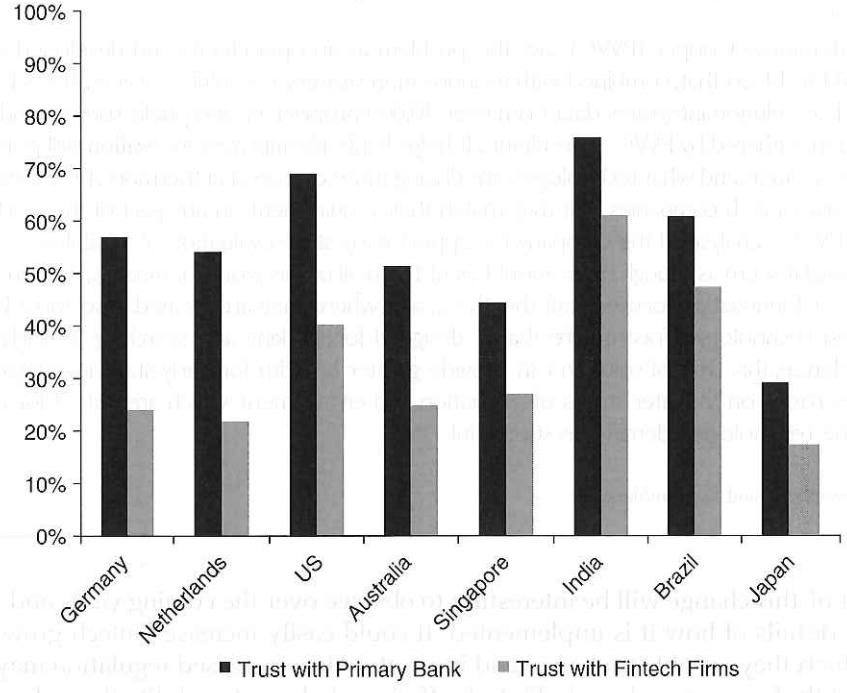


**Figure 20-2 Consumers' trust of their primary banks versus their trust of Fintech firms**

## Case Study 20-3

## An Innovative Solution for Finding Innovative Technology

It takes significant effort for banks to identify new technology that can be potentially adopted and utilized. Typically, a funnel approach is used to filter potential matches; for every hundred companies that are researched and engaged at a preliminary level, something like ten will be evaluated in depth, and one will be chosen to move forward with. It is crucial that the front end of this process works effectively, so that viable candidates are not overlooked and omitted from consideration. Yet, finding and selecting the right Fintech companies from the tens of thousands that exist around the world is a major challenge.

*(Continued)*

*(Continued)*

Part of the challenge is for banks to clearly define their requirements in terms of what they are looking for in external technology providers. That is to say, banks need to clearly specify what types of solutions and vendors will actually be feasible to integrate into the banks' technology and business infrastructure. Another part of the challenge is tracking the interactions of team members within an innovation group with external companies. Managing that information is paramount for being able to identify potential matches for new technology requirements. For example, consider a bank based in Europe that has an innovation center based in Silicon Valley, where a staff member meets with a startup focused on cybersecurity. A year later, a cybersecurity-related business requirement is identified at headquarters. If the information from the meeting with the cybersecurity startup is not well documented and easily locatable, the startup may not be considered to fulfill the bank's need. While technology can support this need, a high level of discipline from bank staff to record their interactions is also required.

Price Waterhouse Cooper (PWC) saw this problem as an opportunity and developed a technology solution called De Novo that, combined with its innovation strategy consulting services, helps banks address this problem. The solution integrates data from over 40,000 proprietary and public sources and combines it with information gathered by PWC's consultants. It helps banks identify how innovation will potentially affect different business areas and what technologies are driving those changes. Furthermore, De Novo helps banks identify potential Fintech companies that may match their requirements in any part of the world. Banks can also leverage PWC's analysis of the company to support early-stage evaluation of suitability.

While it might seem as though banks would want to do all of this work themselves, they are constrained by the number of innovation-focused staff they have, and where they are located. Also, most banks do not have their own technology infrastructure that is designed for tracking and searching through this type of information. Hence, this type of solution can provide greater breadth for early-stage investigation, enabling banks to focus more on the later stages of evaluation and engagement, which are critical for ensuring that adoption of the technologies identified is successful.

*Source:* http://www.strategyand.pwc.com/denovo.

The impact of this change will be interesting to observe over the coming years and will be largely determined by details of how it is implemented. It could easily increase Fintech growth, but reduce the speed at which they are able to change and innovate. Also, increased regulation may help increase the level of trust that consumers have in Fintech offerings, helping to solidify their place in the market as legitimate competition to established financial institutions. As shown in Figure 20-2, which is based on a survey of 16,000 customers in 32 countries, there is a wide variation in the level of trust that consumers place in their bank versus Fintech firms. In Germany, the Netherlands, and the United States, the difference in trust of banks over Fintechs is greater than 25%. Hence, in some markets, significantly increasing customers' level of trust in Fintech companies could have a major impact on the market. Also, keep in mind that in developing markets, fraud risks related to Fintech firms' financial products are quite real concerns for consumers. As a case in point, a criminal trial began in China in 2016 related to an alleged fraud by an online peer-to-peer lending platform that involved over US$8 billion in investor funds [3].

## 20.3 DISTRIBUTED LEDGER TECHNOLOGY

Blockchain is a classic example of innovation in financial services. It has provided financial institutions of all types and sizes as well as Fintech companies with a clear area to focus on for innovation. Much

of interest in blockchain has been focused on using it to create new solutions. At the same time, much of the activity has been driven by the fear of not understanding the technology and the opportunities and threats that it presents. Financial institutions have been concerned that technology advances such as blockchain could be the next Uber-like event for the financial services industry. That is, a new disruptive technology could quickly upend the existing business model of banks without them being aware early enough to take defensive action. This section discusses basic concepts, applications, challenges, and prospects related to distributed ledger technology. Digital currencies that make use of digital ledger technology are covered in Chapter 7.

## 20.3.1 Concepts

### 20.3.1.1 Overview

To begin with, it is important to clarify the meaning of the terms *distributed ledger* and *blockchain*. The term *ledger* is taken from the field of accounting where it refers to a permanent record of financial transactions. Typically for payments and other financial transactions, participants rely upon a clearing house or central counterparty that maintains a *centralized ledger* that keeps track of ownership and transaction flows between participants. A *distributed ledger* serves the same purpose, but is not managed and maintained by a central authority. Instead, it is maintained by multiple parties that perform the recordkeeping and updating activities on copies of the ledger in parallel. The term *blockchain* originated from the seminal paper that launched the Bitcoin digital currency, describing the digital ledger implementation that it used. Today, the term *blockchain* is generally used to describe the data structure and management process of a distributed ledger based on the general principles of the one used for Bitcoin.

Thought of another way, distributed ledgers are a type of database that exists in multiple locations and is shared amongst its users and possibly other entities. In many applications, they enable users to demonstrate ownership of virtual assets. For instance, Bitcoin's blockchain contains the transaction history of every Bitcoin in circulation and can determine which Bitcoin addresses were the owners of any coin at any given point in time. Bitcoin's blockchain uses a data structure and management process that provide a permanent record that is immutable, transparent, and secure. Generally, cryptography is used to secure the information stored in the blockchain and authenticate the parties involved in the transactions it records. In essence, it is a chain of validated transaction records, which are grouped together into blocks, that grows with each new set of transactions that is added to it. Moreover, there is no single blockchain implementation. The blockchain data structure and management process have been adapted and customized for many different purposes.

### 20.3.1.2 Structure and mechanics

With regard to the structure and mechanics of blockchain, there are three key components:

- a network protocol that supports communication between participants;
- a network of computers that store and manage transaction data; and
- a process for managing records that is based on achieving consensus between participants.

A key feature of blockchain is that its data, in part or in its entirety, is maintained on many different computers, "nodes", within the network. Nodes coordinate with one another to maintain the consistency of the distributed ledger. *Permissionless* blockchain implementations, such as the one used by Bitcoin, allow free and open access to the distributed ledger. Since the ledger is publically available, anyone can retrieve the entire blockchain transaction record history from nodes on the network.

| Input String | Hash Value |
|---|---|
| "Credit $10.00 to acct 12345678 from acct 87654321" | 4D4B4E362E1E1C491A2742ADB5A8EBF5 |
| "Credit $10.01 to acct 12345678 from acct 87654321" | E8E394F751072093606966C1DB670F4D |

**Figure 20-3 A comparison of the hash values for two different strings**

This feature provides transparence and resilience. If the network of participants is sufficiently large, the unavailability of any single node or small group of nodes will not affect the ability to process transactions. In contrast, often when central authorities manage ledgers, their records are not publicly accessible. If the central authority is unavailable, transactions cannot take place. On the other hand, *permissioned* blockchain implementations limit who can participate in the network and do not usually make the transaction information publically available.

When a blockchain transaction is processed, the initiator of the transaction will first distribute the transaction request to nodes on the network that validate the transaction's digital signature and review previous transactions that have been recorded by the blockchain to verify that the address transferring the funds actually owns them. The transaction will then be grouped with other verified transactions into a "block" that is proposed as an update to the distributed ledger. Miner nodes will perform computationally intensive verification of the block and, when they reach a consensus that the transaction information is valid, the transaction is approved for inclusion in the ledger. The block is then distributed to all the nodes in the network for inclusion in their copy of the ledger. The nodes that contribute the computing resources to validate transactions are rewarded with a small amount of its underlying digital currency, either as part of the protocol or by users voluntarily paying "transaction fees" to miners to encourage them to incorporate the users' transactions into the blockchain.

The consensus mechanism helps prevent fraudulent activity by a small number of bad actors entering false information into the blockchain. The process for achieving consensus between network participants varies between blockchain implementations. One consensus mechanism, which is used by the Bitcoin blockchain, is referred to as a proof-of-work scheme. Proof-of-work requires miners to solve computationally difficult problems to "win" the block and gain the reward. The problem used for proof-of-work must be hard to solve but easy to validate. Alternatively, proof-of-stake schemes may also be used. In this case, network participants need only prove how much of the digital currency they own. The participants' proportion of overall ownership, i.e., their stake, is used to weigh their vote in determining consensus. Proof-of-stake schemes avoid the hardware and energy costs associated with mining in proof-of-work schemes and ensure that the entities responsible for validating transactions have a vested interest in the integrity of the blockchain.

Blockchain also uses a cryptographic hash function to provide security. The hash function takes as input all of the transactions in the block as well as the block's meta-data and generates a string that serves as a digital signature that is recorded alongside the transaction records in the blockchain. When nodes verify information stored in the blockchain, they rerun the hash function on the record information to verify that the same digital signature is generated. If the record information has been modified, the hash function will generate a different digital signature. Figure 20-3 shows an example of how even a very minor change to the hash input value will generate a completely different hash value. The hashing algorithm used for this example was MD5*.

### 20.3.1.3 Special Characteristics

To identify and evaluate use cases and applications that are suitable for distributed ledgers, it is useful to consider some of the unique characteristics of that technology. Perhaps the most distinctive and

* The MD5 hashing algorithm was used in this example for convenience. Readers should note that it is no longer considered to be secure and, therefore, should not be used in solution implementations.

important characteristic of blockchain is its decentralized nature. There is no "owner" of the blockchain and there is no single point of failure. The peer-to-peer design of the system enables new participants to join the network at anytime and in any location, without any formal application or approval process. This decentralized architecture also helps provide scalability. While having a decentralized structure has many advantages, it also comes with downsides. For instance, some network participants may not agree with design changes that are made to the blockchain implementation and opt to continue using an older version. Such schisms can lead to divergent blockchains that are used in parallel, and potentially compete and conflict with one another.

Another key characteristic of blockchains is trust. The transaction history in the blockchain is transparent and openly auditable. Furthermore, in contrast to the implementation of most other ledger systems where users' trust is in the central authorities that are responsible for maintaining the account ledger, the trust of the users of blockchain is in the design of the system. For example, people who deposit their money in banks in the United Kingdom place their trust in their local bank and the Bank of England to faithfully maintain records of their holdings. In contrast, owners of Bitcoin do not trust individual miners or other participants in the Bitcoin network per se. Rather, they trust the mechanisms designed into Bitcoin's blockchain implementation that ensure that the participants involved in processing transactions perform their duties and that the fidelity of the account records are maintained. The security provided by blockchain's use of cryptography is another aspect that instills trust in its users. While the behavior of software algorithms is more predictable than the behavior of people, there is the risk that potential defects in the design or implementation of computer code used for the blockchain could compromise trust in the overall function that it provides.

The immutability of blockchain is an important characteristic in that it ensures that verified transactions are final and irrevocable. In most cases, transactions recorded in ledgers that are maintained by central authorities may be undone or reversed at the discretion of that entity. For example, stock exchanges have been known to reverse trade executions in cases of exceptional market conditions. Alternatively, banks can reverse charges to a customer's credit card account that they believe are fraudulent. In the case of transactions recorded on a blockchain, particularly those that are public and fully decentralized, undoing transactions is not an option*. While irrevocability provides a strong level of assurance to blockchain users, it also limits the ability to correct mistakes, recover funds in the case of theft, and comply with interventions by legal authorities.

The fully automated nature of blockchain implementations is another characteristic that is unique and is attractive to its users. Avoiding manual processing eliminates the potential of human error in transaction processing and eliminates discretionary decisions regarding how transactions will be handled. As discussed in Case Study 18-3, decisions made by individuals or organizations can potentially undercut the validity of transactions. Automation also enables fast transaction processing. Moreover, blockchains' potential to automate the execution of agreements that are formally specified, by means of implementing smart contracts, may be where their greatest value lies.

#### 20.3.1.4 Smart Contracts

Smart contracts are an offshoot of blockchain technology. While the idea behind smart contracts has been around for over a decade, the Bitcoin blockchain was the first practical implementation of one. However, the blockchain that Bitcoin uses was not designed to support the execution of smart contracts. In contrast, other blockchain implementations, such as Ethereum, which is discussed in Chapter 7, provide open and flexible smart contract capabilities that can be applied for a broader range of uses.

In essence, smart contracts are computer programs that can execute the terms of an agreement, which is specified in a programming-like language, between users of the blockchain network. Typically, network participants who are not directly involved with the transaction hold the value to be transferred

* The closest option to undoing transactions on a blockchain is to create a hard fork, as discussed in Case Study 7-6, whereby a new instance of the blockchain is created and must be adopted by users.

in escrow and control the delivery of the whole or parts of that amount based on verifying that conditions specified within the smart contract are met. For example, a smart contract could be used to implement a coupon-based debt security, similar to a bond. The smart contract would specify the amount of the coupons and when they should be paid, as well as when principal should be returned. Once parties involved in the transaction are committed to it, the blockchain would automatically facilitate the initial fund transfer, the subsequent coupon payments, and return of principal at the end of the term.*

Smart contracts provide a number of benefits compared with traditional paper-based contracts. Since no manual processing is involved, the execution cost will be lower, the speed of transactions will be faster, and the risk of human errors occurring will be minimized. The execution risk is also reduced because it is a trusted set of network participants who carry out the terms of the agreement and performance is not dependent on the parties who formed the agreement. That said, it is critical that the specification of smart contracts be precise and fully match the intent of the parties involved. With traditional agreements, the parties involved can address flaws with the way an agreement was drafted by subsequently agreeing to a particular interpretation or by following through with the spirit of the agreement. On the other hand, smart contracts generally do not provide this type of flexibility.

### 20.3.2 Applications

While there are many potential applications for blockchain technology, it is best suited to those that take advantage of its unique characteristics, which were discussed in Section 20.3.1.3. In particular, processes that involve multiple writers of information to a shared repository are a natural fit for using blockchain. Situations where blockchain can eliminate the need for one or more intermediaries in a transaction process also provide a compelling reason to use it. Likewise, where participants in the process are distributed geographically, especially across international borders, blockchain can provide benefits. Typically the advantages provided by using blockchain are related to speeding up transaction processing times, lowering costs, and improving resilience. Nevertheless, before basing a solution on blockchain technology, it is prudent for technology architects to consider whether using other time-proven technologies could provide the same or possibly greater benefits.

Besides determining the underlying rationale for using blockchain technology, it is important to consider the context of problem and business process that must be supported. For instance, using blockchain may increase the complexity of the overall process leading to increased operational risk. If the use of blockchain introduces new potential security vulnerabilities, they must also be factored into the overall value that the solution provides. Furthermore, when collaboration between stakeholders—such as end users, innovators, established institutions, lawmakers, and regulatorsis required, the likelihood and timeliness of their cooperation must be considered. These are critical factors in the overall success of blockchain-based solutions. Nontechnical considerations can easily derail blockchain solutions when the replacement of infrastructure, significant changes to existing processes, or alterations to legal or regulatory frameworks are required. It is important to note that blockchain-based digital currencies have been able to thrive because they addressed a need that was able to sidestep many of these complicating factors.

Table 20-1 lists some of the many proof-of-concept projects and commercially oriented initiatives that are focused on creating blockchain-based technology solutions. In some cases, multiple institutions have been involved, but only one or two are listed for brevity. Of note, many of the institutions that are experimenting with blockchain are trusted intermediaries, which run the risk of potentially being displaced by that technology. The last example in the table was included to highlight that blockchain has potential applications outside of financial services as well.

* Counterparty credit risk is ignored in this simplified example; it is assumed that the funds would be available when required for transfer.

**Table 20-1 Digital ledger solution development initiatives**

| Business Application | Institution(s) | Description |
|---|---|---|
| Cross-border payments | Santander Bank | Uses a mobile application to perform next-day international money transfers that are processed using blockchain. |
| Trade finance | Standard Chartered, DBS | Tracks the processing status of trade invoices using the Ripple distributed ledger. |
| Interbank and cross-border payments | Visa | Uses blockchain for international bank-to-bank transfers and smart contracts to support regulatory and compliance requirements. |
| Property title registry | Swedish government | Records the real estate transactions on blockchain enabling involved parties—e.g., the government, banks, brokers, buyers, and sellers—to track their state of progress. |
| Digital sovereign currency | Bank of Canada | Developing a digital version of the Canadian dollar using blockchain. |
| Interbank and cross-border payments | Monetary Authority of Singapore (MAS) | Banks deposit cash as collateral with the MAS in exchange for blockchain-based digital currency that is issued by the MAS. Banks can then pay one another directly using digital currency without sending payment instructions via the MAS. |
| Cheque payments | Bank of Tokyo-Mitsubishi UFJ | Uses blockchain technology to issue, transfer, and collect electronic checks. |
| Trade finance | HSBC, Bank of America Merrill Lynch | Uses blockchain to model a letter of credit transaction. |
| Syndicated loans | R3 | Uses blockchain to process syndicated loan information, eliminating the need for each bank to maintain its own lending platform. |
| Repurchase (repo) market transactions | Depository Trust & Clearing Corp. | Uses blockchain to manage mortgage-backed repurchase transactions in real time, with support for netting and offsets. |
| Settlement of securities | Deutsche Bundesbank, Deutsche Börse | Uses blockchain to implement payments and securities transfers and support settlement of securities transactions. |
| Trade finance | Barclays | Executed a letter of credit transaction using blockchain. |
| Food supply chain tracking | Walmart | Uses blockchain record and track details about each party in the food-handling supply chain and transactions between them. |

One of the most evident applications for blockchain technology is the clearing and settlement of payments. Bitcoin and other digital currencies have clearly demonstrated the applicability of blockchain in this area. By eliminating traditional intermediaries—such as SWIFT, correspondent banks, and national automated clearing house (ACH) operators—in the international remittance processing chain, Bitcoin has enabled transactions to be processed faster, more reliably, and at lower cost. While consumers have been the main users of digital currencies, banks can also benefit from using blockchain to more efficiently process interbank payments.

Another application for blockchain that has garnered significant attention is trade finance. In this context, blockchain technology can support the secure sharing of transaction-processing information between multiple parties in near-real time. Accelerating this communication process can greatly reduce the time required for payment settlement and speed up the delivery of goods. Blockchain technology can also be used to increase the transparency of asset ownership and the placement of liens on collateral that is used in trade finance transactions. Better availability of this information can help reduce the risk of fraud, as discussed in Section 10.1.1. What is more, using smart contracts to automate the fulfillment of trade finance transactions, which is a very manual process today, could greatly reduce the processing costs and operational risk.

It is unclear which of these applications will actually lead to meaningful solutions, as opposed to just being research and development exercises. For all the work being done with blockchain, as of 2017, there were many proof of concepts using distributed ledgers, but little in the way of mainstream commercial applications.

### 20.3.3 Challenges

Many of the use cases that blockchain is being employed to experiment with sound compelling. For instance, reducing the time and cost to perform payment and trade finance transactions would produce significant benefits for the parties involved. However, the question is whether blockchain is really required to solve these problems or whether the same objective could be achieved using traditional technologies. For instance, as discussed in Chapter 9, many countries are already migrating their payment infrastructure to support near-real-time transactions without using blockchain technology. Likewise, as discussed in Chapter 10, banks have struggled for years with digitizing trade finance documentation. While blockchain appears well suited to improve the efficency of trade finance processes, it is difficult to imagine that just by using this technology, it will be possible to sidestep the inertia that has plagued the shipping industry and limited the effectiveness of other technology solutions. Furthermore, blockchain use cases often require participants to use standard data formats and communication mechanisms for transferring information electronically. Yet history has shown that achieving that goal is, in many cases, very difficult.

One of the key changes that are necessary to raise the maturity and digital ledger technology is the availability and widespread use of open standards that solution developers and users can rally around. As seen with the case of mobile payments, discussed in Chapter 9, competition between the ecosystem participants could easily derail progress toward bringing innovative technology into the mainstream. Even where financial institutions have teamed up to push blockchain technology forward, as in the case of the R3 CEV consortium, some major banks eventually left it and stopped funding initiatives through that body. To date, there have been many different blockchain infrastructure initiatives going in different directions. It is unclear how participants' strategies can be drawn together so that the negative effects of market fragmentation are minimized. Even Bitcoin has been subject to technology-related schisms, which in 2017 led to a fork in its blockchain and the creation of another version of the digital currency, Bitcoin Cash.

Privacy and security concerns could also hold back the use and acceptance of distributed ledger technology. The transparency that publicly accessible blockchains provide can work against them in terms of providing privacy for their users. Security flaws in the design or implementation of a blockchain may only be uncovered after it is in use, compromising the solutions that have been built upon it. Likewise, components built on top of blockchain may have security vulnerabilities that bring the integrity of the overall technology solution into question. As discussed in Chapter 7, the cyberthefts of Bitcoin and Ether digital currencies show how limited understanding of the security risks of new technology can materialize into financial losses and cast doubt on the underlying technology*.

* Besides the cybertheft of ether digital currency that occurred in 2016, in 2017, around $30 million dollars worth of ether was stolen through the exploitation of a vulnerability in a digital wallet implementation.

Furthermore, regulatory and legal uncertainty may hinder the growth of solutions that are based on blockchain. So far, regulators have encouraged blockchain initiatives within the industry; however, it is unclear how they will treat solutions that make it past the proof-of-concept stage and are put forward for customers to use. Given the inherent and unknown risks with this new technology, it would not be surprising if regulators set a high bar for banks to show that they have adequately identified, evaluated, and mitigated the potential risks related to solutions using distributed ledger technology. Additionally, related legal considerations, such as whether blockchain records can be used for financial audit purposes or for transaction confirmation purposes, need to be established. For instance, uncertainty over how smart contracts will be treated in a court of law, which became a very real concern with the hacking of the DAO (discussed in Case Study 7-6), could present barriers to widespread use and adoption of this technology.

### 20.3.4 Prospects

A survey of 200 international banks in 2016 showed that 15% of the respondents planned to launch products based on blockchain in 2017, and 65% expected to do so by 2019 [4]. Another survey of over 300 senior executives who were knowledgeable with regard to blockchain found that more than a quarter of the respondents reported that their companies had already spent over $5 million on blockchain technology and that a quarter also expected to spend more than $5 million on this technology in 2017 [5]. Additionally, during 2016 there has been a surge of patent applications on technology related to blockchain.

With all the focus on and resources applied to blockchain technology by financial institutions and Fintech firms around the world, one would hope that some significant applications will eventually result. Clearly, distributed ledger technology powered the rise of digital currencies; however, banks had little, if anything, to do with the course of that innovation. Perhaps the biggest question is whether banks or Fintech firms will be able to find another compelling application that provides new or improved services that is dependent on the use of distributed ledger technology. Interbank payments is one application area that has gained some traction. To support new use cases, some banks and Fintech companies are creating their own proprietary blockchain infrastructure that provide improved features. For example, JP Morgan's Quorum platform is based on Ethereum, but provides additional privacy, performance, scalability, and governance capabilities. Likewise, Ripple's blockchain implementation increases the speed at which transactions are completed.

Blockchain technology may find specific niches that it can be applied successfully within, which are less affected by its current limitations and shortcomings. Digital currencies provide a good example of such a niche. Users have not been put off by their potential risks, and regulators have, to a large extent, have not tried to directly govern them. Likewise, land and title registries appear to be a natural fit for the structure and purpose of blockchain technology. Beyond providing distributed ledger capabilities, blockchain may spawn other innovations as it evolves. For example, smart contracts show promise for enabling the complete automation of business transactions between organizations where there is no inherent trust relationship, and, hence, may be where the greatest potential lies.

## 20.4 TECHNOLOGY INNOVATION OPPORTUNITIES

Beyond digital ledgers, there are many other areas where financial institutions can innovate. First, this section reviews three technology areas, open application programming interfaces (APIs), artificial intelligence (AI), and predictive analytics, which banks are in the process of adopting. Then it discusses other technologies that may have significant impact in the future: digital identity management, quantum computing, and augmented reality. Other innovation areas—such as big data, cybersecurity, analytics, cloud computing, and mobile devices—are discussed in other chapters.

### 20.4.1 Open APIS

In recent years, it has become increasingly important for financial institutions to provide APIs that can be accessed externally by third parties and provide access to customer data and transactional capabilities. There are several factors that are driving the shift to provide open APIs. One factor has been the opportunity to address new business needs. For example, banks that have provided open APIs for processing payment card transactions have been able to better serve business' websites and mobile applications that accept card payments from their customers. Another factor is the pressure that regulators have applied to financial instructions to provide greater access to their customers' information and support an "open banking" environment. For instance, European Union member states will begin implementing the Second Payment Services Directive (PSD2) in 2018 which requires banks to allow third parties, which have customers' authorization, to access their account information without a contractual agreement in place with the banks. The regulators' view is that customers are the owners of the information that financial institutions hold about them, and if they provide consent, should be able to allow third parties access that information. Also, an important factor for providing open APIs is to provide a channel for collaboration with Fintech companies, which can use the APIs to create innovative services and experiences for customers.

Financial institutions that already have channel-services architectures in place, as discussed in Chapter 3, are well positioned for providing APIs that are externally accessible. Most of the work that they will need to perform to provide these services is to rewrap existing APIs that are already used internally. In that process, the API wrappers will need to conform to whatever standard is used to present APIs externally. Access through open APIs will need to be limited only to the functions and data that are designated for external use. It will be necessary to determine how best, from a security standpoint, to allow external access to the open APIs. Such considerations include deciding whether the open APIs should be accessed via existing servers or new ones, determining what additional "holes" in the network firewalls will need to be opened to allow external access, setting up additional monitoring for the new API services, and analyzing what potential attack vectors may be introduced. In some cases, new vulnerabilities may be created, but not by the APIs themselves. Rather, vulnerabilities may arise from the use of new communication platforms that are put in place to support external network access to API functions.

Financial institutions that do not have channel-services architectures in place will find it much more difficult to provide open APIs. If the APIs do not already exist internally, the work to create them will likely be an enormous challenge. The effort involved in designing, building, and testing APIs is considerable. If the APIs are not being used internally, there is a good chance that they have a potentially large number of defects that will be discovered when they are used externally. In turn, customer satisfaction could suffer if too many defects are encountered.

Besides reviewing how open APIs can be supported by banks' internal technology infrastructure, strategies for providing external access to APIs must also be considered. One strategy is for banks to develop their own API developer portals. In this case, the bank designs the APIs and hosts the API connectivity services. This approach provides banks with the greatest level of control but also requires substantial implementation and maintenance effort. Another strategy is for banks to partner with third-party service providers or data aggregators and provide access to customer information through their API portals. This strategy reduces the time and effort required to provide open APIs, but also limits banks' influence over how the APIs will be presented and accessed. Alternatively, in cases where a bank outsources the operation and maintenance of its core IT systems to a third-party processor, the processor may provide hosted API services on behalf of the bank.

While there are potential advantages that come from providing open APIs, there are also downsides. One downside is the added cost of testing and maintaining another communication channel. Any time underlying systems are upgraded and enhanced, the externally accessible APIs that are dependent on them will need to be tested and may need to be modified. Likewise, once services or data have been

made available externally, they can be difficult to withdraw later. A future decision to drop support for some or all of a bank's open APIs may invite a public backlash from customers and partners who use applications that employ those APIs. Furthermore, if the open APIs prove to be wildly popular, there is the risk that the high usage volume could cause systems to become overloaded and provide poor performance, once again leading to potential backlash.

Open APIs can also introduce business risks. Banks are already struggling to avoid being disintermediated by Fintech companies. By providing access to proprietary information to potential competitors, banks risk accelerating this process and devaluing one of their key assets and competitive advantages—customer trust. By opening these doors, banks run the risk their relationships with customers may become further removed, and their ability to directly reach and make a positive impression on customers will be diminished. Moreover, allowing third parties to access customer information will only increase the likelihood that it will be leaked at some point through a data breach at one of the third parties that is accessing it.

### 20.4.2 Artificial Intelligence

For several decades, AI has been touted as the next big thing for financial services, but at least thus far, banks have not realized major benefit from this technology. However, the increased availability of supercomputing power, ongoing research, and renewed interest of Fintech and other companies in AI may lead to greater fruition in the coming years. In particular, machine learning—the ability for computers to learn on their own from exposure to information and without being programmed for a specific purpose—holds promise. This technology automatically creates analytical models based on the historical data to predict future outcomes. Machine-learning algorithms can adapt to changing conditions by continuously processing new information. They can also process a large number of input variables—much greater than a human analyst could manage—and determine how much they relate to specific outcomes. In a 2016 letter to shareholders, JP Morgan's chief operating officer identified machine learning as one of the key innovation areas that the bank was focusing on. Specifically, the bank was looking to machine learning to support cybersecurity, trading strategies, communication channel, and automated service response activities. Banks can use machine-learning strategies to deconstruct business process activities, model those activities, and then replicate and automate routine tasks (Case Study 20-4). While this approach is not suitable for all banking activities, it holds promise for certain areas, such as basic customer-service interactions. Chatbots, which provide automated service responses as part of web chat sessions, already use AI to automatically answer straightforward customer questions. The challenge for AI is to be able to address more complex queries and consistently

**Case Study 20-4**

**Financial Institutions' API Developer Portals Make Their Debut**

During 2016 and 2017, a number of banks launched API Portals for software developers. Spanish bank BBVA launched eight open APIs after spending a year working with businesses and developers to test its API services. BBVA's APIs support integration with merchants' checkout processes so that customers have the option to finance their purchases with loans from the bank. BBVA also provides anonymous aggregated customer information through its APIs as a commercial offering to other businesses. To use the production APIs and access live customer data, developers must go through a vetting process with the bank in a test environment. Citi, Capital One, and Standard Chartered also launched API developer portals. The services

that they provide through APIs include marketing offers, rewards, account information access, transaction authorization, fund transfers, account acquisition, and business transaction banking.

Visa was another financial institution that has provided API-based developer platforms. As of 2017, it offered approximately 60 APIs that catered to the needs of banks, merchants, and Fintech companies. Furthermore, Visa's APIs support payments made by Internet-enabled household devices and cars. In some cases, they have been designed to support business-specific requirements, such as the distribution of funds to drivers by ride-sharing services.

Also, in the US, NACHA-The Electronic Payments Association set up an API Standardization Industry Group to help proactively manage the proliferation of bank-specific APIs. Its overarching goal is to provide guidance for the financial services industry on governance and standards that will help support the adoption, consistency, and security of APIs. During its inaugural meeting in May of 2017, it identified common API use-case categories, such as data sharing and payment access. It also identified key concerns, including how standardization can be enforced, whether interoperability is likely to be achieved through API standardization, what security requirements should be in place for APIs, and how standardization will affect competition.

*Sources:* Castellanos, S., "Visa Prepares for the Future of Payments With API Push," *Wall Street Journal*, June 20, 2017, https://blogs.wsj.com/cio/2017/06/20/visa-prepares-for-the-future-of-payments-with-api-push/; Mondres, T., "How Banks Are Using APIs to Balance Security and Openness," *ABA Banking Journal*, May 10, 2017, http://bankingjournal.aba.com/2017/05/how-banks-are-using-apis-to-balance-security-and-openness/?utm_campaign=Fintech%20201705 12&utm_medium=email&utm_source=Eloqua; Peyton, A., "Standard Chartered Launches Open Banking API Developer Portal," *Banking Technology*, February 10, 2017, http://www.bankingtech.com/727781/standard-chartered-launches-open-banking-api-developer-portal/; "BBVA Launches Open API Marketplace," *Finextra, May* 24, 2017; https://www.finextra.com/newsarticle/30614/bbva-launches-open-api-marketplace; API Standardization Industry Group, "Inaugural Meeting Summary Report," NACHA-The Electronic Payments Association, May 2017, https://www.nacha.org/system/files/resources/API-Standardization-Industry-Group-Inaugural-Meeting-Summary-Report-May-2017.pdf.

come up with the right answers. AI may also be combined with other emerging technologies such as speech analytics, as discussed in Chapter 16, to help increase the rate of response of contact center agents to customer queries.

Marketplace lenders have used machine-learning models to make credit decisions, as a supplement or an alternative to traditional credit-scoring approaches. Machine learning can identify complex relationships between data available from a wide variety of sources and resultant consumer behavior. The large number of potential variable combinations makes it impractical to use traditional, human-driven analysis approaches. Machine learning also enables credit decision criteria and scoring models to be dynamic and adapt to changing market conditions. Nevertheless, using machine learning to make credit decisions can run afoul of fair lending regulations. For instance, biased credit-approval decisions may occur in cases where a machine-learning algorithm uses variables that are correlated with ethnicity, even though ethnicity itself is not a direct input. Accordingly, in some cases, being able to understand how AI makes a decision can be as important as the decision itself.

There are a number of different machine-learning algorithms that can be used. Many of them, such as deep-learning algorithms, are computationally intensive. In turn, vendors have created cloud-based platforms that are specifically designed to support the execution of machine learning algorithms. Some machine-learning algorithms have also been designed to run on graphics processing unit (GPU) chip sets, to take advantage of their large-scale parallel-processing architecture and reduce the time required for computation.

There are many potential applications for artificial intelligence in financial services. AI is well suited for analyzing volumes of data to find patterns and anomalies, the nature of which vary and change over time. This information can be useful for identifying fraud, abusive trading practices, and cyberattacks. AI can also automate the analysis of complex documents, greatly reducing processing

costs. As a case in point, JP Morgan has leveraged machine learning to extract 150 key data elements from 12,000 commercial credit agreements. A task that would take the bank's staff as many as 360,000 hours to perform, AI technology was able to complete within seconds [6]. Eliminating inconsistencies in the interpretation of document information, from one person to the next, and eliminating manual data-entry errors can avoid processing mistakes. This is particularly important in business areas that are document-intensive, such as trade finance and regulatory compliance.

Over the past several decades, many functions that were performed by people—such as processing of equity and foreign exchange orders, handling paper cheque deposits, and executing trading strategies—have already been automated. It is a foregone conclusion that over time, AI will automate many more business activities. In many cases, AI can perform tasks more efficiently, quickly, and cost effectively. Yet, overshadowing AI's use are claims that automating cognitive tasks will cut employment in the financial-services industry. There is a long history of similar concerns, going as far back as the 19th century when machines began automating manual tasks that factory workers performed. Generally, automation of both manual and cognitive tasks has focused on routine, repetitive tasks. As a result, jobs have shifted to non-routine tasks and those that require greater judgment and more dynamic skills. Rather than destroying jobs, to a large extent, automation has redefined them.

### 20.4.3 Predictive Analytics

AI can also be used to implement predictive analytics, which is an important area where financial institutions can innovate. While the ideas and technologies that underlie predictive analytics are not new, outside of areas such as fraud detection and marketing, this capability has not been broadly adopted for other purposes. There has been a lot of hype around using big data for predictive analytics; yet, in many cases, financial institutions can benefit from applying predictive analytics to relatively small datasets that can be aggregated and processed more quickly and easily than big data.

Predictive analytics uses past data to create models that can forecast outcomes based on new data. A wide range of techniques can be used to implement predictive analytics. Regression methods are one of the main types of techniques that are used, with linear and logistic regression being two of the most common. Machine-learning techniques are also commonly used, including neural networks and cluster analysis. Off-the-shelf software can be used to perform predictive analysis, including commercially available and open-source packages, the latter of which are often accessed using the python or R programming languages.

With regards to applications for predictive analytics, it is commonly used for fraud detection and identification of cross-selling opportunities. However, operations and risk management are two other areas within financial services where it could also provide significant benefits. In the context of operations, improving the ability to predict demand and utilization could help managers allocate resources more efficiently. That is to say, inaccurate estimates of demand can lead to allocating too few resources, which can negatively affect service levels, or allocating too many resources and unnecessarily driving up expenses. This is particularly relevant to the allocation of staff in contact centers and branches. In terms of reducing risk, predictive analytics can help make debt collection strategies to be more effective and orient them to more closely match specific customer characteristics and circumstances. Predictive analytics can also help manage risk related to cybersecurity threats by predicting when and how cyberattacks may occur.

There are several reasons why the predictive analytics is not pervasively used across banks' different business areas. Lack of data availability and poor data quality are common hindrances. In particular, where real-time information is necessary, an information-bus architecture (discussed in Chapter 2) may be required. Also, managers may lack knowledge about predictive analytics and fail to understand how it can be applied in business and operational contexts. Unfortunately,

analytics solution vendors will sometimes promote their systems as almost magical solutions that can, by themselves, transform business. In reality however, it is critical that the people who use those tools understand the business context in which they will be used, their capabilities, and potential applications. Rather than making major investments in software platforms, greater value can be often achieved by performing experiments and implementing small-scale projects that serve as learning opportunities.

### 20.4.4 Digital Identity Management

Digital identity management—the identification of users and control over their access to online resources—is a prime area for innovation. Traditional authentication mechanisms, such as using username and password credentials, have a number of concerns. Most critically, they can become compromised through security breaches and malware attacks. Also, as the volume of online services has grown, the number of online credentials that users must keep track of has increased to a state where many people are unable to manage them securely. For example, it is not uncommon for people to use the same username and password across multiple accounts. Furthermore, security breaches, such as the Equifax breach in 2017, have compromised personally identifiable information (PII) for hundreds of millions of people. As a result, it is unclear how effective PPI information will continue to be for identity-verification purposes.

There are several opportunities to improve and streamline digital identity management. Leveraging biometric information is at the forefront. Already, fingerprints, voiceprints, eye images, and facial recognition have been used to authenticate users for specific applications. The wide-scale use of mobile phones and their ability to capture biometric information is a key advancement that can facilitate the use of this approach on a broader scale. Individuals can also be identified by their location and movement patterns, which can be tracked by global positioning system (GPS) and accelerometer technologies within mobile phones. While each of these identification mechanisms has security weaknesses individually, in combination they have the potential to identify users more securely and with less effort than other existing mechanisms.

Moreover, centralizing the management of digital identity information could greatly improve the users' experience with authenticating to online services. It could eliminate the need for different online services, i.e., Internet-banking websites, to implement their own solutions. National governments are well positioned to act as centralized authorities for digital identity management. However, for the most part, they have not embraced the opportunity. Alternatively, blockchain technology could be used to support decentralized identity managment services. Although digital identity management solutions are still emerging in their own right, they are likely to have major impact on financial institutions in the future.

### 20.4.5 Quantum Computing

While quantum computing—using the quantum properties of atoms to perform computational operations—is still in its infancy, the development of this technology could have profound implications for the financial services industry. This technology can decrease the computational time required for some algorithms tremendously. In particular, it makes it practical to use algorithms that can compromise traditional public-key encryption methods and thus, potentially rendering them unsecure. Given that so much of financial services technology is underpinned by secure communication that is achieved through encryption, it is difficult to imagine the consequences that would ensue if and when quantum computing technology advances further and becomes more widely available. Already, the National Institute of Standards and Technology (NIST) in the United States has begun working with researchers to develop new encryption algorithms that provide stronger defenses against quantum computing capabilities.

### 20.4.6 Augmented Reality

New hardware technology also holds promise for innovation in financial services. While, from a banking perspective, next-generation watches that provide connectivity to mobile devices turned out to be a damp squib, advances in other areas hold promise. New hardware technology that supports virtual and augmented reality has the potential to provide a new and unique customer communication channel that could enable services that do not exist today. Virtual reality headsets could provide a better way of communicating complex information within banks and also to customers. Likewise, augmented reality applications, particularly when combined with mobile devices, provide an opportunity for financial institutions and Fintech companies to develop creative solutions that have widespread appeal to customers. The global popularity of the Pokémon Go application provided just

## Case Study 20-5
## Regtech Enters the Spotlight

One of the most recent branches to emerge within Fintech is Regtech, companies that develop innovative solutions to help financial institutions better address regulatory needs. One key area of focus has been on driving down the compliance costs, which, along with costs related to risk and governance, are estimated to represent 15–20% of the banks' ongoing operational costs. To put things in perspective, in 2013, JPMorgan added 4,000 compliance staff and spent $1 billion implementing additional controls. The same year, HSBC planned to add 3,000 compliance staff and its headcount in this area totaled over 7,000 employees. Another Regtech area of focus is analytics. The goal of applying analytics is to better organize and sift through the masses of information that financial institutions maintain. By generating higher-quality reports more quickly, banks can identify risks and address potential compliance issues more effectively.

Regtech companies bring a technology-oriented view to compliance operations, which traditionally have been dominated by manual processes. In many cases, the approach banks' compliance functions have taken when faced with new regulatory challenges has been to add headcount. The agility and speed that characterize Fintech companies are important assets for driving change, especially in a conservative and deeply embedded part of banks' business. Regulators have been a proponent of Regtech and have emphasized the need for financial institutions to innovate and to use technology to fulfill regulatory and compliance requirements more effectively. In particular, the Financial Conduct Authority (FCA) in the United Kingdom has encouraged banks there to leverage systems and tools when implementing and monitoring controls.

One interesting development in the Regtech space was the planned purchase of a consulting firm focused on regulation and compliance that has over 600 employees by IBM. The goal of the purchase is to provide IBM's AI supercomputer, Watson, with the background knowledge and training it needs to understand the regulatory compliance domain. While it is unlikely that computers will ever be able to fully replace compliance staff, it does hold the promise of automating some routine and mundane work, so as to reduce the number of staff that is required.

*Sources:* Noonan, Laura, "Banks Face Pushback over Surging Compliance and Regulatory Costs," *Financial Times*, May 28, 2015, https://next.ft.com/content/e1323e18-0478-11e5-95ad-00144feabdc0; Memmingerm, Matthias, Mike Baxter, and Edmund Lin, "You've Heard of Fintech, Get Ready for 'Regtech'," *American Banker*, September 7, 2016, http://www.americanbanker.com/bankthink/youve-heard-of-fintech-get-ready-for-regtech-1091148-1.html; Ernst & Young, "Innovating with RegTech," 2016; Crosman, Penny, "IBM Buying Promontory Clinches It: Regtech Is Real," *American Banker*, September 29, 2016, http://www.americanbanker.com/news/bank-technology/ibm-buying-promontory-clinches-it-regtech-is-real-1091692-1.html.

a taste of what was possible with augmented reality using mobile devices. As this technology becomes more mainstream and is directly supported by mobile devices and their operating systems, more innovative applications will emerge. The challenge, and opportunity, will be in identifying how this technology can be made relevant to financial services customers.

## 20.5 SUMMARY

This chapter covered:

- how financial institutions and Fintech companies are approaching the process of innovation;
- innovation opportunities related to blockchain technology; and;
- various technologies that have the potential to disrupt the financial services industry.

This is the final chapter; however, additional information related to the topics covered in this book can be found at the author's website: www.financialservicestechbook.com.

## 20.6 CONCLUSION

As discussed throughout this book, the importance of "digital bankers" is growing, and their numbers will continue to increase in the coming years. As a case in point, at Goldman Sachs, the IT staff account for close to a third of the bank's employees. It is hard to predict just how pervasive the role played by technologists in the financial services industry will be another ten years from now, but it is clear that the growth trend is likely to continue. There is little doubt that as time progresses, the line between business and technology will become more difficult to define. To be effective, bankers will need to have technical proficiency and, conversely, IT staff will be required to understand business practices and operations. To remain relevant in a world that is being redefined by technological advancements such as blockchain and AI, workers must be ready to acquire new knowledge and find ways to improve existing processes using technology. Financial institutions can help themselves too by developing digital banking skills in their employees and improving their understanding of innovative technologies. Moreover, both executives and frontline staff need this knowledge to effectively compete and collaborate with Fintech companies.

It has been the aim of this book to provide the reader with background knowledge that will be helpful for improving the financial services industry. Understanding the fundamental concepts, process structures, and designs of financial services solutions will provide a solid base for making informed decisions and beneficial changes. Likewise, the case studies presented have provided perspectives on previous industry successes and failures.

However, there is no substitute for experience. Every situation has its own unique challenges; hence, it is impossible to create repeatable recipes for success. Only through practice and reflection can we begin to understand specific business contexts and which courses of action will be most effective to change them. It is often said that we learn more from our setbacks than from our advances. Therefore, although we may strive to avoid setbacks, when they do occur, we should be prepared to learn from those experiences.

Processes and technology are merely tools and cannot make improvements by changing or applying themselves; only people can make these tools effective. There is an opportunity for the older generation of financial services workers, who understand how processes and systems currently work and how they have evolved over time, to collaborate with the upcoming generation, who can better imagine how they can work more effectively in the future. By bringing together people, processes, and technology, we can all help improve the financial services industry.

## FURTHER READING

### Books

Antonopoulos, A., *Mastering Bitcoin: Programming the Open Blockchain* (California: O'Reilly Media, 2017).

Chollet, F., *Deep Learning with Python* (New York: Manning Publications, 2017).

Kumar, A., *Learning Predictive Analytics with Python* (California: O'Reilly Media, 2016).

Monetary Authority of Singapore, *MAS-ABS API Conference EBook*, 2016.

Muller, A. C., *Introduction to Machine Learning with Python* (California: O'Reilly Media, 2016).

### Papers and Articles

Basel Committee on Banking Supervision, "Sound Practices: Implications of Fintech Developments for Banks and Bank Supervisors," August 2017, http://www.bis.org/bcbs/publ/d415.pdf.

Chakraborty, C. and Joseph, A., "Machine Learning at Central Banks," Bank of England, September 2017, http://www.bankofengland.co.uk/research/Documents/workingpapers/2017/swp674.pdf.

EBA_May2016_eAPWG_Applying_cryptotechnologies_to_Trade_Finance.pdf.

EBA Working Group on Electronic Alternative Payments, "Applying Cryptotechnologies to Trade Finance," Euro Banking Association, May 2016, https://www.abe-eba.eu/downloads/knowledge-and-research/

Office of the Comptroller of the Currency,"Exploring Special Purpose National Bank Charters for Fintech Companies," December 2016.

"Special Report on Artificial Intelligence," *Economist*, June 25, 2016, https://www.economist.com/news/special-report/21700761-after-many-false-starts-artificial-intelligence-has-taken-will-it-cause-mass.

UK Government Office for Science, "Distributed Ledger Technology: Beyond Block Chain," January 2016, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf.

### Web

"ABA Banking Journal Special Report: Fintech and New Frontiers in Bank Innovation," http://bankingjournal.aba.com/2016/10/fintech-and-new-frontiers-in-bank-innovation/.

ABA Fintech, http://aba.com/fintech.

## ENDNOTES

1. PWC, "Unleashing the Power of Innovation," 2013.
2. Capgemini, "World Retail Banking Report 2016."
3. Miller, M. "China's $8.6 billion P2P fraud trial starts: Xinhua," *Reuters*, December 15, 2016, http://www.reuters.com/article/us-china-fraud-ezubao/chinas-8-6-billion-p2p-fraud-trial-starts-xinhua-idUSKBN1450I2.
4. Schaus, P., "Blockchain Projects Will Pay Off—10 Years from Now," *American Banker*, December 2, 2016, http://www.americanbanker.com/bankthink/blockchain-projects-will-pay-off-226128-10-years-from-now-1092670-1.html.

5. Deloitte, "Deloitte Survey: Blockchain Reaches Beyond Financial Services with Some Industries Moving Faster," *PR Newswire*, December 13, 2016, http://www.prnewswire.com/news-releases/deloitte-survey-blockchain-reaches-beyond-financial-services-with-some-industries-moving-faster-300376792.html.

6. Zames, M. "2016 Letter to Shareholders: Redefining the Financial Services Industry," JP Morgan, https://www.jpmorganchase.com/corporate/annual-report/2016/ar-ceo-letter-matt-zames.htm.

— — —

7. Irrera, A. and Gertrude Chavez-Dreyfuss, G. "Bitcoin splits, but clone off to slow start," *Reuters*, August 2, 2017, http://www.reuters.com/article/us-bitcoin-split-idUSKBN1AH5F1.

8. Graham, L., "$32 Million Worth of Digital Currency Ether Stolen by Hackers," *CNBC*, July 20, 2017, https://www.cnbc.com/2017/07/20/32-million-worth-of-digital-currency-ether-stolen-by-hackers.html.

9. Horlacher, C., "Centralized Blockchain Projects are Doomed to Failure," *American Banker*, January 31, 2017, January 31 2017, https://www.americanbanker.com/opinion/centralized-blockchain-projects-are-doomed-to-failure.

10. World Economic Forum, "The Future of Financial Infrastructure," August 2016, http://www3.weforum.org/docs/WEF_The_future_of_financial_infrastructure.pdf.

11. Miller, M., "China's $8.6 Billion P2P Fraud Trial Starts: Xinhua," *Reuters*, December 15, 2016, http://www.reuters.com/article/us-china-fraud-ezubao/chinas-8-6-billion-p2p-fraud-trial-starts-xinhua-idUSKBN1450I2.

12. American Bankers Association, "Understanding APIs".

13. Courchange, M. and Skanderson, D., "Fair Lending in the Brave New World of Big Data," *ABA Bank Compliance*, May-June 2017.

14. "Automation and Anxiety," *Economist*, June 25, 2016, https://www.economist.com/news/special-report/21700758-will-smarter-machines-cause-mass-unemployment-automation-and-anxiety.

15. "Answering the Machinery Question," *Economist*, PWC, "Breakthrough Innovation and Growth," September 2013.

16. "FinTech Regulatory Sandbox," http://www.mas.gov.sg/Singapore-Financial-Centre/Smart-Financial-Centre/FinTech-Regulatory-Sandbox.aspx. https://www.jpmorgan.com/global/Quorumhttps://ripple.com/.

17. Chavez-Dreyfuss, G., "Sweden Tests Blockchain Technology for Land Registry," *Reuters*, June 16, 2016, http://www.reuters.com/article/us-sweden-blockchain-idUSKCN0Z22KV.

18. Nash, K. S., "Wal-Mart Readies Blockchain Pilot for Tracking US Produce, China Pork," *Wall Street Journal*, December 16, 2016, http://blogs.wsj.com/cio/2016/12/16/wal-mart-readies-blockchain-pilot-for-tracking-u-s-produce-china-pork/.

19. Chanjaroen, C. and D. Boey, "StanChart, DBS's Trade Finance Distributed Ledger: How It Works," *Bloomberg*, May 22, 2016, https://www.bloomberg.com/news/articles/2016-05-22/stanchart-dbs-s-trade-finance-distributed-ledger-how-it-works.

20. Dunkley, E., "Santander Pilots Blockchain Payments App," *Financial Times*, May 26, 2016, http://www.ft.com/cms/s/0/2df2f65c-234f-11e6-9d4d-c11776a5124d.html.

21. Arnold, M., "Visa Eyes New Link in Blockchain Payments," *Financial Times*, September 1, 2016, http://www.ft.com/cms/s/0/483e315e-6fa6-11e6-a0c9-1365ce54b926.html.

22. Stafford, P., "Canada Experiments with Digital Dollar on Blockchain," *Financial Times*, June 16, 2016, https://www.ft.com/content/1117c780-3397-11e6-bda0-04585c31b153.

23. Monetary Authority of Singapore, "Singapore's FinTech Journey—Where We Are, What Is Next," November 16, 2016, http://www.mas.gov.sg/News-and-Publications/Speeches-and-Monetary-Policy-Statements/Speeches/2016/Singapore-FinTech-Journey.aspx.

24. MUFG, "Hitachi and BTMU Start Proof of Concept Testing for Utilizing Blockchain Technology for Check Digitalization in Singapore," August 22, 2016, http://www.bk.mufg.jp/global/newsroom/news2016/pdf/newse0822.pdf.

25. Barreto, E., "Banks and Tech Firms Apply Blockchain to Trade Finance," *Reuters*, August 10, 2016, http://www.reuters.com/article/us-asia-trade-blockchain-idUSKCN10L17D.

26. Macheel, T., "Banks Test Blockchain for Syndicated Loans with Symbiont, R3," *American Banker*, September 27, 2016, http://www.americanbanker.com/news/bank-technology/banks-test-blockchain-for-syndicated-loans-with-symbiont-r3-1091625-1.html.

27. Macheel, T., "DTCC, Digital Asset Holdings Build Blockchain for Repurchase market," *American Banker*, March 29, 2016, http://www.americanbanker.com/news/bank-technology/dtcc-digital-asset-holdings-build-blockchain-for-repurchase-market-1080142-1.html.

28. Deutsche Bundesbank, "Joint Deutsche Bundesbank and Deutsche Börse Blockchain Prototype," November 28, 2016, https://www.bundesbank.de/Redaktion/EN/Pressemitteilungen/BBK/2016/2016_11_28_blockchain_prototype.html.

29. Kelly, J., "Barclays Says Conducts First Blockchain-based Trade-finance Deal," *Reuters*, September 7, 2016, http://www.reuters.com/article/us-banks-barclays-blockchain-idUSKCN11D23B.

30. Chirgwin, R., "NIST Readies 'Post-quantum' Crypto Competition," *The Register*, May 4, 2016, http://www.theregister.co.uk/2016/05/04/nist_readies_postquantum_crypto_competition.

31. Guerrera, F., "How the Financial Sector Sees Technology As Its Saviour," *Financial Times*, February 21, 2011, http://www. ft.com/cms/s/0/a8ff2548-3de3-11e0-99ac-00144feabdc0.html.

32. Nash, K. S. and S. Norton, "Morgan Stanley Plans to Drop Out of R3 Blockchain Group," November 22, 2016, http://blogs.wsj.com/cio/2016/11/22/morgan-stanley-plans-to-drop-out-of-r3-blockchain-group/.

33. "The great chain of being sure about things", *Economist*, Oct 31, 2015, http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable