CHAPTER

9 Designs for Digital Organizations and Big Data Analytics

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Learning Objectives

After reading this chapter you should be able to:

1. Explain the impact of digital technology on organizations as it evolved from mainframe computers to the Internet of Things.
2. Describe the differences between a traditional "pipe" organization and a new "platform" organization.
3. Define how big data analytics is distinct from previous data analysis activities within organizations and specify various approaches to organizing big data scientists within an organization.
4. Explain how artificial intelligence improves efficiency and decision making in organizations and discuss its potential downsides.
5. Explain how IT can be used for social network analysis and knowledge management in organizations.
6. Describe how organizational design is changing because of advances in artificial intelligence.

Chapter Outline

Before reading this chapter, please check whether you agree or disagree with each of the following statements:

MANAGING BY DESIGN QUESTIONS

1 **Platform-based organizations are a new form of organization, but the fundamental assumptions are the same as for a traditional industrial organization.**

I AGREE _____ I DISAGREE _____

2 **Artificial intelligence is objective and bias-free compared to human decision making in organizations.**

I AGREE _____ I DISAGREE _____

3 **Big data analytics gives good results for making decisions by using carefully selected samples of data.**

I AGREE _____ I DISAGREE _____

A few weeks before the H1N1 flu virus made headlines, engineers from Google published a surprising paper in the scientific journal *Nature*. It explained how Google could predict the spread of the winter flu in the United States down to specific regions and even states. Google gets more than three billion search queries every day and saves them all. Engineers took the 50 million most common search terms and compared the list with Centers for Disease Control data on the spread of seasonal flu between 2003 and 2008, looking for correlations between the frequency of certain search queries and the spread of flu. They processed 450 million different mathematical models to test the terms, comparing their predictions against actual flu cases. The Google team struck gold: the software found a combination of 45 search terms that had a strong correlation between their predictions and the official figures. The *Nature* paper was largely overlooked outside the world of computer scientists, but it created a splash among health officials. When a new virus emerges and spreads quickly, the only hope health officials have is to slow the spread of the disease, but to do that they need to know where it already is. Although the CDC receives information from doctors, public health clinics, and hospitals, the data are always a couple of weeks out of date. With a rapidly spreading disease, two weeks is an eternity. Google's method, built on the power of "big data," could tell where the flu had spread in near real time, not a week or two after the fact.[1]

Big data is one of the most recent advances in the field of information technology (IT), and it is reshaping companies and entire businesses. Amazon.com collects tons of data on customers, including what books they buy, what else they look at, how they navigate through the website, and how much they are influenced by promotions and reviews. The company uses algorithms that predict and suggest what books a customer might be interested in reading next. Netflix uses big data analytics to predict the types of shows you will want to watch. Moreover, the predictions get better every time a customer responds to or ignores a recommendation.[2]

Today, IT developments have sparked the creation of a new organizational form, called a platform-based organization, including companies such as Facebook, Airbnb, and Uber, which are truly digital organizations. Within traditional large companies, big data analytics has also spawned new business opportunities.

In addition, a large corporation can create its own digital platforms to connect employees on key projects. These new forms of IT are digitalizing organizations in all industries to maintain a competitive edge in the face of growing global competition and rising customer demands for speed, convenience, quality, and value. The primary benefits of digital technology for organizations include its potential for improving decision making as well as for enhancing control, efficiency, and coordination of the organization internally and with external partners and customers. Some organization theorists believe new digital technology developments are gradually replacing the traditional hierarchy in coordinating and controlling organizational activities.[3]

Purpose of This Chapter

Information is the lifeblood of organizations. Managers spend at least 80 percent of their time actively exchanging information. They need this information to hold the organization together. The vertical and horizontal information linkages described in Chapter 3 are designed to provide managers with relevant information for decision making, coordination, evaluation, and control. It isn't just facilities, equipment, or even products and services that define organization success, but rather the information managers possess and how they use it. Highly successful organizations today are typically those that apply the advances in digital technology most effectively.

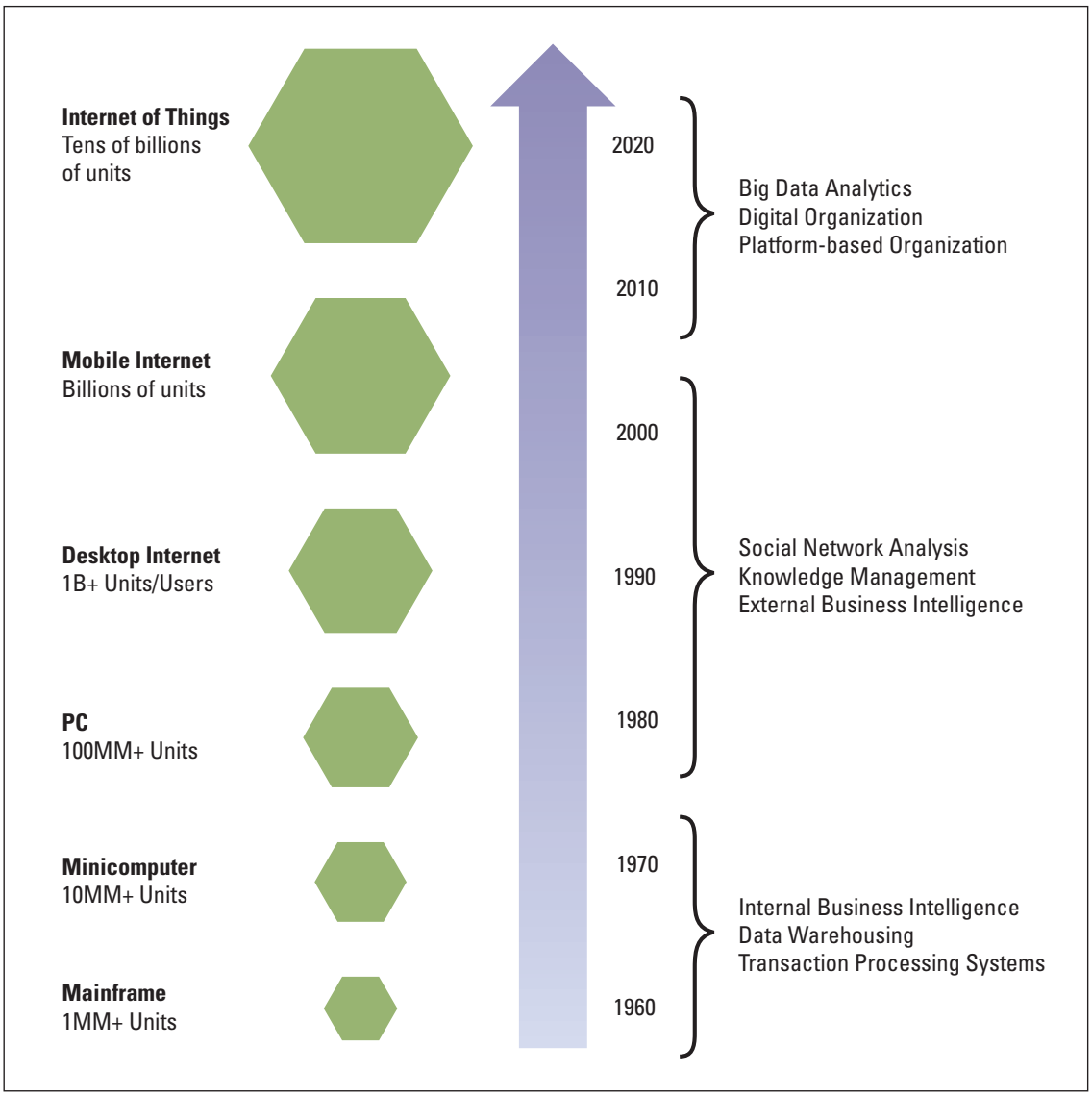
The ways in which organizations collect and use information has changed dramatically in recent years. This chapter examines the evolution of IT from mainframe computers to digital organizations. The chapter begins by looking at the explosion of digital information in the organizational world. Then the chapter explores the new form called platform-based organizations, followed by the application of big data analytics and artificial intelligence in extant organizations. The remaining sections of the chapter related to new information technologies include a discussion of knowledge management within companies, and how companies add strategic value through the use of internal network analysis. The recent digital innovations are a natural outgrowth of earlier applications and have led to a quantum leap in new business opportunities, a dramatic jump in business digitalization, strengthening internal and external organizational relationships, and strategic success. The final section of the chapter presents an overview of how digital innovations affect organization design.

9.1 The Digital Information Explosion

Traditional information media involved a human being. The telephone, television, and radio media were focused on a human participant. In the early days of computers, the essential communication was still between a computer and a human being. That changed with the advent of digital media. **Digital media** means that information or data can be both created and consumed by machines, and thereby be generated, modified and distributed on digital electronic devices. A human being is not required.

Exhibit 9.1 illustrates the evolution of IT. Initially, mainframe computer systems in organizations were applied to operations. These initial applications

EXHIBIT 9.1
Evolution of Information Technology



were based on the notion of machine-room efficiency—that is, current operations could be performed more efficiently with the use of computer technology. These systems became known as **transaction processing systems** (TPSs), which automate the organization's routine, day-to-day business transactions. A TPS collects data from transactions such as sales, purchases from suppliers, and inventory changes, and stores them in a database. For example, at Enterprise Rent-A-Car, a computerized system keeps track of the 1.4 million transactions the company logs every hour. The system can provide front-line employees with up-to-the-minute information on car availability and other data, enabling them to provide exceptional customer service.[4]

The mainframe also enabled the subsequent use of data warehousing and internal business intelligence software to expand the usefulness of these accumulated data. **Data warehousing** is the use of large databases that combine all of a company's data and allow users to access the data directly, create reports, and obtain responses to what-if questions. **Internal business intelligence** refers to the high-tech analysis of a company's data in order to make better strategic decisions.[5] Sometimes referred to as *data mining*, business intelligence means searching out and analyzing data from multiple databases across the enterprise, and increasingly from outside sources as well, to identify patterns and relationships that might be significant. Retailers are some of the biggest users of business intelligence software. Managers at companies such as Wet Seal, a fast-fashion clothing company selling mainly to teenage girls and young women, and Elie Tahari, a maker of designer clothes, need to spot changing sales trends fast, so they are continually mining sales data. Wet Seal created a web feature called Outfitter that allows users to put together their own outfits online; mining the 300,000 user-generated outfits gave managers an early lead on the trend toward wearing dressy tops with casual pants and jeans.[6]

Mini-computers were smaller and cheaper versions of the mainframe that could be used in parts of the organization away from the centralized mainframe. They were smaller versions of transaction processing systems. The development of desktop computers meant that every person could have a computer on which to communicate with other people, do one's own work, and connect to larger databases. This was an even more decentralizing process than the mini-computer, and connected desktops allowed people to share information via knowledge management systems. The use of connected desktop computers also enabled network analysis. Both knowledge management and network analysis will be described later in this chapter.

The advent of the wired Internet was a big breakthrough for information technology. Suddenly employees could gain access to a huge web of information from around the world.[7] The mobile Internet enabled the emergence of **big data analytics**. This is one of the newest business technologies and refers to new sensing technologies and processes for gathering, searching and analyzing massive, complex sets of data that traditional data processing applications cannot handle to uncover hidden patterns and correlations.[8] Walmart collects more than 2.5 petabytes of data every hour from customer transactions and uses those data to make better decisions (a petabyte is about a million gigabytes or the equivalent of about 20 million filing cabinets full of written data).[9] Facebook uses the personal data you put on your page and tracks and monitors your online behavior, and then searches through all those data to identify and suggest potential "friends" and to target advertisements. The majority of this chapter focuses on these two higher-level stages in the evolution of IT.

The most recent jump in the information explosion is to the internet of things. The term "Internet of Things" was coined by the British technology pioneer Kevin Ashton in 1999. Previously, the Internet had been dependent on people for its supply of information. But now impersonal "things" can themselves generate and receive data. Now things are connected and can communicate with each other. Billions of devices, including laptops, PCs, and especially smartphones, generate trillions of data points. Connecting devices to automated analytical systems makes it possible to gather information, analyze it, and create a response without human intervention.

Now every "thing" can have a chip inserted to communicate data to other devices. A "thing" could be a hairbrush, a home thermostat, a shirt or dress, a toaster, a refrigerator, a fitness collar for your dog, or a baby thermometer. In business, a thing can be something as large as a jet engine or a railroad locomotive. Each of these dumb items becomes smart and linked into the Internet with potential for two-way

communication. For example, in a "smart" home keyless door locks would send a text message when activated, lights would switch on or off when there is movement in a room, air conditioning or heating could be turned on or off based on personal preference and people's locations, and the same with refrigerators and coffee machines.[10] With the application of advanced analytics for artificial intelligence, these data had the potential to provide companies with better insight into users and devices. Artificial intelligence could also control devices in various ways. For example, clothing equipped with sensors would be able to detect when an older or ill person fell, and small containers holding medications would "note" whether a patient had taken prescribed pills and could send an email or text message reminder when needed.

The Internet of Things also enabled the latest stage of digital organizing, which is the new platform-based form of organization. The platform-based organization relies heavily on technology to connect producers and consumers digitally, thereby requiring fewer people, buildings, or infrastructure.

REMEMBER THIS

- Mainframe computers in the 1960s allowed organizations to undertake transaction processing systems, data warehousing, and internal business intelligence.
- Later developments in personal computers and the Internet supported knowledge management, social network analysis, and external business intelligence.
- The Internet and mobile devices enabled the development of platform-based digital organizations.
- The Internet of Things enabled tens of billions of data-gathering units and the prominence of big data analytics in an ever-increasing number of organizations.

9.2 Pipes versus Platforms: A New Organization Form

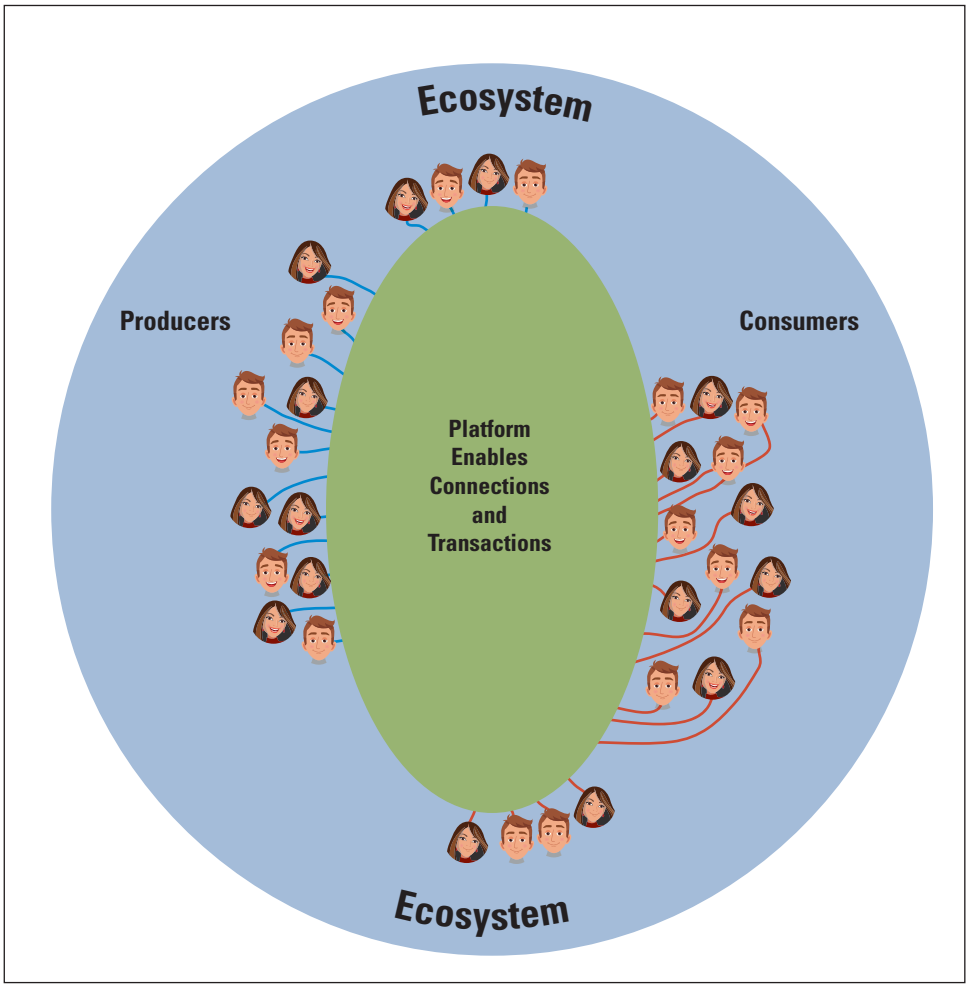
The traditional organization that has been around for ages is called a "pipe." This has been the dominant form of successful business corporations. Pipe firms work in a linear order, acquiring resources at one end of the pipe, making stuff within the pipe, and pushing the result out the other end for sale to customers. The pipe represents a sequential process to produce a good or service. Every consumer product that people have used in the past essentially came to us through a pipe organization. All manufacturing runs on a pipe model. Television and radio are also pipes discharging content for us. The education system is a pipe because teachers push knowledge out of the school pipe. Prior to the Internet, most of the service industries ran on a pipe model as well.[11]

Without the Internet and mobile digital devices, platform-based businesses would not have been possible. Platforms do not make stuff and push it out to customers. **Platform-based organizations** connect and enable users to both create and consume something of value. As a business, a platform allows users to create value on the platform for other users to consume. This is a huge shift from any organizational form we have known during the industrial era. In a platform-based organization, producers and consumers are connected via digital technology (computers,

smartphones). For example, YouTube or Airbnb are digital connectors that link thousands of independent producers (videographers, individuals with homes, rooms, or apartments for rent) with thousands of consumers (video watchers, vacationers). The owners of the platform-based business provide the software and the central processing computers that connect other people into the ecosystem (Chapter 5) it created. The users both create and consume any product or service.[12] The owners can earn money by charging a fee for the transaction or by exposing users to advertising.

As illustrated in Exhibit 9.2, a platform is a business model that creates value by facilitating exchanges (connections) between two or more interdependent groups, usually consumers and producers. In a large platform organization like Facebook, other groups such as app developers may participate as well. To encourage exchanges, platforms harness and create large networks of users and resources (producers) that can be accessed on demand. Platform-based organizations create communities that allow users to interact directly with one another via their digital media devices. Platform businesses such as Facebook, Uber or Alibaba, do not create and control inventory via a supply chain the way linear organizations do. Successful platforms facilitate connections by dramatically reducing the cost of exchanges between producers and consumers.[13]

EXHIBIT 9.2
Platform-Based Digital Organization Ecosystem



Source: Based on Alex Moazed, "Platform Business Model—Definition; What Is It? Explanation," Applicoinc.com, Platform Innovation Blog, May 1, 2016, https://www.applicoinc.com/blog/what-is-a-platform-business-model/ (accessed May 20, 2019).

A platform-based business is a complete organizational form, not just a piece of technology. It is more than a website or a piece of software. It is a whole organization that creates value by bringing together producers and consumers. This is a giant change from traditional businesses that use a supply chain and operational processes to make and sell tangible products. The dramatic shift in thinking is that what a company owns matters less than the resources it can connect together.

9.2a Two Types

Most platform-based organizational forms are one of two types. **Exchange platforms** facilitate 1:1 interactions among members. **Maker platforms** facilitate 1:1,000s interactions among members. A ride-hailing company such as Lyft is an example of a 1:1 interaction (exchange platform). A single passenger (consumer) books a single driver (producer). During the ride the driver is not available on the platform to connect with another rider. The consumer and producer engage in a single transaction. On the other hand, on maker platforms the producer creates something that a large number of consumers can use simultaneously, such as a YouTube video. The same is true for a livestream on Twitch, where many people can watch other users playing video games. The producer is broadcasting to as many people as possible to consume the broadcast. The fundamentals of both types of platform-based organization are the same in the sense that they provide a digital connection among producers and consumers, and the business is anchored in digital transactions rather than the exchange of physical products or services based in buildings and equipment.[14]

Amazon started as a maker platform by making books available to a rapidly growing number of consumers. Its ecosystem was relatively small and the platform connected consumers (book buyers) with the supply of books. As Amazon began allowing other businesses to sell goods on its website, it evolved to more of an exchange platform. The businesses selling on the site are producers and purchasers are the consumers. In the case of autonomous small businesses, Amazon does not provide any products. Amazon provides the digital platform and software that facilitates the digital connections among producers and consumers.

The two most successful platform-based businesses to date are Google and Facebook. The number of platform organizations at the highest level of the world economy is growing fast. In 2016, four of the top five companies on *Forbes*'s list of most valuable brands were platform companies, as were 11 of the top 20. As of 2017, the top five companies by market capitalization in the United States were all platform businesses. Some platform businesses you may recognize include Amazon, eBay, Zillow, Instagram, YouTube, Twitch, WhatsApp, Waze, Lyft, Pinterest, Square, and Kickstarter. Platform companies such as Alibaba, Tencent, and Baidu are prominent in China and much of Asia.[15]

9.2b Foundational Assumptions

The basic assumptions underlying a traditional company no longer apply in new platform-based companies. These assumptions pertain to assets, hierarchy, and control.[16]

Pipe Assumption 1. The first assumption of traditional linear industrial organizations is to create competitive advantage through increasing size of capital assets, including buildings, manufacturing facilities, administrative functions, and support

structures. Pipe companies acquire size and impact through mergers and acquisitions to gain market share, pricing power and global reach.

Platform Assumption 1. Capital assets can be owned by the connected producers and consumers of the platform. The platform can minimize rather than add assets. Consumers can get news from their own computers or smartphones rather than from a manufactured newspaper. Hotel companies (pipe organizations) build and own huge buildings in which to house guests, but the Airbnb buildings in which guests are housed are owned by the dispersed owners who rent their apartment or house to consumers on Airbnb's platform. Lyft and Uber do not own the cars or employ the drivers used in their ride-hailing businesses. The transportation assets (autos) are owned and provided by the drivers, who are considered independent contractors rather than company employees.

Pipe Assumption 2. Organizations act as information processing structures or hierarchies (Chapter 3), such as the British Army, McDonald's, the Roman Catholic Church or Southwest Airlines. Important information moves toward the center and top levels of the organization for decision-making.

Platform Assumption 2. Information in the digital era travels extremely fast and widely. For example, Twitter notified the U. S. Eastern Seaboard of an earthquake emanating from southern Virginia. Emergency workers, communities, and other stakeholders received the information faster than what a business organization could provide. Social media and new digital technologies move information better than the old formal organization systems. Thus, the formal organizational hierarchy is not effective for processing information at light speed.

Pipe Assumption 3. Managers are promoted into positions of increasing responsibility as they gain experience and show talent for making bigger decisions for the company.

Platform Assumption 3. Algorithmic systems embedded in the platform software are more consistent, impartial, and faster for making decisions than are humans in many areas. An **algorithm** is a set of systematic rules built into the platform software to accomplish desired outcomes in many areas. As an example, Google uses algorithms to rank the results for each of the millions of searches on its website each day. The decisions are better and faster than humans could do. Why use a slow chain of command to make decisions when algorithms can make most decisions faster and better?

Traditional organizations may seem clumsy and slow compared to the new platform organizations. The new form uses fewer assets, communication is much faster than in human hierarchies, and many decisions are made quicker and more objectively. However, even platform organizations need a hierarchical structure for some aspects of the core business. One suggestion is that the human hierarchy of the platform organization should be focused more on culture processing than on information processing.[17] Digital platforms cannot shape culture, which is a human activity. Without direction from the leaders and hierarchy, the culture of a platform organization may go awry. Consider the case of Uber. Uber fits the platform model assumptions. Capital investment is modest because drivers are contractors rather than employees and they pay for their own cars. Uber has far fewer employees and physical assets when compared to traditional companies of similar market value. Uber is lean at the corporate level because there is no need for human dispatchers or interviewers, a large marketing organization, or a large HR department to manage drivers as employees. The software app makes

transactions seamless and nearly effortless for both rider and driver. Communication between producer and consumer is nearly instantaneous via digital devices connecting through the platform.

IN PRACTICE

Uber

Uber is one of the better-known platform-based companies and operates unlike traditional organization forms. Interactions with the company are strictly digital. To get a ride on Uber, you download the app and create an account. When you open the app, your location is detected via GPS. The app also shows nearby drivers on the map. When you agree to the estimated fare you are connected to the Uber driver who can accept your request within seconds. The driver receives data on the rider's previous Uber experience and can accept or reject a request. Uber uses a bidirectional rating system to flush out bad riders and drivers, who can be deactivated. You can track the car on your screen as it approaches. The driver has your desired destination in the built-in GPS. When the ride is completed, the fair is automatically paid through the app.

Uber experienced growing pains associated with aggressive growth goals designed to dominate the emerging platform-based ride-hailing industry. The corporate culture was left to evolve on its own with little attention from management. In 2017, two former employees posted long blog posts detailing repeated experiences of sexual harassment and the failure of HR executives to respond. Moreover, many cities responded negatively to Uber's willful ignorance of ride-hailing regulations. London suspended Uber for a period of time until it became a better corporate citizen. Uber co-founder and CEO Travis Kalanick was videotaped berating the driver of an Uber car who complained about the company's payments to drivers. The video went viral.[18]

What went wrong at Uber? Executives did not focus their attention on forming and reinforcing a positive organizational culture and values. A "tech-bro" culture emerged that was unsatisfying to internal employees as well as many drivers and riders. Uber's early-stage focus on growth at all costs created a backlash. Some users boycotted Uber and urged others to do the same. Uber drivers and riders are regulated, instructed, and evaluated by software algorithms. Algorithms run almost everything at Uber, including how drivers are hired, retained and rated, surge pricing, driver dispatch, and advertising.[19] The fundamental belief in algorithms to run company operations allowed the culture to go out of control. The organizational hierarchy is a better mechanism for influencing organizational culture and values. Senior leaders in the hierarchy at platform companies should think of themselves as culture-processers rather than information-processers. Travis Kalanick was dismissed as CEO and a new CEO, Dara Khosrowshahi, was hired to improve Uber's culture values and reputation. Algorithms cannot establish cultural norms or inspire loyalty. The current CEO and other top leaders are working to establish a whole healthy culture at Uber.[20]

ASSESS YOUR ANSWER

1 Platform-based organizations are a new form of organization, but the fundamental assumptions are the same as for a traditional industrial organization.

ANSWER: *Disagree.* The basic assumptions underlying a traditional company no longer apply in new platform-based companies. Platform-based companies use fewer assets, information travels faster and more widely, and there is less need for hierarchy than in traditional companies.

9.2c Platform Design Recommendations

Platform-based organizations are still relatively new. There have been few studies exploring the impact of platforms on organization design. There are no hard and fast rules for platform-based companies, but a number of recommendations have emerged based on what is known about this new organizational form. To effectively design a platform-based organization, leaders should influence a positive corporate culture, invest in employee talent, and develop employees' soft skills.

BRIEFCASE

As an organization manager, keep these guidelines in mind:

Use a platform-based organization because it uses fewer capital assets, enjoys rapid digital communication, and employs less hierarchy than a traditional organization. Decide whether to be a maker platform or an exchange platform. Influence a constructive corporate culture so that a "tech-bro" culture does not emerge.

Envision a Constructive Culture. CEOs and other top leaders should be capable of communicating their vision for both the cultural and digital dimensions of their companies. The technical/digital mindset within a platform business should not overwhelm or take priority over corporate culture. In one survey, companies whose employees think they made an effective digital transformation tend to have cultures that value agility, risk taking, distributed leadership, collaboration, and data-driven decision-making.[21] These cultures do not happen by accident. Leaders must proactively establish the desired cultural norms and values. Technology-focused employees may be content to let culture emerge on its own, in which case core values are less predictable. A change management consultant proposed that culture is the most important part of the digital transformation process. Rather than letting technology drive culture, it should be the other way around. Leaders should set culture norms first, and then proceed with building the new technology platform and infrastructure.

As one real-life example of culture oversight, Uber's culture became anything but constructive during the founding CEO and other top managers' intense focus on rapid growth to the exclusion of establishing positive culture values, as described earlier. Fortunately, the company's new CEO and top management team are toning down Uber's grow-at-all-cost values while working to build a more collaborative culture and repair Uber's "bad-boy" reputation.[22]

Invest in Digital Talent. Acquiring the right talent with the right digital skills and mindset is a challenge for many companies. There is a scarcity of digital talent. During a labor shortage, it is as important to hold onto current talent as it is to find new talent. A culture that allows people to experiment and make mistakes is attractive to employees. When a company is transitioning to a digital organization, current employees who do not have strong digital skills often prefer training within the organization to leaving to join another company. A study by MIT Sloan School of Management found that over half of employees at companies in the early stages of digital transformation were planning to leave their organization in the next three years. This was true for senior management as well, largely because of a lack of opportunity for digital development opportunities. Digitally mature organizations are more than five times as likely as their peers to provide resources and opportunities to develop their employees' digital acumen.[23] A McKinsey report suggests that a lot of talent can be nurtured inside the firm rather than always recruiting technical specialists from outside. Just basic digital competency may be better than deep technical knowledge.[24]

It is smart for a platform company to become a magnet for talent. Employees and executives are highly inclined to jump ship if they feel they do not have opportunities to develop digital skills. Consider that VP-level executives without

sufficient digital opportunities are 15 times more likely to want to leave within a year than are those with satisfying digital challenges. In successful digital companies, development efforts for talent management go far beyond traditional training. These businesses create compelling cultural norms for achieving career growth ambitions while acquiring digital skills and experience, which help employees want to stay.[25]

Promote Soft Skills and Team Building. In a digital world, the technology tools change so fast that technical skills may seem transient. The companies best prepared to handle a digital transformation tend to focus on developing employees' human skills. Studies have found that, when putting together a list of skills needed for effective twenty-first century organizations, soft skills like communication and developing a network are equally important to technical skills. In an open-ended survey question, 38 percent of respondents said that instead of technical know-how, a change-oriented mindset, including the ability to be flexible, adaptable, and curious, was the skill most central to success in a digital workplace. Although Walmart is not a platform organization, as it develops employees' digital skills, it also encourages them to collaborate across organizational boundaries. Walmart purposefully organizes activities to create "collisions" between associates working on projects who might not have worked together previously. One thing that accelerates results at Walmart is when people who have different backgrounds and come from different regions are now working together on common problems.[26]

Breaking down functional silos and focusing on cross-functional collaboration is considered crucial to success in digital environments. More than 70 percent of digitally maturing businesses are using cross-functional teams to organize work and are charging these teams with implementing digital business priorities. The need for soft skills is based on the drive for cross-functional teams because digital employees do not function in isolation. The processes in a platform-based organization are tightly integrated, so effective collaboration enables greater organizational effectiveness. Cross-functional teams are what enable a terrific customer experience. Cross-functional teams also encourage employees to think differently and more broadly. Participating in a cross-functional team pulls people out of their small segment of the business to see the bigger picture. The importance of working cross functionally has become so important that some companies are using special interviewing tools to ensure that new hires have the requisite soft skills and cross-functional team abilities to get work done.[27]

People want to work in a culture that encourages them to continuously learn, grow, and gain new digital experiences. One way some companies help employees keep learning is to encourage them to participate in digital platforms and digital communities away from work. They can share ideas with and learn new skills from experts in other organizations. Instead of asking staff members to be secretive about their work, some businesses encourage people to be active on platforms such as GitHub, where they can collaborate on the development of cutting-edge technical tools. This strategy can help attract and retain employees who want to learn about the newest technologies while also gaining better social skills from working on these collaborative projects. Organizations that do not develop employee talent are likely to see employees and executives jump ship to competitors that do.[28]

REMEMBER THIS

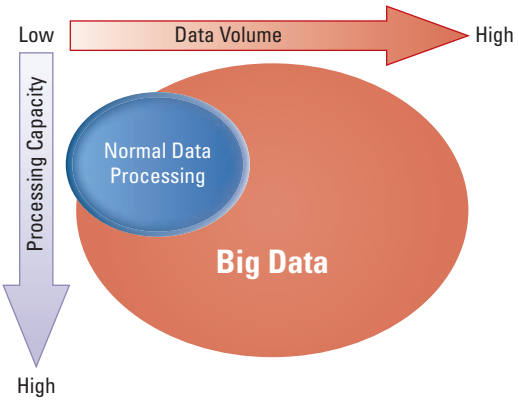
- The "pipe" is a traditional organization that transforms raw materials into products or services for customers.
- The "platform" is a new organizational form that digitally connects producers and consumers rather than producing a product or service of its own to sell.
- Platform-based digital organizations are of two types. Exchange platforms facilitate 1:1 producer-consumer interactions among members (think of Uber). Maker platforms facilitate 1:1,000s producer-consumer connections (think You Tube).
- The foundational assumptions of platform-based digital organizations differ from those of pipe organizations in that they use fewer assets, there is faster information flow, and there is less hierarchy.
- Platform-based digital organizations can lose control of corporate culture and therefore leaders must try to influence a constructive culture.
- Platform-based organizations must invest in digital talent and promote soft skills and team building to create a culture in which people want to work.

9.3 Big Data Analytics

One of the hottest terms in IT is big data. **Big data** refers to any massive data set that exceeds the boundaries and conventional processing capabilities of traditional IT. Big data requires a nontraditional approach; it requires that managers throw out the old way of thinking and take a totally new approach to data processing. Exhibit 9.3 illustrates how big data are different from regular data.

Big data includes data sets with sizes beyond the ability of traditional software tools to manage and process the data within an acceptable time frame. As described earlier, big data analytics refers to the process of examining large data sets to uncover hidden patterns, correlations, and other useful information and make better decisions. Because the data sets are so massive, big data analytics often cannot be done with existing analytics tools; thus, a new class of big data technology has emerged.

EXHIBIT 9.3
Big Data Is Really Big



Source: Based on Steve Duplessie, "Big Data: A Better Definition," Enterprise Strategy Group blog, January 6, 2012, http://www.esg-global.com/blogs/big-data-a-better-definition/ (accessed December 20, 2014).

In an era of digital media, businesses and their customers are expecting more from big data. Big data has value for which customers will pay, making it an excellent business proposition. People and companies are attaching sensors to things that have never been measured before. On a personal level, consider what happens when you use a Fitbit. The device's sensors gather data from your movements and activities, including number of stairs climbed, distance walked or run, calories consumed, calories burned, sleep patterns, and total number of steps taken. Most users were unaware of much of these data until they strapped on the sensors within a Fitbit. Fitbit users can access data about their habits which is synced from the device to the user's smart phone or computer. A dashboard allows users to track their progress. Moreover, this kind of health data can be aggregated, and health habits shared with others, such as a health professional or a software health analytics program. Using the aggregated data, a doctor could develop a more thorough picture of a patient's overall health and habits.[29]

In industrial business, the "Industrial Internet of Things" is producing unimagined amounts of useful data. Siemens wind energy business provides an illustration.

IN PRACTICE

Siemens Gamesa

Siemens Gamesa, a leader in the renewable energy industry, maintains the industry's largest amount of historical data in a database growing daily with data collected from over 10,000 wind turbines worldwide. Inside each smart turbine are hundreds of sensors that continuously transmit more than 200 GB of data per day to a state-of-the-art diagnostic center in Denmark. At this center, advanced analytics and 24/7 human monitoring convert raw data into valuable insights.

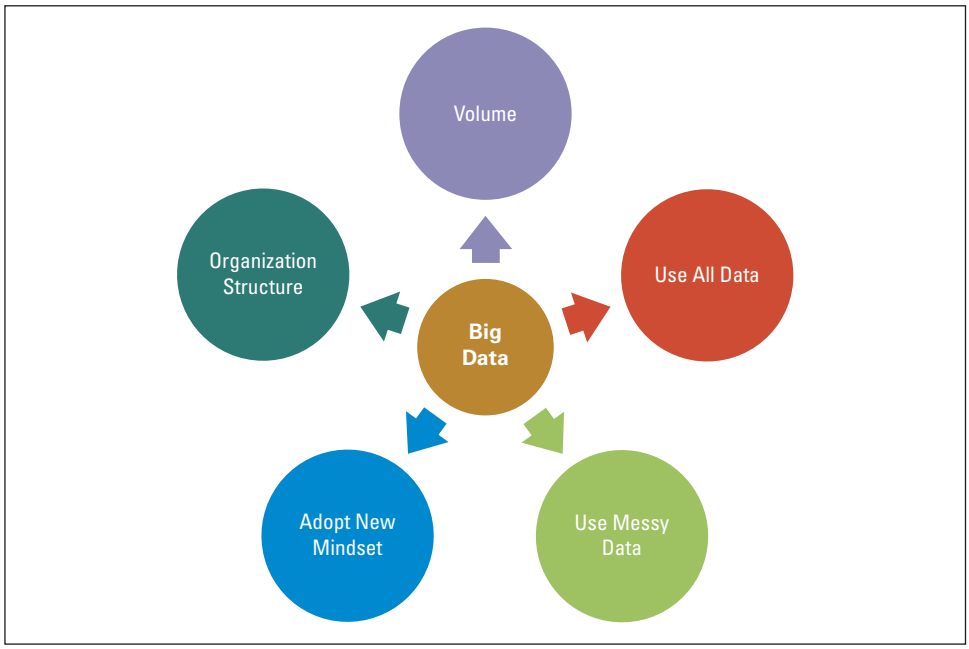
Siemens Gamesa uses data analytics techniques and experienced personnel to "see" what is happening inside the wind turbines and to understand why it is happening. These data enable Siemens personnel to prevent unscheduled breakdowns. Around 130 analytics experts check data on factors such as vibration diagnostics indicative of potential damage, wind direction, weather, service reports, and the performance of similar models, to determine when and how a turbine should be serviced days, weeks, or months in advance. The predictive capability reduces unplanned maintenance and downtime, adding weeks of profitable production and months to the life of the turbine.[30]

9.3a Big Data Requirements

Exhibit 9.4 illustrates five elements of big data, each of which is discussed in the following sections.

Volume. Big data are *really* big. They are so big they are hard to comprehend. Quintillions of bytes of data are created every day, and as IBM figures it, about 90 percent of the data that exist in the world today were created within the last two years.[31] By the year 2020, the volume of digital data is expected to surpass 40 zettabytes. One zettabyte is 50 percent more than all the grains of sand on all the Earth's beaches—an astronomical amount of information. Data can be collected easily and often without awareness on the part of individuals being recorded. Many automobiles are recording data all the time. Our physical locations have become data. If you start up Google maps on your smartphone, it immediately knows where you are. Even our interactions with each other have become data, say Viktor Mayer-Schönberger and Kenneth Cukier, the authors of a book on big data, who refer to this new phenomenon as the "datafication of everything."[32]

EXHIBIT 9.4
Elements of Big Data Function



Source: Based on Figure 1.1 Cracking the Big Data Nut, in David Loshin, *Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph* (Morton Kaufmann, 2009), 3.

BRIEFCASE

As an organization manager, keep these guidelines in mind:

Change your mindset to take maximum advantage of big data analytics. Learn to use all the data you have, not just a sample. Look for patterns and correlations that might be significant.

If all the data available today were printed in books, they say the books would cover the entire surface of the United States 52 layers thick. Placed on CD-ROMs and stacked up, they would stretch to the moon in five separate piles.[33] We are drowning in data but making them mean something is the challenge. For example, Dell realized there were over seven septillion possible configurations of Dell products on its website. To create a new system of "optimized configuration," the analytics team looked for the most common configurations people were choosing, narrowing the seven septillion down to a couple million, even identifying a few models that could be stocked into pre-configured inventory, saving both Dell and customers time and money.[34] "Storing data, recording data is cheap today," says Radhika Subramanian, CEO of analytics solutions provider Emcien. "Now data is everywhere. Everyone has data. It's like dirt."[35]

Use All Data. Using big data, people and companies can do things that weren't possible with smaller amounts. Rather than using just a sample of their data, companies now have the power to capture and store all the data from their operations, which can lead to interesting correlations. For example, one company found that people who buy small felt pads for the bottom of chair legs to protect their wooden floors are typically good credit risks. An analysis of used cars found that orange cars are half as likely as others to have defects.[36] So what? Managers with a big data mindset embrace these correlations, even if they don't see an immediate underlying cause or purpose. Some correlations prove highly valuable. In *Predictive Analytics*, Eric Siegel talks about how companies use big data to quantify how likely it is that a particular customer will default on a loan, upgrade to a higher level of cable service, or look for another job, for example. Citizens Bank was able to cut losses from check fraud by 20 percent thanks to better data analysis. FedEx can reportedly identify with 65 to 90 percent accuracy which customers are likely to move to a competitor, enabling the company to offer incentives to stay.[37]

Use Messy Data. As the size of data sets increases, so do inaccuracies. Think about a small grocery store, which may count the money in the cash register each night

down to the last penny. The same couldn't be done for a country's gross domestic product. A devotion to rigid exactness is given up in a big data world; managers are content with a general direction. Big data are often messy, vary in quality, and come from different sources. Because there is less error than from using sampling, though, managers can live with these inaccuracies. Amazon ran a test to see whether personal book recommendations from editorial staff or from data-based computer analyses generated more book sales. The computer analysis won hands-down. Websites collect massive amounts of messy data on customers. By using all the data and looking at correlations, companies such as Amazon, Netflix, eHarmony, LinkedIn, and Facebook can recommend books, products, friends, dates, and groups without even knowing why people might be interested in them.[38]

Adopt a New Mindset. The big data approach requires a new mindset. It requires surrendering to the data. "I was very sad about the editorial team getting beaten," said Greg Linden at Amazon. "But the data doesn't lie, and the cost was very high."[39] One of the earliest encounters many people had with the big data mindset was the 2011 movie "Moneyball." Brad Pitt portrays Billy Beane, the legendary general manager for the Oakland Athletics baseball team, who in 2002 built one of Major League Baseball's winningest teams with one of its smallest budgets. Rather than rely on the intuition of scouts, who would sometimes reject a player because he "didn't look like a major leaguer," Beane relied heavily on data and statistical analysis. If the analysis said an overweight college catcher that nobody else wanted should be a number-one draft pick, Beane went for it. The movie focuses on clashes between the analytics expert and the chief scout and manager, who had a hard time letting go of the idea of making decisions based on intuition and years of experience. Since that time, most other sports teams have adopted big data statistical techniques to some degree for making decisions. This chapter's BookMark describes how the Houston Astros combined data analytics and old-fashioned scouting to come up with a winning team. "There's still a place for [guys with stopwatches or playing hunches], but technology has changed the game forever," said Steve Greenberg, former deputy commissioner of Major League Baseball.[40]

Such clashes are playing out in companies across the world as managers with a big data mindset run up against those who believe decisions should be made based on historical information and manager experience. That might be why many big data supporters start new companies, such as Google's Larry Page and Sergey Brin, Amazon's Jeff Bezos, eBay's Pierre Omidyar, and FlightCaster.com's Bradford Cross. Cross and some friends analyzed every flight over the previous 10 years, matched against historic and current weather data, to predict if a flight in the United States was likely to be delayed. FlightCaster lost its first-mover advantage when a larger firm, FlyOnTime.us, began doing the same thing, and Cross sold his firm to Next Jump, a company that manages corporate discount programs using big data techniques.[41]

2 Big data analytics gets the best results with carefully selected samples of data.

ANSWER: *Disagree.* Big data analytics uses all data, not just samples as in traditional data analysis. By using all the data, the findings are considered more accurate for the entire population. This is a major departure from traditional data collection based on small samples.

ASSESS YOUR ANSWER

BOOKMARK 9.0 HAVE YOU READ THIS BOOK?

Astroball: The New Way to Win It All

By Ben Reiter

In 2014, the Houston Astros were considered one of the worst baseball teams in the last half-century. Three years later, they were World Series champions. *Sports Illustrated* staff writer Ben Reiter predicted this unlikely accomplishment in a June 30, 2014 *SI* cover story. His subsequent book, *Astroball: The New Way to Win It All*, is a fascinating account of how the Astros got the "scouts" and the "nerds" to work together to engineer one of the greatest turnarounds in baseball history.

SCOUTS OR STATS? YOU NEED BOTH!

After the hit book and movie *Moneyball*, the story of how Oakland As' general manager Billy Beane effectively used sophisticated statistical analysis, other teams grudgingly began hiring "dorks in polos and khakis," as Reiter puts it, to work alongside baseball lifers who had previously ruled the front office as scouts. The problem became one of having old-fashioned scouts in one corner and the analytic nerds in another, each side resenting the other and usually disagreeing about player decisions. The Astros general manager Jeff Luhnow wanted to get scouting and analytics to work together, recognizing that "success is not a matter of man or machine but of man *plus* machine."

- *Let the Scouts Do Their Job!* Luhnow urged scouts to continue making subjective decisions about players and prospects based on their intuition and experience. Then, he encouraged them to collect unique data and share their data and insights with the number-crunchers.
- *But Use the Stats Too!* Luhnow's leading partner in the transformation was Sig Mejdal, a former blackjack dealer and NASA scientist who became head of the Astros' Nerd Cave as the director of decision sciences. One of Mejdal's toughest jobs was making sure the nerds listened to the scouts.
- *Make It a "Stout" Decision.* The Astros developed proprietary software that analyzes every available bit of data on a player or prospect, including scouting reports, to calculate a numerical rating called Stout, for half stats, half scouts. The Stout is an internal metric that makes a decision about a player as simple as the one in blackjack: hit or stay, keep or trade, play or bench.

PUTTING IT ALL TOGETHER

Reiter's story is filled with juicy tidbits on player decisions, such as how shortstop Carlos Correa was an unexpected pick that was made based on reports from scouts rather than nerd number-crunching, how right fielder George Springer was saved from being cut by the statistical analysis, and how third baseman Alex Bregman was "as clear-cut a top pick as any member of their front office had ever experienced" based on a combination of scouting and analytics. Reiter also provides an interesting account of the team chemistry that contributed to success. *Astroball* outlines the key decisions, unexpected incidents, missteps, and strokes of luck that led from the bottom of the pack to a world championship.

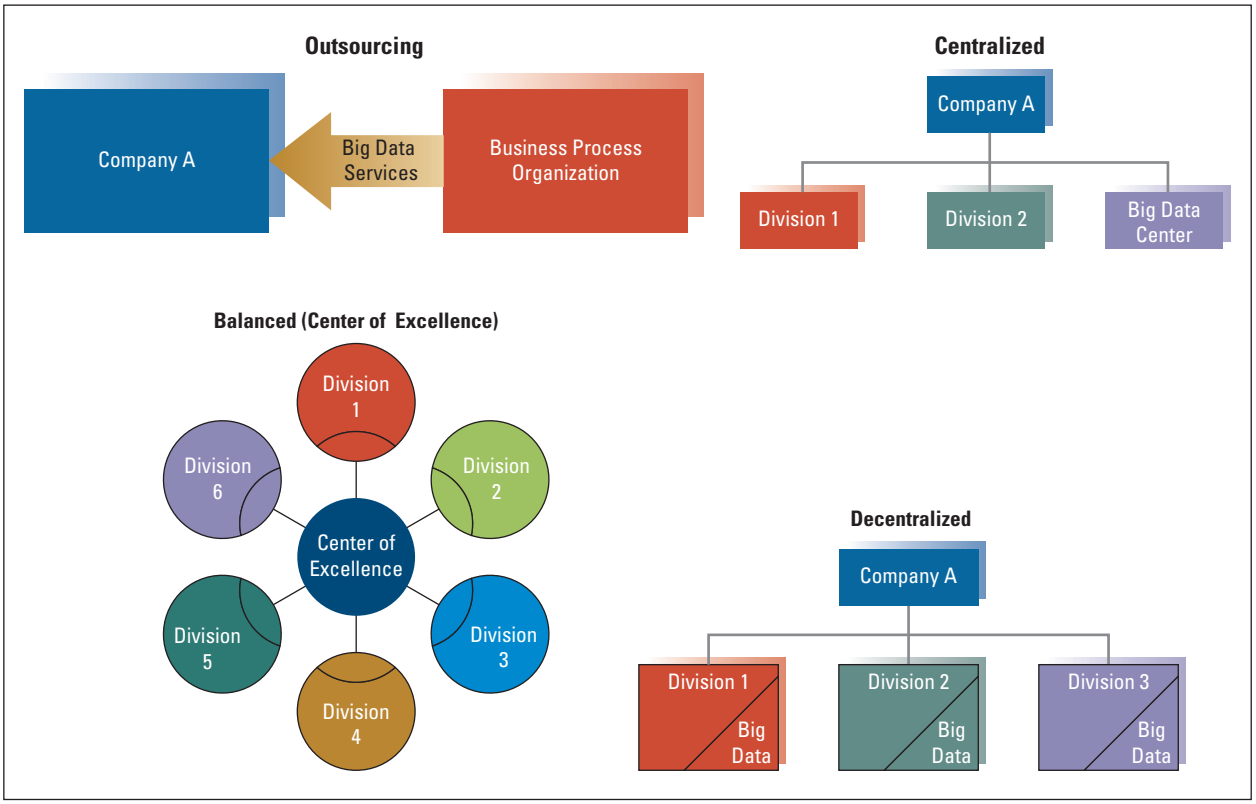
Astroball: The New Way to Win It All, by Ben Reiter, is published by Crown Archetype.

9.3b Big Data and Organization Structure

One crucial question concerns how to organize big data activity within the enterprise. Should the function be centralized or decentralized? Should data specialists be located in a central pool or attached to business units or functions? To which existing unit or function should they report? As with many other activities within organizations, there is no "one best way." Exhibit 9.5 illustrates four structural options for setting up a big data operation. Various structural forms may work best depending on the size and type of organization.

Outsourcing. The first option is to outsource analytics activities. This is a popular choice because many companies don't have the knowledge and experience to put together an analytics team. In addition, finding big data scientists and analysts is not always easy. Because big data analysis is such a hot topic, there is a shortage of skilled analysts looking for jobs. Numerous business process organizations (BPOs)

EXHIBIT 9.5
Alternative Structures for Organizing Big Data Analytics



handle call center operations, computer programming, legal research, accounting, and other services for organization, and business analytics is the latest on the menu of services these firms offer. BPOs in India, for example, have highly skilled analytics teams.

One benefit of outsourcing is that it increases flexibility by making fixed costs variable. Setting up an in-house division can be expensive. For companies that don't have in-house capabilities, outsourcing provides a way to quickly obtain the resources to execute analytics projects and gain important insights at a lower cost. In markets where finding workers with analytics skills is difficult, outsourcing might be the only way to get a foothold in big data analytics and achieve an advantage over competitors. The outsourcing firm can often provide resources and training for the company's own employees.[42]

Another form of outsourcing is to use **data intermediaries**, firms that collect data from multiple organizations and analyze the combined data for them.[43] For example, Siemens Gamesa's data center in Denmark can monitor wind turbines for other companies and provide feedback on expected maintenance and repairs. Visa and MasterCard do analysis on the billions of transactions from cardholders in 210 countries to predict consumer and business trends and sell the data to others. A division called MasterCard Advisors discovered that when people fill up their gas tanks at around 4:00 P.M., they are likely to spend between $35 and $50 at a grocery store or restaurant within the next hour.[44]

BRIEFCASE

As an organization manager, keep these guidelines in mind:

- If you are just starting with big data, consider outsourcing to an organization that has the people, skills, and processes to handle big data analytics effectively and efficiently.
- If you use an in-house unit, use centralized big data to attain a critical mass of experts, achieve efficiency, and share innovations across the enterprise. Decentralize big data if analysts need to work more closely with each division and tailor their models to each division's needs. Use a balanced design with a Center of Excellence to assign a few analysts to specific divisions while the rest remain centralized to work on coordination of organization-wide problems.

Centralized. For companies that want to set up an in-house unit for analytics, the big question is whether to centralize or decentralize. The first in-house model in Exhibit 9.5 centralizes analytics by locating all big data experts in a single department.[45] The advantages are that this achieves a critical mass of analysts and is the easiest way to ensure that the unit can obtain the necessary data and develop the necessary expertise to efficiently test and use various statistical, data-mining, and predictive models. Managers have to decide whether the unit will report to one of the departments, such as finance or marketing, or to a chief data officer (CDO), who reports directly to the CEO. The problem with having a central analytics group report to one of the functions, such as finance, is that applications outside of that function might go unnoticed or unaddressed.[46] Procter & Gamble has had an analytics group since 1992 and as a result is adopting big data analytics ahead of most companies. At P&G, the CIO is currently serving the CDO function by working with the business units to introduce new analytical approaches, and given the company's long history incorporating analytics, this approach seems to be working fine. Intel uses a partnership between the CIO and the chief marketing officer to take the lead in big data analytics. IBM uses an enterprise transformation head who reports to the CEO as the equivalent of a CDO.[47]

Balanced Design. Another in-house approach is to use a balanced or hybrid design, which places a small number of data scientists in a "center of excellence" led by a CDO, while the remainder stay in the various functional departments or business units.[48] The Center of Excellence plays a coordination role, assessing needs, prioritizing projects, and so forth. This might be thought of as a hub and spoke design, such that a team of experts in a central unit is available to provide coordination, answer questions, and provide assistance concerning data analytics to various departments and business units. This design recognizes that each unit has its own analytics priorities, such as strengthening promotional efforts for marketing or optimizing inventory levels for operations. However, it also honors the need for building up analytics expertise that can be applied organization-wide and coordinating the data analytics strategy. An analyst from the center of excellence might be assigned to one of the units for a specific project, which helps to build expertise within the unit.[49] Morgan Stanley recently set up a center of excellence to manage the increasing volume and complexity of data the firm deals with.

IN PRACTICE

Morgan Stanley

Morgan Stanley, like most financial institutions, has amassed tons of data over the years, with more than one petabyte (equivalent to about one million gigabytes) now entering the bank's systems every month.

Marieke Feenstra/Shutterstock.com

To cope with and gain value from the data deluge, Morgan Stanley recently established its Data Center of Excellence, made up of about 30 experts in data architecture, infrastructure and governance. These specialists act as data advisers to the different business and technology divisions within the organization, helping to establish best practices and controls around data quality and security. The team is working closely with Morgan Stanley's AI team, for instance, to make sure algorithms in areas such as commercial real-estate loan analysis or fraud detection are using data that are accurate,

up-to-date, and complete. The team helped develop an application that allows traders to analyze the risk of a loan without having to do deeper analysis manually. Another system analyzes transactions that can indicate fraudulent behavior. "In the past, you couldn't consume the data in the speed that was needed to get these insights," said Katherine Wetmur, Morgan Stanley's international CIO, who leads the Data Center of Excellence team. Wetmur and other Morgan Stanley leaders believe the center of excellence approach can help the firm more effectively manage and use data as a strategic asset.[50]

Another large organization that uses the center of excellence idea is General Electric. GE launched its big data initiative called the Industrial Internet in 2009. By May 2011, GE had embedded thousands of sensors in power plants, jet engines, utilities companies, oil rigs, and medical systems. Connecting hundreds of thousands of sophisticated sensors to one another gave GE a strategic advantage from its new capabilities. However, prior to 2011, the company's digital technology efforts were scattered. The various businesses employed thousands of software professionals but there was no overarching strategy guiding their technical choices and commercial offerings. Each business unit made choices according to local conditions and each used a different technology. A group of senior leaders found 136 data products across the businesses and only 17 were profitable. GE managers decided to bring the data scientists together in a global center of excellence that would serve all businesses equally.[51]

Decentralized. This approach totally decentralizes data analytics, so that data scientists are spread throughout the organization, with a small group of analysts in each department or business unit. The fully decentralized approach is the easiest way for analysts to collaborate with the respective departments or business units and tailor their models to each unit's needs, but it makes it difficult to share innovative solutions across unit boundaries and achieve critical mass on organization-wide problems and opportunities. Siemens Corporation, for example, created the Siemens Digitalization Program to make it a world leader in combining the physical and digital worlds. Siemens went in the opposite direction of GE, reasoning that its corporate strategy was based on the specific offerings of the business units. Leaders feared the business units would lose their influence with customers if Siemens took a centralized digital approach. Business units were encouraged to build on their own digitalization ideas rather than have top-down mandates. However, Siemens leaders also understand that, with a smaller data analytics group in each business, there is the question of whether each group will have the expertise needed to obtain the necessary data and deploy the appropriate analytical models.[52]

Caesars Entertainment also wrestled with this question and went from decentralized to centralized analytics to increase efficiency and effectiveness of the big data analytics function. At Caesars, with more than 70,000 employees and casino resorts on four continents, data analytics is used not only to understand customers and create a richer customer experience at each property but also to improve operations—everything from food and beverage analytics to human resources analytics. At one time, each Caesars property had its own analytics team of three or four people, but executives believed greater centralization was needed to reap the benefits of data analytics. Centralizing analytics at Caesars has given all the operations a uniform view of their business and a common language across the organization. The centralized team provides support to each of the businesses and facilitates innovation across different areas of the organization and through partnerships outside the organization.[53]

REMEMBER THIS

- Big data analytics, a direct outgrowth of earlier business intelligence applications, uses digital technologies to examine huge data sets to uncover hidden patterns, correlations, and other useful information and make better decisions.
- Elements of big data are its massive volume, the potential to use all the data rather than just samples, the use of "messy" data, and the need for a new mindset.
- Some companies outsource big data activities to business process organizations or use data intermediaries, because it is tough to build big data capabilities in-house. As more people gain the skills, however, more organizations are building their own big data analytics departments.
- Companies can choose to centralize big data activities, decentralize big data to departments or divisions, or use a Center of Excellence.

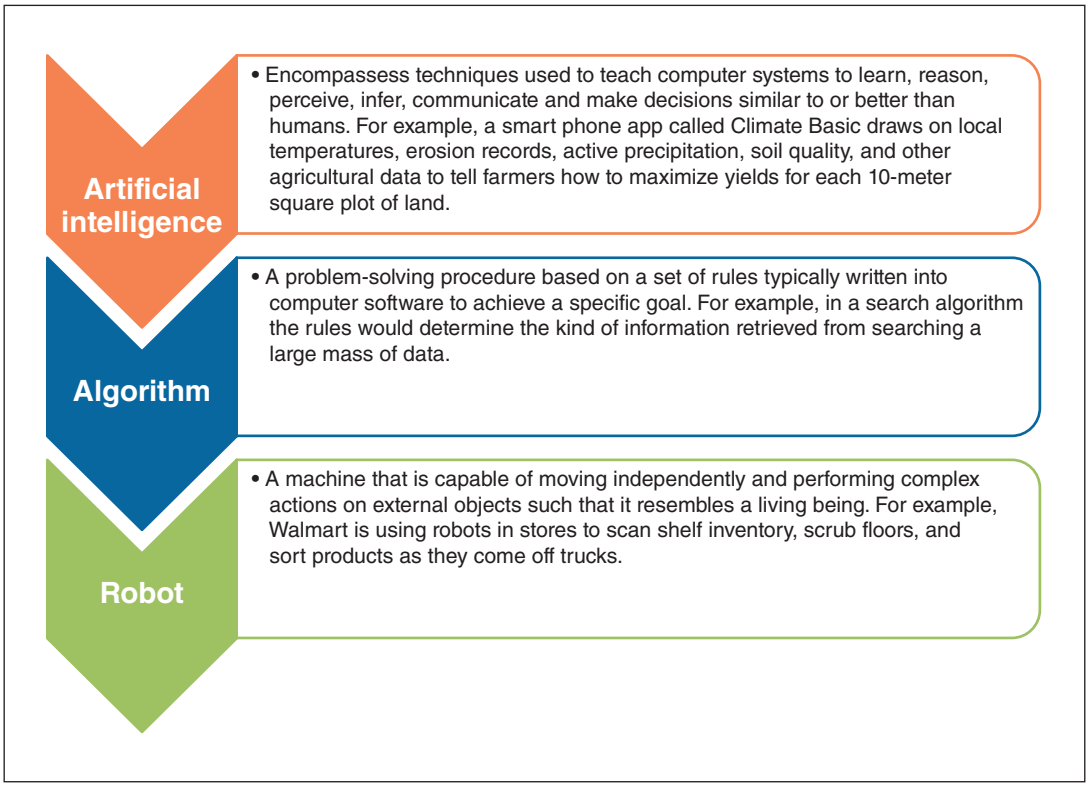
9.4 Artificial Intelligence

Much of the power underlying the smart factory, platform-based organizations, and big data is the software known as **artificial intelligence**. With the ability to make decisions equal to or better than human beings, computer-based artificial intelligence (AI) is being rapidly adopted in organizations' core manufacturing technologies. Exhibit 9.6 defines AI and some of the other new technologies being used in today's organizations. AI is also creeping into aspects of organization management. For example, new software is automating mundane office tasks in operations such as accounting, billing, payments, and customer service. AI programs can scan documents, check the accuracy of customer records, enter numbers into spreadsheets, and make payments. Another application is to check on expense account fraud. Manual expense account audits may be a thing of the past as computers use AI to eliminate questionable write-offs such as wine at lunch or a round of golf. These office work applications are just beginning, and the AI systems will continue to learn as they go. For now, most office applications focus on menial, routine tasks that free workers from the drudgery jobs.[54]

Even more AI progress has been made in HR recruiting and hiring. IBM is using its own AI platform called Watson Candidate Assistant, for example, to infer specific skill sets from the roles listed on a candidate's resume. If work on an advertising campaign over the past year is listed, Watson infers that the work involved digital marketing skills. The technology then presents the candidate with several job opportunities based on the identified skills. Candidates receive opportunities to apply for jobs they may never have thought of. Watson continually learns from the three million job applications IBM receives annually. The technology knows the specifics of IBM's jobs in 170 countries, understands the skills needed for each, and maps that knowledge onto the data coming in from job applicants. Watson Recruitment, another AI tool, helps IBM prioritize resumes for recruiters without considering personal details like age or gender.[55]

Unilever is also using AI in the HR function. Unilever is using algorithms to replace personal resumes. For a job applicant, the first three rounds of interviews and assessments—filling out the job application, playing a set of online games, and submitting a video of oneself responding to questions—do not involve a Unilever

EXHIBIT 9.6
New Information Technologies Used in Organizations



Source: Based on Jackie Snow, "An A. I. Glossary," *The New York Times*, October 18, 2018, F3; John McCormick, "Test Your Knowledge of Artificial Intelligence," *The Wall Street Journal*, April 1, 2019, https://www.wsj.com/articles/test-your-knowledge-of-artificial-intelligence-11554136673; and Anand Rao, "A Strategist's Guide to Artificial Intelligence," *Strategy+Business*, May 10, 2017, https://www.strategy-business.com/article/A-Strategists-Guide-to-Artificial-Intelligence?gko=d2e2b.

employee. An applicant meets a hiring manager only when recommended by an algorithm. AI software and algorithms do most of the hiring work. Goldman Sachs and Walmart's Jet.com are testing similar digital hiring tools.

Unilever places ads on Facebook and other targeted websites. Applicants can apply in just a few clicks. An algorithm scans the applications to identify appropriate candidates, thereby weeding out more than half of the pool. Candidates then play a set of 12 short online games to assess skills such as concentration and short-term memory. At this point, 60 to 80 percent of candidates are eliminated. AI also assesses how quickly people respond to questions, their facial expressions, and vocabulary. The final step is an in-person interview with a human resource manager. Unilever says hiring is faster and more accurate using AI, because 80 percent of applicants who make it to the final round get job offers and 80 percent accept.[56]

9.4a Is AI an Objective Decision Maker?

Three researchers at the University of Toronto built a system that could analyze thousands of photos and teach itself to recognize everyday objects, such as flowers, cards, and dogs. The system was so effective that Google bought the small startup company. The system sparked a technological revolution. Machines suddenly could

"see" in a way not possible previously. This accelerated the progress of driverless cars and other robotics that needed to see more like a human being. It also improved the accuracy of facial recognition services that could be used for social networks such as Facebook or for law enforcement agencies.[57]

With its relentless focus on facts, AI seems to overcome a typical supervisor's prejudices. However, AI can have its own biases, such as favoring job candidates who have characteristics similar to those the software has seen before. Researchers soon noticed that facial recognition services were less accurate when used with women and people of color. Prominent AI researchers from Microsoft, Google, and several top universities and other organizations signed a letter calling on Amazon to stop selling its facial-recognition technology to law enforcement agencies because the software was biased against women and people of color. In one academic publication that tested facial-recognition software, the software mistook women for men 19 percent of the time, and misidentified darker-skinned women for men 31 percent of the time. In another example, a major company built a job-applicant screening program that automatically rejected most women's resumes. Another company developed facial-recognition algorithms that mistook many black women for men. Broader evidence of bias came in a 2018 study of three facial-recognition tools of the kind used by law-enforcement agencies to find criminal suspects or missing children. Analyzing a diverse sample of 1,270 people, the programs misidentified up to 35 percent of darker-skinned women as men, compared with the top error rate for white-skinned men of only 0.8 percent.[58]

This bias may arise because developers testing their products often rely on data sets that lack adequate representation of minority groups or women. One widely used data set, for instance, is more than 74 percent male and 83 percent white. When engineers test algorithms on these data sets that contain primarily people like themselves, the results tend to be accurate. Moreover, although companies have stepped up efforts to recruit women and minorities, computer and software professionals who write AI programs are still largely white and male. Subtle unconscious biases may be built into some AI algorithms right from the start if developers are not consciously thinking about racial and gender differences.[59]

One solution would be for developers to increase racial and gender diversity on their design teams. The value of team diversity is illustrated by Microsoft, which recruits employees with diverse creative and artistic skills to help write programs that interact with human beings. Team members have included a playwright, a comic-book author, a songwriter, an essayist, a novelist, and a philosophy major. The diversity and professional skills equipped the teams to write appropriate language and anticipate diverse user reactions.[60]

ASSESS YOUR ANSWER

3 Artificial intelligence is objective and bias-free compared to human decision making in organizations.

ANSWER: *Disagree.* It seems as if AI would overcome a typical supervisor's prejudices, but AI can have its own biases that are built into the decision-making software. Developers testing their products often rely on data sets that lack adequate representation of minority groups or women. Subtle unconscious biases may be built into some AI algorithms right from the start if developers are not consciously thinking about racial and gender differences.

9.4b Is Nudge Management Going to Be Your Coach?

Imagine you are sitting down for morning coffee with your management coach or mentor. You review your goals in your new job as a manager and wonder whether you are spending your time wisely. The coach provides tips on your smart phone in 5- to 10-minute videos that you watch in spare moments during your workday.

Your coach in this situation is a manager-training web-robot powered by artificial intelligence in IBM's Watson. The coach's name is Amanda. One coaching mini-assignment might be to ask more questions rather than "telling" associates what to do. The instruction might be "see if you can go a whole day and manage only by asking questions. Think of it like a secret game you are playing. Instead of telling or giving an idea, how can you have an effect through questions? If someone asked for your opinion, ask back, 'What do you think?' If someone wants you to decide something for them, ask, 'What would you do if you were me?'"[61] When a manager recently texted that she doubted her ability to review a colleague's performance, the web-robot coach chided her for being too hard on herself, based on the manager's personality trait score of being highly conscientious. Coach Amanda helped another manager run a richer brainstorming session by suggesting he ask more questions. Many managers like taking their training on the job, right when they need it, rather than in formal classes. At Fidelity Investments, this kind of coaching AI software is helping employees and managers give and receive feedback more easily. If the AI software identifies a morale problem, such as a feeling among employees that the manager's decisions are being made too secretively, the manager might be texted to explain his decisions more clearly. At the same time, employees might get messages aimed at restoring trust in the manager by suggesting he or she has good intentions and is really busy.[62]

AI coaching programs use the concept of **nudge management**, which applies insights from the behavioral sciences to offer gentle reminders, or nudges, toward desired behaviors, such as a reminder to seek a person's attention or urge an action.[63] Nudge management is about improving an individual's decision-making with regard to health, wealth, happiness, and goal achievement. Nudge management theory is based on the economist Richard Thaler's Nobel Prize-winning research into how people make decisions based on what is easier rather than on what is in their best interest. A well-timed nudge can prompt a person to make better decisions. For example, by employing nudge management employees may be made aware of their own distracting and often unconscious actions such as constantly checking e-mail, web browsing, social media, and so on. Software can detect these patterns and perhaps change the default settings in the e-mail software to turn off the sound effect of an incoming e-mail or only allow access to the e-mail inbox once every hour.[64]

Google tries to nudge workers toward happiness. Google's nudge system, for example, helps remind employees to be the person they want to become. One manager said the bite-size reminders made it easy to take action right away when he was prompted to ask members of his team for their opinions before he made a decision. Another manager might be reminded to hold one-on-one meetings with staff members to discuss development goals.[65]

BRIEFCASE

As an organization manager, keep these guidelines in mind:

Use artificial intelligence to take over routine organizational tasks. Delegate greater responsibility to the remaining employees doing nonroutine tasks. Use AI as a management coach whenever possible. Be cautious about relying too heavily on AI to oversee and control employees, and never let an algorithm evaluate or fire an employee without human contact.

9.4c Algorithmic Control May Be Your New Boss

Artificial intelligence has the potential to solve some of the world's toughest problems, such as reducing automobile deaths and helping doctors diagnose

diseases. Data and algorithms are presented as objective, neutral, even benevolent helpers. The algorithms give us convenient food delivery services, personalized movie recommendations, and determine the news we see on Facebook. Moreover, AI has the potential to perform routine tasks so that more nonroutine work can be decentralized to humans in the form of greater responsibility and work that is more satisfying.

However, there is another side to the story. When employees do work that is measurable and somewhat routine, AI can assert a level of control over workers that is fine-grained down to minor details. **Algorithmic control** is the use of software algorithms to set targets, measure performance, provide feedback, and decide rewards for employees. Seemingly, there may be no place for an employee to hide from algorithmic control. UPS governs the working life of a delivery truck driver with a handheld device and more than 200 sensors on each delivery truck that track everything from seat belt use, to backup speeds, to stop times. When a driver stops and scans a package for delivery, the system records the time and location and when a customer signs for the package. Much of this information goes to a supervisor in real time.[66] Uber and other ride-hailing apps use algorithms to watch everything a driver does. Personal statistics are comprehensive, including riding acceptance rates, cancellation rates, hours spent logged in, acceleration smoothness, trips completed, and passengers' ratings of their performance. Selected statistics are displayed to drivers as motivating tools, with messages such as, "You are in the top 10 percent of partners!" In addition, if drivers fall below 4.6 stars on a 5-star rating system, they may be deactivated.[67] Some companies are giving employees ID badges to wear. The badges track employees' movements through the office and record with whom they talk and how long they spend in conversation. A survey from the American Management Association found that 43 percent of employers monitor employee e-mail, 45 percent track employee keystrokes, and 66 percent monitor the Internet use of their employees.[68]

At its worst, AI can be used to evaluate and fire an employee without human contact. Documents obtained by *The Verge* claimed to show how Amazon used a computer system to automatically track and fire hundreds of fulfillment center employees for failing to meet productivity quotas. Is this a grim glimpse into the future in which AI is your boss? The documents indicated that Amazon's system tracks the rates of each associate's productivity and automatically generates any warnings regarding quality or productivity, as well as terminations, without input from supervisors. It is not clear whether Amazon still uses this system. An Amazon spokesperson said Amazon would never dismiss an employee without first ensuring the employee had received support and coaching to help improve and emphasized that Amazon's objective is to provide long-term career development. An anonymous employee wrote a piece for *The Guardian* that claimed workdays at Amazon are managed down to the second. Employees say they feel they are treated like robots when they are so comprehensively measured by digital trackers and indicators in these automated systems.[69]

Why are organizations using algorithms for such intense control? Because it pays off financially by reducing employee variability and slack. UPS in some cases has added 10 stops to a driver's workday. Drivers who are not up to standard at Uber can be identified and deactivated. The new algorithmic control systems produce impressive results for the bottom line. After United Grocers, a large wholesaler, implemented an electronic tasking system for its warehouse workers, the firm was

able to cut payroll expenses by 25 percent while increasing sales by 36 percent. A study of chain restaurants found that electronic monitoring decreased employee theft and increased hourly sales.[70]

9.4d AI Implications for Organization Design

The rapid growth of artificial intelligence applications in organizations suggests two adjustments to organization design: 1) create a new senior AI position and 2) decentralize authority to employees doing nonroutine work.

Add a Chief Artificial Intelligence Officer. Creating a position in the organizational hierarchy for a senior AI specialist may help organizations deploy the technology more effectively. A handful of companies have introduced the new role of chief artificial intelligence officer (CAIO) to help move this evolving technology beyond the initial stages. Companies that have hired AI chiefs, such as Toronto-Dominion Bank Group, say the executive works across organizational boundaries and spots new areas where AI can improve the business. The CAIO defines strategies, coordinates projects, and recruits hard-to-find data scientists and other AI experts. Some forward-thinking companies want an AI officer to be at the table when discussing what the future looks like. As one CAIO explained, "Everyone expects AI to be the most transformative technology of our generation. It is going to completely change how our business operates. The role I play is one of managing the disruption."[71]

One important application of AI strategy at Toronto-Dominion Bank is developing a predictive model for the mortgage business. The model analyzes credit bureau data, account and transaction data, demographic information, and data from other sources to spot banking clients who are likely thinking of buying a home. Once a potential mortgage client is identified, a bank representative will reach out to the person to discuss next steps to begin the loan process. The model can predict very early on when customers might be in the process of buying a home. Reaching out to show interest in a potential borrower is much more effective than waiting at the branch for them to show up wanting to complete a mortgage application.[72]

Decentralize Authority. With respect to the organizational hierarchy, AI can be expected to take over many routine tasks, so much of the remaining nonroutine work is likely to be accomplished by loosely governed decentralized groups of people with a combination of skills needed for whatever problem arises. In an automobile plant, for example, robots already do much of the routine physical work that used to be done by people. In the not-too-distant future, robots may be doing all the routine work. The job of humans is becoming primarily one of designing new vehicles and production processes, repairing the machines, and dealing with other nonroutine problems that arise during daily operations. People who do nonroutine work do not need to be managed the same way as traditional factory workers. Like employees in consulting firms and research organizations, nonroutine employees often know better than their managers what needs to be done and how to do it. Nonroutine employees are best managed with the freedom to do their work. Complete the questionnaire in the "How Do You Fit the Design" box to see how your work habits align with greater decentralization and autonomy. People who do the nonroutine work might be organized into something resembling a team holacracy rather than a traditional organizational hierarchy.[73]

HOW DO YOU FIT THE DESIGN?

HOW WILL YOU HANDLE DECENTRALIZATION AND AUTONOMY?

As machines take over more routine work, and digitalized organizations decentralize the remaining nonroutine work, do your work habits include making your own plans and setting your own goals? Answer the following questions as they apply to your work or study behavior. Please answer whether each item is Mostly True or Mostly False for you.

	Mostly True	Mostly False
1. I set clear, specific goals in more than one area of my work and life.	_____	_____
2. I have a definite outcome in life I want to achieve.	_____	_____
3. I prefer general to specific goals.	_____	_____
4. I work better without specific deadlines.	_____	_____
5. I set aside time each day or week to plan my work.	_____	_____
6. I am clear about the measures that indicate when I have achieved a goal.	_____	_____
7. I work better when I set more challenging goals for myself.	_____	_____
8. I help other people clarify and define their goals.	_____	_____
9. Trying for specific goals makes life more fun than being without goals.	_____	_____

Scoring: Give yourself one point for each item you marked as Mostly True, except items 3 and 4. For items 3 and 4 give yourself one point for each one you marked Mostly False. If you scored 4 or less, goal setting behavior may not be natural for you. A score of 6 or above suggests a positive level of goal setting behavior and better preparation for a decentralized role in a digital organization.

Interpretation: An important part of digitalized organization life is setting goals, measuring results, and reviewing progress for yourself and others. The preceding questions indicate the extent to which you have already adopted the disciplined use of goals in your life and work. Research indicates that setting clear, specific, and challenging goals in key areas will produce better performance. Not everyone thrives in a decentralized organization, but as an organization employee or manager, setting goals, assessing results, and holding yourself or others accountable will enhance your impact. Goal setting can be learned.

REMEMBER THIS

- Artificial intelligence encompasses techniques used to teach computer systems to learn, reason, perceive, infer, communicate and make decisions similar to or better than human beings.
- AI is having a big impact on the administrative processes in organizations, including spreadsheets, checking customer records and employee expense accounts, and making payments.
- Even more progress has been made in HR recruiting and hiring. Companies such as IBM and Unilever use algorithms for the first few rounds of job candidate interviews.
- AI may not be as objective as it appears. Managers should be alert for bias toward minority groups.
- AI has excellent potential for coaching managers and other employees through nudge management.
- Algorithmic control systems can measure every aspect of routine work to seemingly gain more work from employees with the loss of employee autonomy.

9.5 Other Digital Applications in Organizations

Organizations are also using a variety of other digital information technologies to improve coordination, collaboration and knowledge sharing among employees, to enhance efficiency and effectiveness, and to add strategic value. Social network analysis and knowledge management are important elements of the digitalization of organizations.

9.5a Social Network Analysis

A valuable technique enabled by IT is called **social network analysis** (SNA), which can help managers learn about informal relationships and network structures within an organization. With SNA they can know who has influence and who doesn't, who people turn to for answers, who has the knowledge and technical capability to be innovative, and who has leadership potential. SNA was developed by scientists as a social theory to diagram relationships among people that differ from the formal hierarchy. A large petroleum organization conducted an SNA and found a striking difference between the formal structure defined by hierarchical reporting relationships and the way in which information actually flowed through the organization.

IN PRACTICE

Exploration and Production Division

The deep-sea drilling industry is highly competitive and highly capital-intensive. Executives knew they could reap huge cost savings if every platform could drill as quickly and cost-efficiently as the company's best. The question was whether people were effectively sharing knowledge and best practices. A first step in a social network analysis was to map the interactions for the top 20 executives in the Exploration and Production Division (E&PD). The results were surprising.

The SNA revealed that in the informal information flow there was a complete separation with no communication between the Production Department and the Drilling Department, and only a single manager who linked the Production Department with the Exploration Department in the information flow. In other words, the actual information flow was not sufficient to meet the need for coordination. The mapping also found that the senior vice president was relatively peripheral to the flow of information. Interviews with managers and further investigation provided insight into how the E&PD could more effectively manage the flow of information and knowledge-sharing.[74]

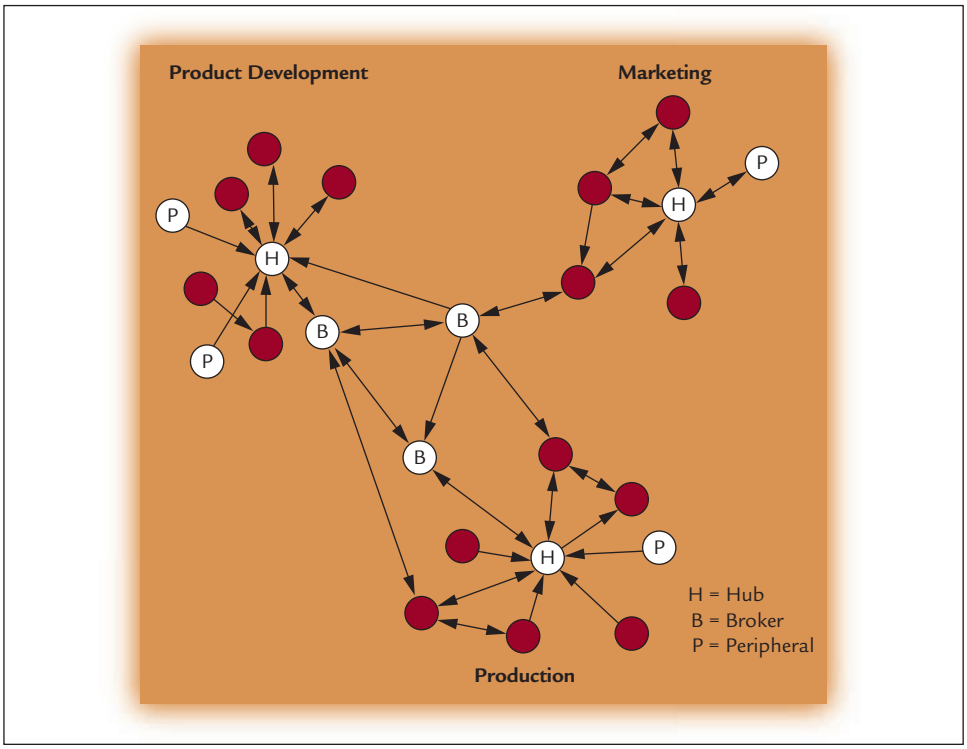
As this example shows, the structure as defined by the informal information flow may be very different from the formal organization structure as defined by the hierarchy. Social networks include people who turn to one another for help, advice, information, and support, whether or not they are in the same work group. It is within these networks that much of an organization's work gets done.[75] "There is a secret structure at every organization that spells success or failure. You can't see it in the org chart or in the flow of money on the spreadsheet. But within this [informal] structure, the assistant in the third cubicle from the elevator may be more crucial than the suit in the fancy corner office," says corporate anthropologist Karen Stephenson.[76]

People play different roles in social networks. Three roles, or patterns of relationships, seen over and over in organizations are the hub, the broker, and the peripheral player. *Hubs* are people who are at the center of an information network. These are people who are sought out for their knowledge and information. Hubs

tend to have more influence than other employees. They may have technical expertise and organizational memory, as well as a set of relationships that helps them get information that other people need. Hubs are the "go to" people in an organization. If they don't know the answer, they know where to find it. A long-time salesperson might be a hub because he or she has developed connections with other salespeople as well as with clients, managers, and people in other departments, and has years of knowledge about how the organization works. *Peripheral players* have the fewest number of connections and operate on the boundaries of a network. They are marginal players, but they can still be important because they may have niche expertise or valuable outside contacts. These might not be needed on a daily basis but could be useful during a crisis or for specialized projects. Of particular importance are the *brokers*, the people who have a knack for connecting people across boundaries and subgroups.[77] Brokers link specialized pools of knowledge and integrate the larger network within the organization. For example, a well-known investment bank won the business of a major account from a rival bank thanks to David Hawkins, a manager who played a broker role. The client had been with the rival bank for years. However, Hawkins had connections to different product and service groups within his bank that the executive at the rival bank didn't have within his firm. Hawkins served as a link across his bank's groups and introduced the client to them, which enabled his bank to create a more targeted and customized financial solution that met the client's unique needs.[78]

Exhibit 9.7 illustrates the three roles in a hypothetical organization, showing how the broker connects different parts of the larger network. Understanding these informal networks offers a competitive advantage to a company. By knowing who is facilitating high performance in others, who is collaborating, and who has personal connections, managers have a tool through which to help the company improve,

EXHIBIT 9.7
Roles in a Social Network



innovate, expand, and grow.[79] IBM has been using SNA for years. SNA experts work with companies to find their hidden networks by asking employees simple questions like the following:

"To whom do you go for a quick decision?"
"Whom do you hang out with socially?"
"To whom do you turn for advice?"
"Whom do you go to with a good idea?"
"To whom do you go for career advice?"[80]

SNA can be administered in the form of an electronic employee survey or by tracking e-mail messages among employees. Here are some examples of information that a sophisticated network tracking system might provide:

- Who is working with whom in the company's social network?
- Who are the informal leaders, and who has leadership potential?
- How does knowledge and information flow through an organization?
- Who is being overutilized, and who is being underutilized?
- Who are the experts in a company before they retire so their knowledge can be stored or transferred?[81]

Social network analysis can uncover hidden workplace relationships. It offers clear delineation of relationships through data, facts, and statistics instead of relying on rumor and innuendo. These data can be used to change the organization. For example, after reviewing the results of the SNA, the packaged food company Mars found that people in the snack food division in New Jersey weren't talking enough with peers in the Los Angeles food division, creating duplication of work and missing opportunities for collaboration and information sharing. Now Mars builds in ways for colleagues on both coasts to keep in touch with each other, and their performance reviews are based in part on their informal networking activities.[82]

Sometimes a stronger intervention is needed to change networking patterns. A global consulting organization discovered that two subgroups had formed based on technical and nontechnical skills. Clients needed a combination of "soft" strategy and organizational design smarts combined with "harder" technical knowledge. The split between the two groups came about because individuals gravitated toward each other based on common work-related and professional interests, attending the same conferences, and time spent working together. With guidance from management, each subgroup learned what the other group offered to clients. The groups were brought together to discuss the situation, which ultimately led to changes in how the groups operated. These changes promoted knowledge sharing and collaboration. The final result of collaborative groups gave the consulting company a distinct advantage that resulted in more sales and happier clients.[83] Systematic manager interventions based on SNA can help a company build a healthy pattern of informal relationships that replace ad hoc dysfunctional relationships.[84]

9.5b Knowledge Management

One important outcome that can begin with SNA is to improve an organization's knowledge management. **Knowledge management** refers to the efforts to systematically find, organize, and make available a company's intellectual capital and to foster a culture of continuous learning and knowledge sharing.[85] The company's **intellectual capital** is the sum of its knowledge, experience, understanding, relationships, processes, innovations, and discoveries.

Knowledge management is supported when people have ways to share information and ideas and are rewarded for doing so. A common form of corporate information sharing is an **intranet**, a private, companywide information system that uses the communications protocols and standards of the Internet but is accessible only to people within the company. To view files and information, users simply navigate the site with a standard web browser, clicking on links. Intranets can improve internal communications and unlock hidden information. They enable employees to keep in touch with what's going on around the organization, quickly and easily find information they need, share ideas, and work on projects collaboratively.

Companies need ways to transfer both codified knowledge and tacit knowledge among people across the organization.[86] **Codified knowledge** is formal, systematic knowledge that can be articulated, written down, and passed on to others in documents, rules, or general instructions. Tacit knowledge, on the other hand, is often difficult to put into words. **Tacit knowledge** might include how to interpret the look on a negotiator's face or the learned experience of working with a client over a long period of time. It is based on personal experience, rules of thumb, intuition, and judgment. It includes professional know-how and expertise, individual insight and experience, and creative solutions that are difficult to communicate and pass on to others. As much as 80 percent of an organization's valuable knowledge may be tacit knowledge that is not easily captured and transferred.[87] With about 10,000 baby boomers reaching retirement age every day, some large traditional companies are looking for ways to stem the loss of all the "tribal knowledge they are taking with them" as they go.[88]

IN PRACTICE

BAE Systems

A manager at BAE Systems recently demoted himself. As he moves toward retirement, he now works as an assistant to a young employee who joined the company from the U.S. Navy to do the job the manager once held. The two have been meeting regularly for some time, talking about various projects, exchanging advice, and sharing tips. They worked together on a bid to handle maintenance and repairs on an amphibious ship for the Navy. The older manager had managed that contract for 11 years, but when it was renewed this time, he handed the project over to the newer employee and demoted himself to assistant.

Chris Ison/PA Images/Getty Images

It's all part of BAE's plan to keep the multinational defense and aerospace company from losing the tacit knowledge residing in the heads of thousands of retiring employees. When BAE learns that an employee with deep organizational knowledge plans to retire, the company forms a knowledge-transfer team made up of people of varying ages working in the same area. Creating relationships between older and younger employees is an effective way to capture tacit knowledge and manage the transfer of leadership to Millennials, says Andrew Muras, BAE's advanced learning manager. Vikram Ravinder, a 29-year-old Deloitte consultant who has worked with a retiring mentor, agrees. "Millennials bring data and analytics," Ravinder said, "but boomers have experience they can rely on when the data isn't sufficient."[89]

Other companies are also striving to find ways to prevent the loss of tacit knowledge as employees retire or leave the organization. Organizations also want to create knowledge management practices that encourage ongoing knowledge sharing. Two approaches to knowledge management are outlined in Exhibit 9.8.[90] The first approach deals primarily with the collection and sharing of codified knowledge, largely through the use of sophisticated IT systems. Codified knowledge may include intellectual properties such as patents and licenses; work processes such as policies and procedures; specific information on customers, markets, suppliers, or competitors; competitive intelligence reports; and benchmark data. The second approach focuses on leveraging individual expertise and know-how—tacit knowledge—by connecting people face to face or through interactive social media. Tacit knowledge includes professional know-how, individual insights and creativity, and personal experience and intuition. With this approach, managers concentrate on developing personal networks that link people together for the sharing of tacit knowledge. The organization uses IT systems primarily for facilitating conversation and person-to-person sharing of experience, insight, and ideas. Some companies use **expert-locator systems** that identify and catalog experts in a searchable database so people can quickly identify who has knowledge they can use.[91]

Encouraging and facilitating the sharing of tacit knowledge isn't easy. Despite the fact that companies have spent billions on software and other technology for knowledge management, there is some indication that knowledge sharing has fallen short of managers' goals. For instance, 60 percent of employees surveyed by a Harris poll said work was often duplicated in their organizations because people were unaware of one another's work. Fifty-four percent said their companies missed opportunities to innovate because of poor collaboration and information sharing, and 51 percent said managers regularly made poor decisions because employee knowledge isn't effectively tapped.[92] For example, through conversation and ongoing interaction, salespeople often come to know what top executives in a client's organization want in a product or service. With this tacit knowledge, the salespeople could help develop

BRIEFCASE

As an organization manager, keep these guidelines in mind:

Establish systems to facilitate both codified and tacit knowledge sharing among employees to help the organization learn and improve. Use social network analysis to learn about informal relationships and patterns of influence.

EXHIBIT 9.8
Two Approaches to Knowledge Management

Knowledge Management Strategy	Codified	Tacit
	Provide high-quality, reliable, and fast information systems for access of explicit, reusable knowledge	Channel individual expertise to provide creative advice on strategic problems
	People-to-documents approach	**Person-to-person approach**
	Develop an electronic document system that codifies, stores, disseminates, and allows reuse of knowledge	*Develop networks for linking people so that tacit knowledge can be shared*
Information Technology Approach	*Invest heavily in information technology, with a goal of connecting people with reusable, codified knowledge*	*Invest moderately in information technology, with a goal of facilitating conversations and the personal exchange of tacit knowledge*

Source: Based on Morten T. Hansen, Nitin Nohria, and Thomas Tierney, "What's Your Strategy for Managing Knowledge?" *Harvard Business Review*, March–April 1999, 106–116.

better solutions for the client, refine their firm's marketing message, and increase their company's revenue. Yet many organizations lack the internal information-sharing networks to tap into this tacit knowledge. Salespeople naturally concentrate on forming networks with customers and potential customers, not with people inside the company.[93] Managers should understand and manage internal information networks so that tacit knowledge can be shared more easily.

REMEMBER THIS

- Two important elements of the digitalization of organizations are social network analysis and knowledge management.
- Managers can use social network analysis to increase coordination and collaboration. Social network analysis helps managers identify the hubs of informal information exchanges within the organization and the informal leaders who serve to connect people and groups across organizational boundaries.
- Managers also use intranets and other digital IT systems to promote the sharing of both codified and tacit knowledge.

9.6 Digital Impact on Organization Design

Managers and organization theorists have been studying the relationship between technology and organization design and functioning for more than half a century. As we mentioned in Chapter 8, IBM's CEO Study found that technology topped the list of external forces executives expect to significantly influence their organizations over the next few years.[94] In recent years, the advances in digital IT have had the greatest impact in most organizations.[95] Some specific implications of these advances for organization design are smaller organizations, decentralized structures, improved internal and external coordination, and new network organization structures.

1. *Smaller organizations*. Some Internet-based businesses, such as the platform-based organization form we discussed earlier, exist almost entirely in cyberspace; there is no formal organization in terms of a building with offices, desks, and so forth. One or a few people may maintain the site from their homes or a rented work space. Even for traditional businesses, digital IT enables the organization to do more work with fewer people. Customers can buy insurance, clothing, tools and equipment, even cars over the Internet without ever speaking to an agent or salesperson. In addition, new digital systems automatically handle many administrative duties within organizations, reducing the need for clerical staff. The Michigan Department of Transportation (MDOT) used to need an army of workers to verify contractors' work. Large projects often required as many as 20 inspectors on-site every day to keep track of thousands of work items. Today, MDOT rarely sends more than one field technician to a site. The employee enters data into a laptop computer or digital device using road construction management software tied to computers at headquarters. The system can automatically generate payment estimates and handle other administrative processes that used to take hours of labor.[96] Thanks to IT, today's companies can also outsource many functions and thus use fewer in-house resources.

2. *Decentralized organization structures.* Although management philosophy and corporate culture have a substantial impact on whether IT is used to decentralize information and authority or to reinforce a centralized authority structure,[97] most organizations today use technology to further decentralization. With digital IT, information that may have previously been available only to top managers at headquarters can be quickly and easily shared throughout the organization, even across great geographical distances.[98] In the IBM study mentioned earlier, CEOs see technology as an enabler of openness, collaboration, and less rigid hierarchies.[99] Managers in varied business divisions or offices can now have the information they need to make important decisions quickly rather than waiting for decisions from headquarters. Social business technologies that enable people to meet, coordinate, and collaborate online facilitate communication and decision making among distributed, autonomous groups of workers, such as in virtual teams.
3. *Improved horizontal coordination and collaboration.* Perhaps one of the greatest outcomes of digital IT is its potential to improve coordination, communication, and collaboration across the firm. IT applications can connect people even when their offices, factories, or stores are scattered around the world, and many traditional tools companies use look outdated to young employees. A banking executive from Argentina participating in IBM's study said, "We are the e-mail generation; they are the social network generation." IBM makes extensive use of virtual teams, whose members use a wide variety of social business tools to easily communicate and collaborate. One team made up of members in the United States, Germany, and the United Kingdom used collaboration software as a virtual meeting room to solve a client's tough technical problem within the space of just a few days.[100] Siemens uses a global intranet that connects 450,000 employees around the world to share knowledge and collaborate on projects.[101] MITRE Corporation, an organization that provides consulting and research and development services, primarily to U.S. government clients such as the Department of Defense and the Federal Aviation Administration, uses social networking to overcome traditional barriers such as tenure, location, and functional affiliation that had previously limited information sharing and collaboration at the firm.[102]
4. *Enhanced network structures.* The high level of cross-organization collaboration needed in a virtual network organization structure, described in Chapter 3, would not be possible without the use of digital IT. In the business world, these are also sometimes called *modular structures* or *virtual organizations*. Outsourcing has become a major trend, thanks to digital technology that can tie companies together into a seamless information flow. For example, Hong Kong's Li & Fung is one of the biggest providers of clothing for retailers such as Abercrombie & Fitch, Guess, Ann Taylor, and Disney, but the company doesn't own any factories, machines, or fabrics. Li & Fung specializes in managing information, relying on an electronically connected web of 7,500 partners in 37 countries to provide raw materials and assemble the clothes. IT enables Li & Fung to stay in touch with worldwide partners and move items quickly from factories to retailers. It also lets retailers track orders as they move through production and make last-minute changes and additions.[103] With a virtual network structure, most activities are outsourced so that different companies perform the various functions needed by the organization. The speed and ease of digital communication makes the network structure a viable option for companies that want to keep costs low but expand activities or market presence.

BRIEFCASE

As an organization manager, keep this guideline in mind:

With greater use of IT, consider smaller organizational units, decentralized structures, improved internal coordination, and the possibility of outsourcing or a network structure.

REMEMBER THIS

- Advances in IT are having a significant impact on organization design. Some specific implications of digital IT for organization design include smaller organizations, decentralized organization structures, and improved internal and external coordination.
- Digital technology has also enabled creation of the virtual network organization structure, in which a company subcontracts most of its major functions to separate companies.

KEY CONCEPTS

artificial intelligence
algorithm
algorithmic control
big data
big data analytics
codified knowledge
data intermediaries
data warehousing
digital media
exchange platforms
expert-locator system
intellectual capital
internal business intelligence
intranet
knowledge management
maker platforms
nudge management
platform-based organization
social network analysis
tacit knowledge
transaction processing systems

DISCUSSION QUESTIONS

1. How has the Internet of Things caused an explosion in the data available for analysis in organizations?
2. How do the underlying assumptions differ for a traditional "pipe" organization and a new platform-based digital organization?
3. In what ways might artificial intelligence incorporate bias into its decision making? Explain.
4. Is Amazon an exchange platform or maker platform organization? Explain.
5. How might a hospital administrator trying to implement cross-functional teams use social network analysis to improve communication and collaboration among nurses, doctors, technicians, and other staff?
6. Discuss some ways a large insurance company such as Allstate, Progressive, or State Farm might use social media tools such as microblogs or social networking. Do you think these tools are more applicable to a service company than to a manufacturing organization? Discuss.
7. Describe your use of codified knowledge when you research and write a term paper. Do you also use tacit knowledge regarding this activity? Discuss.
8. Why is knowledge management particularly important to a company that wants to learn and change continuously rather than operate at a stable state?
9. Caesars Entertainment centralized its big data analytics function to be more efficient. Can you think of some competitive issues that might lead a company to go from a centralized big data function to a function that decentralizes to various units?
10. Why do you think the application of digital technology typically leads to greater decentralization in an organization? Might it also be used for greater centralization in some organizations? Explain.

CHAPTER 9 WORKSHOP Manufacturing and Big Data: Organize the Project[104]

The era of big data has arrived. Discussions of terabytes and petabytes that were reserved for supercomputing facilities just a few years ago are common today. Companies are recognizing the tremendous value in the data they create, and they want to capitalize on that value. Manufacturing is leading the way as one of the largest producers of data from factory systems, machines, and sensors.

However, the rapid evolution of big data technologies, coupled with the hype surrounding these technologies, has led to "analytics paralytics" at some manufacturers. Questions of where to start and how to implement a big data technology can be answered in the following exercise.

Step 1: By yourself, place the eight steps below in the sequential order you believe will be most effective for implementing big data analytics in a manufacturing plant. The first step would get a "1" and the last step would get an "8." Put your sequence number beside each item under "Your Sequence."

	Your Sequence	Team Sequence	Expert Sequence
Determine the required data sources			
Trust the new data			
Assign an operations manager as project leader			
Identify internal data/process experts			
Be ready to take curative action			
Target a specific challenge to address			
Define the required analytics			
Deploy and pray			

Step 2: Divide into small teams of three to four members and decide as a group the correct sequence of the eight steps above to implement big data in a manufacturing plant. Record your team sequence of steps in the second column above from "1" to "8."

Step 3: Your instructor will give you the expert's sequence to be placed in column 3 above. Your instructor will also read the rationale for each step in the project sequence.

Step 4: Compute the absolute difference (no minus numbers) between your individual score and the expert score. Add up the differences to derive your total score. Now do the same for the team score. Which score is lower? A low score is better. Did the collective knowledge of your team produce a lower score? Discuss the dynamic within your team that might explain your team score.

CASE FOR ANALYSIS | Hermitage Escalator Company[105]

Hermitage Escalator Company is an independent division of a large international manufacturer that sells and provides maintenance of elevators and escalators. Hermitage was started by an entrepreneur living in Hermitage, Tennessee in 1954, just as the demand for the "magic staircase" began to take off. In 1989 Hermitage was acquired by an elevator company that wanted to provide a full line of lift devices. Hermitage was able to maintain substantial autonomy as a separate division and to retain its brand name.

Hermitage sells over 2,000 escalators each year. Principal areas of escalator sales include department stores, shopping malls, airports, transit system stations, convention centers, hotels, arenas, stadiums, office buildings, and government buildings. At the extreme, an escalator may carry people up multiple stories or hundreds of feet horizontally along corridors such as in an airport concourse.

How Escalators Work

In its simplest form, an escalator is like a conveyor belt with a pair of long chains, one on each side, looped around gears at each end. An electric motor turns the drive gear at the top, which pulls and rotates the chain loops, similar to the chain mechanism on a bicycle. A typical escalator uses a 100-horsepower motor to rotate the gears. The motor and chain system are housed inside a metal structure extending between the two floors.

The chain loops move a series of steps. As the chains move, the steps stay level. At the top and bottom of the escalator, the steps collapse on each other, creating a flat platform. This makes it easier for riders to get on and off the escalator.

Each step in the escalator has two sets of wheels that roll along on two separate tracks. The set of wheels near the top of each step are connected to the rotating chains, and hence are pulled by the drive gear from the top of the escalator. The other set of wheels at the bottom of the step simply glide along its track. The tracks are placed so that each step always remains level. At the top and bottom of the escalator, tracks level off to a horizontal position, flattening the stairway. Each step has a series of grooves so it will fit together with the step behind it and in front of it during the flattening.

The electric motor in an escalator also moves the handrail. The handrail is simply a rubber conveyor belt

that is looped around a series of wheels. This belt is precisely configured so that it moves at the same speed as the steps to give riders some stability.

An escalator is much better than an elevator for moving people a short distance because of the escalator's high loading rate. Escalator speeds vary from about 90 feet per minute to 180 feet per minute. An escalator moving 145 feet per minute can carry more than 10,000 people an hour, many more people than a standard elevator can move.

The Need for Maintenance

Although escalators are simple in concept, like all machinery there are many parts involved that may break down at any time. Safety mechanisms include inlet guards, an operating panel, safety switches, and step switches. The top and bottom operating units include a control panel, drive unit, main gear, drive chain, sprocket, and safety switches. The truss between floors includes the main track, trailing track, moving handrail drive unit, sprocket, moving handrail drive chain, and inlet guard. Other elements include the moving handrail, its interior panel, deck board, and skirt guard. The steps include the tread, riser, step demarcation line, driving rollers, and step chain.

Escalator maintenance is important for customer satisfaction because nobody likes to climb a broken escalator. Maintenance can also be a serious issue. There are horror stories of people falling into broken escalators that opened up when people were climbing up the stairs. Moreover, escalators have collapsed sending people tumbling to the bottom. Escalators have caught fire, such as in 1987 when an escalator in a London Underground station actually exploded, sending flames into the ticketing office, killing 31 people. The cause was the accumulation of pounds of tiny bits of paper and lint that had collected in the inner workings and undercarriage of the machine.

The IoT

Approximately 28,000 new escalators and elevators are installed each year in the United States. Hermitage, like all manufacturing companies, was facing an industrial revolution, popularly known as Industry 4.0 or the industrial Internet of Things, as manufacturing converged with the digital economy, specifically with emerging big data collection systems and analytics. There is much discussion of how to create profitable business models using big data analytics. The best approach may be to identify bottlenecks and other problems, determine what real-time data is needed to overcome the problem, and then apply appropriate sensors, wireless connections, and analytics to collect, transfer and analyze this data. Hermitage must also decide what action should be taken in response to a problem, such as how to provide data or a data visualization to decision-makers, or even how to create decision algorithms that would automatically decide what action should be taken in response to a problem.

Concerns at Hermitage

Mardell Anderson, maintenance superintendent at Hermitage, had a number of concerns about digitalizing the new escalators as part of the industrial Internet of Things. According to Anderson, "Fixing an escalator the first time, every time, is crucial to maintain customers and reduce labor costs. I would really like to see our ability to fix a problem before it happens. Prediction and prevention, as opposed to reaction, is where the industry is headed. We are driving toward preventative and predictive maintenance out of necessity. If we can install sensors and Internet of Things components, we could dispatch the right people to fix the right problem at the right time. Or better yet, prevent the problem from occurring at all."

Low-rise escalator equipment can be maintained with competent technical know-how. Competent maintenance workers make about $50 per hour and can earn over $100,000 a year with overtime. An IoT package is cost-effective on new escalators but expensive to retrofit on legacy escalators. "It will take several years to replace legacy escalators," Anderson said. "In the meantime, we are learning the weak spots in our escalator systems and where sensors would have the best payoff. It would be great if we had information coming from the equipment to tell us which mechanics to send and when to send them but that is several years away on our installed maintenance base. It could be 10 years before we have all of our installed escalators talking and communicating in a meaningful way."

Anderson wanted to be creative in his approach to maintenance during the 10-year interim. "Is it possible to find another way to achieve predictive maintenance? We have a lot of repair and callback history that we could use to do a big data-type effort, even before escalators have sensors and are connected to the IoT. Knowing that a large percentage of our callbacks are related to electric motors and chains, for example, is important. I want us to get better at using the data we already have as we move toward big data analytics."

"A really good mechanic can troubleshoot an escalator over the phone by just asking questions," Anderson says. "There are not millions of things that can go wrong. There is a finite number of questions for every escalator that would lead them down the right path. That kind of knowledge needs to be part of our predictive maintenance system."

Anderson continued, "Our challenge is selecting and positioning the sensors and cameras within the units and

then selecting the right things to measure in order to arrive at predictive capability. Measuring the right things using well-placed hardware and connecting it to the cloud would not achieve our goal without clear rules. The rules of maintenance are not derived from a rulebook, but from the accumulated knowledge and expertise of hundreds of maintenance and repair mechanics over decades of service. As part of the remote monitoring program, our rules for data collection and remote monitoring will allow the first generation of rules to be written that help dispatch the right person to the right problem."

"Now we are taking this knowledge to the next level to do predictive analytics. We want to capture and transfer knowledge that we have in our most talented technicians down to the next generation that will lead us into our future service model. With seemingly unlimited IoT data on the horizon from sensor technology, we will use this information to rewrite the rules on how we dispatch and who we send on service for maintenance calls."

"Predictive maintenance analytics will not be easy to put into practice. For example, with new data coming in, we can expect to see 'false positives' – meaning indicators that something was wrong when nothing was wrong. With matters of safety and satisfaction, how could a technician know if the alarm was a false one? False positives have the potential to increase our costs, not decrease them. Then there is the issue of natural variability in our operating equipment. How can we set parameters on distinguishing what we call "noise" from a problem that requires action? In addition, once it is determined that an action has to be taken, what should that action be? Could a certain maintenance action be bundled together with other maintenance items and then addressed as part of the next regularly scheduled maintenance service?"

"When you move to a predictive model, you can easily drive up costs. If you take every single thing that was sensed and automatically send a technician to check it out, you spend money for each visit with no benefit. That would cost a lot. If there is a safety issue or an error that could cause a shutdown, then dispatch the technician right away. But, if we are being smart, some issues detected can be bundled into our next maintenance visit to the location."

"So, my thinking is that when we write our rules for maintenance and maintenance calls, we should start with analyzing the callbacks and repairs in our history, because that is where we can influence costs and outcomes. The existing data could help us tremendously. We for sure know on which type of equipment each callback or repair occurred."

At Hermitage, all new installations will have an IoT sensor package installed. A big question is how the Internet of Things can be used to increase revenue and decrease rather than increase costs, all the while providing better customer service. How can Hermitage capture all the promise of IoT to deliver more value to the customer and to itself?

Questions

1. How might Hermitage codify and manage the knowledge of experienced maintenance technicians into the new rules to be written for handling maintenance responses under the upcoming deluge of big data from the Internet of Things? Explain.
2. How might big data analytics actually be more costly rather than less costly with respect to maintaining escalators?
3. What specific value might come from analyzing data on past maintenance calls? What specific data do you think would have value? Why?

ENDNOTES

1 Based on Viktor Mayer-Schönberger and Kenneth Cukier, *Big Data: A Revolution That Will Transform How We Live, Work, and Think* (Boston: Houghton Mifflin Harcourt, 2013), 1–2.

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