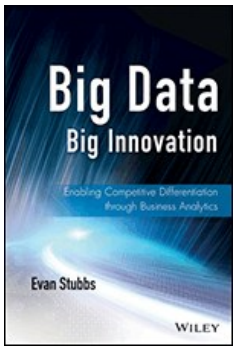

Big Data, Big Innovation: Enabling Competitive Differentiation through Business Analytics

by Evan Stubbs
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Chapter 2: Disruption as a Way of Life

Overview

Talk of psychohistory and precrime might seem better suited to a science fiction convention than an executive briefing. However, the more our world changes, the more we need to question our assumptions. And, therein lies the trap—we've become so accustomed to change that we don't even realize that it's happening any more.

There's an apocryphal parable about a frog in boiling water. While not true, it suggests that a frog's nervous system is sufficiently underdeveloped and that when it's put in cold water and the water is slowly heated, the frog won't know it's in danger until it's boiled alive. Apart from being pretty cruel to the frog, it carries another message. We, collectively, are that frog.

Our world has changed. It's changing at such an accelerating rate that we've lost track of the speed. Perception is relative; at walking speed, someone running past us seems swift. On a highway, someone overtaking us seems fairly lethargic. To the runner, though, the two cars are terrifyingly fast.

Alvin Toffler, one of the world's most famous futurologists, coined the term "future shock" in 1970.[1] In his book *Future Shock* he argued that too much change in too short a period of time would lead to shattering stress and disorientation. This would create a society characterized by social paralysis and personal disconnection. The rate of change he predicted has come to pass. However, he got the impact backward.

We, as a society, have looked change in the face and laughed. What's fantastical one year is commonplace the next. In some cases, even within months; how many times in the last year have you found a device or application you couldn't live without only to have it become such a central part of your life that you don't even realize it's there anymore?

There's danger in this complacency. Just because we're used to the water getting warmer, it doesn't mean that we're out of danger. The rest of this chapter will review five key trends that will fundamentally change the way we view the world over the next decade. These are:

1. The Age of Uncertainty
2. The Emergence of Big Data
3. The Rise of the Rōnin
4. The Knowledge Rush
5. Systematized Chaos

Again, this isn't futurism; they are all already happening. Thus far, their impacts are still relatively small. With advance knowledge, a competent leader still has time to take advantage of them.

[1]Alvin Toffler, *Future Shock* (New York: Random House, 1970).

The Age of Uncertainty

> Change will continue to accelerate and the resulting social complexity and economic interconnectedness will increase the frequency of unintended consequences and unexpected events. Dynamic management focused on emphasizing robustness rather than pure efficiency will become common. Leaders will need to become comfortable with uncertainty, planning for "unknown unknowns," and trust sophisticated monitoring engines that leverage big data.

Ours is a magical time. Every day, we do things that would have been in realms of science fiction not even three decades ago. Twenty years ago, an international telephone call from New York to London cost approximately a dollar a minute.[2] Today, we can videoconference for free on a device that fits in our pocket. The iPhone 5s, a high-specification mobile phone released in 2013, is faster than the MacBook Pro released in 2008, a high-end laptop. In less than five years, we've created a device that's smaller, faster, has greater fidelity, offers mobile connectivity, and has over double the battery life.[3]

Over 23 years ago, *Star Trek* fantasized about the Personal Access Display Device, a handheld computer with a touch-

screen interface. In 2010, Apple launched the iPad, making *Star Trek*'s PADDs real and affordable. In isolation, that's mind-blowing. However, the most fascinating thing about them is that in less than three years from when they were launched, the tablet as a personal computing device was taken for granted and largely commonplace.

The examples are endless. Toys can be shipped and delivered almost overnight from China that quite literally have millions of times more processing power than Apollo 11. Three-dimensional printers are commercially available and consumer friendly. Not only are electric cars such as the Tesla commercially available but Google is road-testing driverless cars. Facebook and Sony are developing commercially viable virtual reality systems. While we're still waiting for our flying cars, the world's closer to the future than ever before.

Communication and information is instantaneous, pervasive, and always-on; no matter where we are, we're plugged in. To a kid, the idea of being involuntarily unplugged is almost inconceivable. With fourth-generation mobile connectivity and portable solar rechargers, even camping no longer offers an escape! The scale of this change is subtle; it sneaks up on you. Given enough exposure, even magic becomes mundane. Therein lies the danger.

The world is changing around us at an accelerating rate. As it does so, it changes us, for good or bad. Much like the industrial revolution, it's not clear yet how this technology will impact society. Thus far, we know that it offers social and professional advantages to those who have it and know how to use it. And, quantitative analysis has shown that access and use of information technology is dependent on income and access to education.[4] This carries with it a stark implication: access (or lack thereof) to information runs the risk of creating an entire social strata of "haves" and "have-nots."

We live in a world where social, cultural and economic capital is dependent on one's ability to connect, communicate, and create through technology. In this world, lacking these skills can create a true digital divide, one that has intergenerational implications. As change accelerates, it becomes that much harder for the disadvantaged to keep up.

While this is clearly a global concern, its implications also fall closer to home. The 2011 U.S. Census showed that only 71.7 percent of households accessed the Internet. While not terribly concerning in isolation, what *is* concerning is the lowest usage rates clustered around the less educated and those with low incomes.[5] It's a measure of the role that technology plays in our lives that some argue that this digital divide is a threat not only to economic mobility and social stability but even democratic representation.[6]

At the micro-level, information is power, both for the individual and the collective. It gives us the ability to network and connect with lost friends. However, it's more than that. The ability to connect and communicate has already supported revolutions in Egypt, Tunisia, and Libya.[7] What affects the individual has also had an effect on the organization. Globalization is easier than it's ever been and location is rarely a barrier to business. At the macro-level, that same decline in communication costs has affected global trading patterns and competitive price advantage, especially in the case of differentiated products.[8]

Digitization has and is fueling disruption. Despite this, the fundamentals of business have not changed. Success still requires innovation, differentiation, and a relentless focus on efficient execution. What *has* changed is the dynamic that information plays in this mix. While information has always conferred advantage, the sheer volume of information available has changed its relative contribution to success.

The greatest irony of our age is that despite having access to more information than ever before, we remain more in the dark than ever. It's true that we generate tremendous amounts of data. In any given day, the digital footprint we leave dwarfs the data we have of entire civilizations. We know more about what the world bought for lunch yesterday than we do about the entirety of ancient Egypt.

It's also true that rather than making it easier to understand our world, all this information instead makes it more confusing. Connectivity comes with a price; the more tightly coupled our industries and lives become, the harder it becomes to predict unintentional outcomes. What could once be said around the watercooler with relative impunity carries different implications when said on Facebook or Twitter. Complexity and interconnectedness bring with them uncertainty, both personally and professionally.

The financial crisis of 2007 was a poignant example of how severe this uncertainty has become. The market at the time was characterized by easy credit. It also saw significant growth of subprime loans from under 10 percent of the total mortgage market to over 20 percent at their peak. The use of complex financial instruments such as mortgage-backed securities, credit default swaps, and synthetic collateralized debt obligations (CDOs) was commonplace.

Together, these established a highly complex financial system that not only increased the distance between the physical asset and the final purchaser but also multiplied the number of actors involved with any particular product. While this theoretically offered the advantage of diversification through blended assets, it also reduced overall transparency and risk lineage. It got to the point where the products became so complicated that some, George Soros included, felt that the authorities and regulators could no longer calculate the risk and instead were forced to simply "take the word" of the banks issuing the products.[9] Eventually, the catastrophe happened; the outcomes of the liquidity crisis are well-known, and in many countries, are still being felt.

The unexpected twist in the story was the level of uncertainty around who would be affected by the progressive fallout and, if so, how badly they would be affected. Our financial markets had become so interconnected and tightly coupled that by the time of the Great Recession, banks in far corners of the world had unknowingly acquired overleveraged or even negative-value U.S. assets. Unpicking this Gordian knot and accurately determining true exposures was difficult and, in some cases, arguably impossible. Systemic risk, financial innovation, regulatory evasion, and complexity may have caused the crisis. Uncertainty, however, characterized the aftermath.

Despite all our scientific, technical, and intellectual advancements, this will be the defining characteristic of our time. We've entered the *era of uncertainty*, a post–information age period of sustained disruption and change. The digital revolution is no longer a revolution; it's simply the new normal. We spend large amounts of time trying to manage our "known knowns" and "known unknowns." Unfortunately, in a world where economic, social, and professional connections are growing exponentially, so do the opportunities for "unknown unknowns."

Incumbents find it increasingly difficult to predict who their next big competitor will be. Facebook came from nowhere and disrupted MySpace in less than two years. BlackBerry and Nokia went from being market leaders to shadows of their former selves, not by the hand of another telecommunications company but by an almost-failed computer company (Apple) and a search company (Google). Financial institutions find themselves under threat not only from hackers and organized crime in specific countries but from disenfranchised teenagers and young adults wearing Guy Fawkes masks.

Systemic complexity creates uncertainty. Nassim Taleb, author and statistician, talks of Black Swans, highly improbably events that have an extreme impact should they occur.[10] By definition, these are outliers and the odds of any of these individually happening remains low. However, the *frequency* with which we experience these events through the age of uncertainty will increase as our world becomes more complex.

Every action has the potential for intentional and unintentional consequences. As we scale our interactions, so do we scale our potential for Black Swans. Most dangerously of all, adapting to this accelerating rate of change requires us to acknowledge that which we know is dwarfed by that which we don't. This isn't the first time we've gone through such a massive shift. However, history has shown that times of rapid disruption usually lead to drastically changed social and economic structures.

Rather than planning for the known, the era of uncertainty will require organizations and individuals to manage and live based on adaptability, flexibility, and robustness. In an environment characterized by rapid and volatile change, the concept of a static business model will eventually seem as archaic and quaint as the horse and wagon.

[2]Joseph S. Nye and John D. Donahue, *Governance in a Globalizing World* (Washington, DC: Visions of Governance for the 21st Century, 2000), 46.

[3]John Gruber, "The iPhone 5S and 5C," *Daring Fireball*, September 17, 2013, http://daringfireball.net/2013/09/the_iphone_5s_and_5c (accessed Jan. 11, 2014).

[4]Martin Hilbert, "When Is Cheap, Cheap Enough to Bridge the Digital Divide? Modeling Income Related Structural Challenges of Technology Diffusion in Latin America," *World Development* 38, no. 5 (2010): 756–770.

[5]U.S. Census Bureau, "Computer and Internet Use in the United States," May 2013, www.census.gov/prod/2013pubs/p20-569.pdf.

[6]Mauro F. Guillen and Sandra L. Suarez, "Explaining the Global Digital Divide: Economic, Political and Sociological Drivers of Cross-National Internet Use," *Social Forces* 84, no. 2 (2005): 681–708.

[7]Wael Ghonim, *Revolution 2.0: The Power of the People Is Greater than the People in Power: A Memoir* (New York: Houghton Mifflin Harcourt, 2012).

[8]Carsten Fink, Aaditya Mattoo, and Ileana Cristina Neagu, "Assessing the Impact of Communication Costs on International Trade," *Journal of International Economics* 67, no. 2 (2005): 428–445.

[9]George Soros, "The Worst Market Crisis in 60 Years," *Financial Times*, Jan. 22, 2008, www.ft.com/cms/s/0/24f73610-c91e-11dc-9807-000077b07658.html?nclick_check=1 (accessed Jan. 11, 2014).

[10]Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007).

The Emergence of Big Data

> The information contained in big data will reduce experience-based barriers to entry in many industry sectors. The traditional separation between many industry verticals will start to collapse and for these industries, differentiation purely based on experience and sector knowledge will progressively evaporate. Leaders will need to become comfortable with the constant threat of disruption from nontraditional competitors.

The sudden focus on big data is more than just a technical fad. It's a manifestation of a broader zeitgeist.

"Big data" has become one of the most used and overused catchphrases. It's getting to the point where if something doesn't have the term somewhere in the brief, someone's not doing their job. Just because it's popular, however, doesn't mean it's overstated. We've been through the information revolution. We've seen knowledge workers come and go. We've even got our head around Web 2.0 as we rocket through Web 3.0 on our way to Web 4.0.

Big data dwarfs all of these, not only for the decade but for the rest of our natural lives as well. Rather than just being hype, our sheer volume of discussion reflects the impact people suspect it will have. It's an idea whose time has come.

Ideas are fascinating. They don't exist in any real sense; they're a shared delusion, carrying us beyond our physicality. Abstraction is powerful and in some ways, it's what distinguishes us as a species. Jean Piaget, acclaimed developmental psychologist, theorized that it's only in our final stage of cognitive development, the formal operational stage, that we make the transition from concrete thinking to abstract logic.[11]

As babies, we are phenomenists. We define our world based on our personal experience, not on the physicality of the objects around us. When we hide behind a sheet, it's arguable that from the baby's perspective, we're not just hiding. We've literally temporarily ceased to exist. As we develop, we progressively make the leap from naturalist interpretation of physical objects to symbolic representation, abstract thought, and metacognition.

The significance of this step is enormous and yet it's often overlooked. While nowhere near a primary measure of self-worth or community value, some have suggested that as many as two-thirds of adults never reach the formal operational stage.[12] We refer to the "economy" or "market" and yet, what is it? To a child, it's a physical place where one can go to buy carrots. It's down the street and to the left, somewhere that smells of earth and spices.

In the abstract, it's a synthetic aggregation of all possible markets in all possible spaces at any point in time. In a multidimensional sense, it's a superposition of everything we can't measure or observe, all at once. It includes even stranger things like derivatives, collateralized debt obligations, and currency created through fractional reserve banking. These exist not even as numbers on a piece of paper but as magnetic fields on hard drives scattered across the globe.

Despite being unreal in a very literal sense, they have the power to change our world. Ideas aren't real. And yet, they replicate, mutate, and at some stage, terminate. They hold a mirror up to our cultural gestalt, reflecting that which is most important to us at a point in time. Richard Dawkins, author and evolutionary biologist, coined the term *meme* to describe this almost evolutionary process of cultural transmission.[13] Successful memes replicate and mutate. Unsuccessful memes stagnate and eventually die. Thanks to the Internet, popular and culturally relevant concepts propagate at the speed of light, ignoring national and social barriers. Resonant concepts grow in strength while irrelevant concepts decline. One only needs to look at doge—so impressive; much sharing.[14]

Memes survive through cultural relevance. And, not all do. Our linguistic landscape is scattered with "lost words," terms that for some reason fell out of favor. The archaic term, *California widow*, seems strange without the background context of a gold rush. *Tyromancy*, the process of divining by the coagulation of cheese, is not as common as it once was. Our language, culture, and ideas represent a snapshot of what we care about and are interested in.

Big data *is* one of these concepts. We talk about it because it's here and it's affecting us. Like most big ideas, though, it's

not just what it means now. It's also what it means for our future. But first, what *is* "big data"?

It's more than just lots of data. Most people have heard of Moore's law,[15] the trend for the number of transistors on a microprocessor to double roughly every 18 months. In less technical terms, computers tend to double in speed about every two years. It's one of the reasons why the iPhone 5s (released in late 2013) slightly beats the original MacBook Air (released in early 2008) in processing benchmarks.

Fewer people have heard of Kryder's law, the trend for storage density to outstrip processing capacity improvements.[16] Our ability to store information has been consistently growing at a rate faster than a chip's ability to process information.

We're generating more data than ever before. We've been through the *structured era*, where we've needed to capture billing information, personal information, financial information, and transaction information.[*] Without an address, there's nowhere to send a bill. Without a name, there's no-one to address a bill to. Without an account or a credit card, there's no way of processing payment. And without a transaction, there's no way of knowing how much to bill.

Capturing, integrating, and exposing this information was hard enough. Organizations have spent hundreds of millions of dollars building warehouses and developing strategies simply to cope with this data. But, we've managed.

As daunting as this was, we're now deep in the middle of the *social era*. While structured data is useful for computers, we prefer text and pictures, often called *unstructured* data. It's estimated that every year, the average worker writes about a book's worth of email.[17] By that measure, any given office is producing as much content as a small-scale publisher, event taking into account the time people spend talking on Twitter, blogging, or catching up on Facebook.

We're not only generating more data than ever before, we're creating *new types* of data. Every photo has within it people, places, and even events. Every status update has mood, location, and often intent. Not only are we having to deal with format changes from structured to unstructured data; we're having to deal with how best to extract latent information from raw data.

However, this pales in comparison to the next wave. e-Commerce gave us visibility over how we spend and save our money. Social gave us visibility over what we're interested in, what we're doing, and who we know. However, there's more. Increasingly, it's no longer about what *we're* choosing to say or do. Our devices are doing it for us.

We're just at the start of the *sensor era*. Smart devices are "chatty." They're smart *because* they have the ability to be chatty. Sensor data has always been around; it's just that historically it hasn't been terribly interesting outside of systems monitoring and maintenance. OBD-II, a real-time onboard diagnostics bus, was made mandatory for all cars sold in the United States as far back as 1996. Intended to support emissions testing, the protocol also gave real-time access to an exhaustive set of statistics on (among other things) vehicle speed, accelerator positions, fuel type being used, and vehicle identification numbers.

This data served an important purpose; detailed data made preventative maintenance easier. Given the right programming, embedded systems can give advance warning of their potential failure. Rather than being the exception, the model used by OBD-II has become the norm. Anyone who's saved their data from a failing hard drive probably has the S.M.A.R.T. (Self-Monitoring, Analysis, and Reporting Technology) monitoring system to thank for it. In making our devices smarter, rather than reducing the data our devices are generating, we've *increased* it. The Boeing 787 Dreamliner, a prime example of modern aviation engineering, generates approximately half a terabyte of sensor data *every flight*.[18]

Lest one think that this is exclusively the domain of transportation or heavy machinery, our personal devices are doing exactly the same thing. The iPhone 5s launched with the energy-efficient M7 chip, a device specifically designed to track motion and movement. Pair that with a GPS and a global database that geolocates wireless networks and any given phone can easily capture and track the most minute of our movements throughout the day.

Every time we make a call, the communication network needs to know where we are, whom we're calling, and how long we spoke to them. Without that metadata, it's impossible to close the circuit and have a conversation. Smart meters track electricity use on a near-real-time basis, giving energy companies direct visibility over intraday energy consumption patterns. Relative to historical standards, the sheer volume of this data is staggering. A typical telecommunications carrier will generate a few terabytes of call detail data every month. A typical energy company that has access to smart meters now has access to more data in a single day than it has had over the last hundred years.

This, fundamentally, is the challenge and opportunity of big data. We're generating *more* data than ever before. We're generating more *types* of data than ever before. And, we're generating it *faster* than ever before. Big data represents an

inflection point in what we consider "normal" relative to historical volumes, variety, and velocity of data.[*]

The challenges that go with this are obvious. To be useful, all this data needs to be stored, accessed, interrogated, analyzed, and used. Unfortunately, the "new normal" of big data gels poorly with how most organizations have made their technology investments. Platforms designed for terabytes of data rarely work well when asked to scale to petabytes or even exabytes. Ask a mechanic to reverse-engineer the family station-wagon into a Formula-1 car and see what happens.

The opportunities are a bit more subtle. It's easy to argue that big data is just the latest version of "data." Simplistically, this is true. However, it's more than this. At the turn of the century, when society looks back and takes stock, the emergence of the term will coincide with the turning point at which the nature of industry, government, and society started to change. As did those who lived through the industrial revolution or heard Gutenberg first speak of his miraculous machine, we have only started to feel the disruption big data will bring with it.

That's a big statement, but it's a valid one. Information asymmetries are well known in economics.[19] In an ideal world, every transaction involves a perfect match between desire and need. Prices are perfect, transactions are frictionless, and barriers to entry are almost nonexistent. However, efficient markets require perfect information, an unrealistic ideal. Where some know more than others, the market operates imperfectly, sometimes outright failing. Prices become distorted and significant barriers to entry emerge, typically controlled by the incumbents who have the advantage of better knowledge.

Perfect information is a fantasy. But, what happens when the fantasy keeps getting closer to reality?

If every single action we make can be captured and shared, where does imperfect information then sit? Our understanding of economics changes fundamentally, as does our understanding of what society looks like. What does privacy mean in a world where every personal and professional relationship is captured as a matter of course? What does energy conservation policy look like where it's possible to understand not only how every single person around the world is consuming electricity in real-time but what the immediate measurable effects of policy changes are? What does drug development look like where you not only have access to the entire world's gene profile but can monitor unknown side effects and unintentional but potentially lethal drug cocktails, not through hypothetical testing but through continuous population monitoring?

The true potential of big data is not better customer engagement. It's not better economic management. It's not even better public safety. These are all byproducts, mere side-effects of information efficiency. What big data implies is a different world, one where many aspects of society and the broader economy become characterized by the potential of near-perfect information, one that is fundamentally disrupted, regardless of industry sector.

These are lofty statements, hyperbolic even. What they are not, however, is unprecedented. The invention of the combustion engine during the industrial revolution disrupted industries, economies, social structures, and even our definition of time.[20] The sudden shift of capital and political influence toward the Vanderbilts, the Rockefellers, and the Carnegies wasn't a coincidence of history; it was a clear demonstration of how disruptive events and technologies change the world as we know it.

Information has always equated to power. Entire sectors have been built on this power inequality, whether it's at the micro-level of selling used goods through to the macro-level of financial markets. Knowing how the market operates and what signals to rely on has been a strong barrier to entry for centuries. In the absence of quantitative information, one has to rely on experience, and without experience, one is powerless.

Big data cracks this edifice; when data becomes plentiful and accessible, the need for experience declines. There's still an argument for monopoly in this—own the data, own the market. Unfortunately, there's almost always a back door. Whether it's through investment, acquisition, collection, or partnering, most data is up for grabs in some form. And, with this data comes the ability to understand the market as well as or better than the incumbents.

This isn't an abstract fantasy. This is already happening. Supermarkets like the Australian brand Coles are getting banking licenses and presenting real competition to the traditional Australian banks, protected as they are by the four pillars policy. The same is true for telecommunications companies such as Rogers in Canada. Nonbanking institutions like PayPal are inserting themselves into the payment chain and actively disintermediating the banks. Media streamers like Netflix and Amazon are generating their own content and diverting subscribers away from cable providers.

If all you have is experience, it's only a matter of time until someone smarter than you works out how to use the data to disrupt you. Big data is more than just more information; it represents the beginning of the end of industry experience as a core competitive advantage. If your differentiation is based purely on sector knowledge, replication is simply a case of getting access to enough data to come to similar conclusions. Thirty years of experience counts for nothing if a graduate

can develop an algorithm that comes to the same conclusion as an expert.

[11]Jean Piaget, *The Origins of Intelligence in Children* (New York: International Universities Press, 1952); and Jean Piaget, *The Construction of Reality in the Child* (New York: Basic Books, 1954).

[12]P. Dasen, "Culture and Cognitive Development from a Piagetian Perspective," in W. J. Lonner and R. S. Malpass (eds.), *Psychology and Culture* (Boston: Allyn & Bacon, 1994).

[13]Richard Dawkins, *The Selfish Gene* (New York: Oxford University Press, 1989).

[14]"Doge," Know Your Meme, http://knowyourmeme.com/memes/doge (accessed Jan. 11, 2014).

[15]G. E. Moore, "Cramming More Components Onto Integrated Circuits," *Proceedings of the IEEE* 86, no. 1 (1998): 82–85.

[16]Chip Walter, "Kryder's Law," *Scientific American* (August 2005).

[*]Structured data in its simplest sense is data that can be organized in a predefined manner. For example, telephone numbers follow a fixed structure as do postcodes. The primary advantage of structured data is ease of analysis. When one knows what the data will always look like, it's relatively easy to analyze. The primary disadvantage is the constraints it implies. Anything that doesn't fit into the predefined structure must be discarded.

[17]Megan Garber, "You Probably Write a Novel's Worth of Email Every Year," *The Atlantic*, Jan.8,2013,www.theatlantic.com/technology/archive/2013/01/you-probably-write-a-novels-worth-of-email-every-year/266942/ (accessed Jan. 12, 2014).

[18]Matthew Finnegan, "Boeing 787s to Create Half a Terabyte of Data per Flight, Says Virgin Atlantic," *Computerworld* UK, Mar. 6, 2013, www.computerworlduk.com/news/infrastructure/3433595/boeing-787s-create-half-terabyte-of-data-per-flight-says-virgin-atlantic.

[*]The 3 *V*s of Big Data were originally coined by Doug Laney as early as 2001 in his report, "3D Data Management: Controlling Data Volume, Velocity, and Variety." For more information, see http://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf.

[19]G. A. Akerlof, "The Market for Lemons: Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics* 84, no. 3 (Aug. 1970): 488–500.

[20]Vaclav Smil, *Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines* (Cambridge, MA: MIT Press, 2010).

Rise of The Rō nin

> A structural tightening of the labor market for skilled professionals will increase the competitive advantage offered by human capital. Salaries will rise and signals that indicate competency will become increasingly inaccurate. Leaders will need to become experts in human capital identification, development, and retention, not just experts in their preferred areas of competency.

Our future is one of uncertainty caused by disruption. However, in disruption there is opportunity. Big data may be the key to unlocking this opportunity, but without an operator, every key is useless.

Business analytics is the catalyst that unlocks value from data.[21] Some have even gone so far as to say it may become a dominant force of competitive differentiation.[22] It is, however a complex discipline. It requires a mélange of skills including mathematics, pragmatism, change management, project management, software development, systems architecture, data management, programming, and business knowledge. Given this highly unrealistic capability set, it shouldn't come as any surprise that skilled practitioners are in high demand. What may come as a surprise is how *significant* the demand is for these people.

A survey of forum members conducted in 2013 by KDNuggets, a data-mining community, found that average salaries had

increased by 13 percent between 2012 and 2013 in the United States and Canada and 12 percent globally.[23] Lest one think this was a one-off data point, a similar survey conducted in the United Kingdom by Harnham, a recruiter, found that 55 percent of respondents saw their salary increase at double the rate of inflation between 2012 and 2013.[24] The Institute of Analytics Professionals of Australia, a professional association for analytics practitioners, found similar results. In their 2013 annual skills and salary survey, over 70 percent of respondents had seen their salaries increase moderately or significantly in the three years prior.[25]

This isn't a cyclical shift. This increase in demand represents a structural shift in the labor market driven by a fundamental change in the nature of business. With data comes the opportunity to do things better, and doing so requires people.

To monetize their data, organizations need access to people with the right skills, mindset, and experience. This isn't easy. Relatively speaking, technology is fairly straightforward. Human capital, however, is hard. While structural shifts like this are not totally unprecedented, the speed at which this transformation is happening is somewhat staggering. Gartner estimated in late 2012 that by 2015, the rise of big data would create over 4 million IT jobs globally, of which 1.9 million would be in the United States. This number grows even larger when second- and third-order effects are taken into account. If each big data–related role creates another three downstream roles, the need to analyze and leverage big data will create demand for another 6 million jobs in the United States.[26]

This speed of transition is creating ripples in the labor market. Of these potential jobs, Gartner estimates that only a third will end up being filled. Again, lest one think that this is an anomaly, McKinsey, a consultancy, came to similar conclusions.[27] Looking further into the future, by 2018 McKinsey estimates that the United States alone would experience a shortfall of as many as 190,000 skilled data scientists and over 1.5 million managers and analysts capable of taking advantage of these insights. In percentage terms, this represents a 50 to 60 percent gap between supply and demand.

Estimates of the shortfall vary between analysts. What's consistent, however, is the trend toward a significant labor market imbalance. The root cause behind this imbalance is not education. Were it so, the rapid rise in skilled postgraduates from China and India might offer a solution. Sadly, as will be covered in Chapter 7, getting the most out of big data requires experience, business knowledge, as well as technical capabilities. These develop best through practical experience.

In his book *Outliers*, Gladwell suggested that it takes approximately 10,000 hours to become the best in any particular domain.[28] This is especially true in business analytics where cross-functional coordination and experience is the norm rather than the exception. Even the best postgraduate is only operating at half-potential without this critical experience.

Some of the impacts of this imbalance are obvious. Salaries will continue to increase, especially for those who meet the profile of value creators rather than statisticians or pure analysts. The limiting factor for many organizations will become their ability to *find* and *keep* the right people, regardless of how well funded projects are. And, labor mobility for those with the right skills will remain high with the most skilled people crossing roles, industries, and even borders to wherever the offering's the most attractive.

The *age of uncertainty* will correspond with the *rise of the rōnin*, a new class of worker that is highly mobile, highly skilled, and yet motivated by factors more complex than money alone. Most are familiar with the samurai, the middle and upper echelons of the warrior class in feudal Japan. Following a complex set of rules known as *bushidō*, the samurai attempted to embody a moral code grounded in loyalty, frugality, and honor. Comparatively well-educated in Japanese society, they swore fealty to a single master. Moral transgressions carried severe penalties; for a truly disgraced samurai, the only option was seppuku, a ritualized form of suicide.

While many know of the samurai, fewer know of the rōnin. On losing their master, not all samurai decided to strictly follow bushidō. Whether it was through desertion or death, some disgraced samurai would become mobile and seek alternative employment. Still carrying their dual swords, they walked a fine line. Those who sought regular, respectable work became mercenaries or enforcers, defending caravans and being bodyguards. Those who sought more opportunistic employment often gravitated toward the gangs, becoming petty criminals or bandits. Their relative lack of responsibilities compared to their loyal brethren often led to a more festive reputation, doing whatever they wanted without any respect to their "betters."

To be a rōnin was to be forced to reinvent oneself, a not insignificant challenge under the Tokugawa shogunate. Equally though, during the Edo period's constrained social order and formalized classist society, the rōnin experienced a level of social mobility and freedom that was unavailable to most, even if that freedom came at a price. Educated, skilled, and experienced, their abilities opened doors that remained closed to many. The lack of predefined direction forced the rōnin to chase that which they were most comfortable or interested in. For some, it was simply survival. For many, it was profit. For others, it was the opportunity to regain honor.

Disruption may not have created the rōnin. It did, however, help them grow. Economic growth, forced land confiscation and concentration under the 300 regional Daiymo, and regulatory change saw the rōnin grow substantially during the Edo period. While the current disruption has different causes, we are seeing the creation of a new class of worker, one that is highly skilled, in significant global demand, and yet motivated by factors far more complex than money alone. These modern-day rōnin are equally as mobile as their namesakes. Thanks to a continually tightening labor market, they have unparalleled professional mobility. Rather than being constrained by industry sector, their skills are highly portable between industries.

While not as experienced or effective as a pure specialist, their ability to use mathematical or computational methods to solve complex problems breaks down many of the barriers between industry sectors. Their raw mathematical talent opens doors and opportunities unavailable to most. Inevitably, their skills lead to significant salaries.

According to the Institute of Analytics Professionals, the median salary of a person employed in the field in Australia is over twice the national median salary!

For these individuals, money is always a consideration. Being largely scientific and numerical in mindset, they usually well understand the opportunity cost of staying in a comparatively low-paid position. However, the leverage they carry creates an interesting dynamic. Maslow's hierarchy of needs provides an excellent lens through which their thinking patterns can be explained.[29] They have no true fear of unemployment; a rising tide lifts all boats. Even in a recessionary market, the demand for their skills continues to rise. With their physiological and safety needs easily catered for, they look for more.

For many, being part of a strong team with a good fit becomes a major consideration. Belonging, therefore, becomes more than an afterthought; if they don't enjoy working with their managers and peers, they can usually easily enough find another team to be a part of. Whether it's through forming personal bonds or being exposed to new ideas, social anxiety or being understimulated/underchallenged can easily be a trigger to look for something else. Without a strong cultural fit, any role they take will inevitably be a transitory one.

Beyond this, many look for esteem and achievement. Sometimes, this takes the form of internal and external recognition and reputation. Other times, it takes the form of applying their skills to solve real problems. These types of people look for more than a nine-to-five job; they want their skills to have an impact on something. Without a sense of personal growth or achievement, they will look elsewhere. Others seek self-actualization. They look to advance knowledge, solve social ills, or otherwise demonstrate mastery of their skills on a daily basis.

Like the rōnin of old, their existence will create both challenge and opportunity. Without them, many organizations will be unable to compete. They will see their data assets go to waste as their competitors take leaps ahead. Like these modern-day rōnin or loathe them, they will become a critical part of every operation.

Most will be comparatively expensive but largely substitutable; a warrior is a warrior. However, some will be truly transformative, blending analytical, domain, and value-creating abilities into an enabler for competitive advantage. Ranging from maladjusted prima donnas to transformative visionaries, the leverage they will carry will create no end of headaches. The power they bring will be enviable, as long as it can be effectively channeled.

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The Knowledge Rush

> In a digital world, absolute control of unique information assets is a source of competitive differentiation. Leaders will need to be aware that by missing out on capturing, acquiring, or augmenting unique sources, they may well be unwittingly permanently locking themselves out of developing markets.

The *age of uncertainty* will lead to new opportunities, many of them centered around the use of *big data* and reliant on *the rise of the rōnin*. These new assets carry with them significant implications.

Few things have the ability to redistribute power or wealth as significantly as the discovery of a new class of asset. The impact can be highly variable. Sometimes, it can lead to the creation of a new empire. Other times, it can lead to improved income mobility and personal independence. One thing, however, is constant—in times of economic disruption, whoever controls the asset controls the future.

The degree to which this can change the world shouldn't be underestimated. In June 1870, John D. Rockefeller founded Standard Oil as his entrypoint into the rapidly growing oil market. The earliest records on file show 1,200 barrels being skimmed from Pennsylvania in 1858. Only 12 years later, when Standard Oil was launched, Pennsylvania was producing an estimated 5.2 million barrels.[30] By the end of the 1870s, Standard Oil was in control of over 90 percent of oil refinery in the United States.[31] To put this in perspective, Pennsylvania alone in 1880 was producing 26 million barrels with the price per barrel having roughly doubled since 1861.[32]

Controlling this new asset was highly profitable; it helped build Rockefeller's empire and contributed significantly to making him arguably the wealthiest man in American history. It's estimated that in today's (inflation-adjusted) dollars, Rockefeller would have been worth almost US$1.5 billion, 1/65 of total U.S. GDP at the time.[33] Vanderbilt, another magnate, followed a similar model through progressively controlling the railroads.

Controlling a unique asset confers power. The ongoing digitization of our world is subtly yet surely seeding the latest disruption; big data is the new oil. Everything we do leaves a data footprint and the future will be like today, only more so. Every time our kids play a game on their latest console, they'll be watched. Whom they play with, how long they play, what they do, even how quickly they play through their games will be registered. Every time we watch cable, our viewing patterns will be captured. People will analyze how many times we've changed the channel, what shows we've watched, even whether we've muted the TV during particular advertisements. Every time we leave the house, our telephone providers will be monitoring where we go, whom we communicate with, and even what information we're looking up while we're mobile.

To most, this might sound like a rather dystopian future. However, it's already here.

Microsoft and Sony both included various online infrastructure as part of their game console offerings in 2006. Through tracking activity, interaction, and effectiveness of play, these platforms allowed players to connect with other players and receive achievements or trophies for finishing particular tasks in games. By necessity, their actions and friends had to be centrally tracked and managed, complete with time-stamps for historical purposes.

Termed "in-game telemetry," this data proved tremendously valuable in understanding how players interact with their games and other people. It gave developers the ability to see where gamers are and aren't succeeding within the game. It gave marketers the ability to see which aspects of the game gamers are most interested in. And, it gave publishers the ability to make objective decisions about where they should be investing. This is a bigger deal than one might initially suppose.

Grand Theft Auto V, a part of a well-known gaming franchise, was estimated to cost over $250 million to develop and

market.[34] The sheer scale of investment in games surprises many. What's even more surprising, however, is that most players never even *see* everything they paid for. A common industry rule of thumb is that less than 10 percent of players will ever play through to the end of a game.[35]

Cutting back the total investment is a no-brainer. The problem is in working out what to cut. It's true that every gamer may only experience a small proportion of the total game content in a free-roaming game. Unfortunately, because they have the freedom to explore, the content *they* see will often be different from the content *other* gamers see. Given that every second of content costs money to design, code, create the assets, and bug-test, being able to see what gamers are and aren't interested in offers significant insight into where investments *should* occur.

In a talk given at GDC 2010, a game development conference, BioWare (a developer owned by Electronic Arts) outlined the sophistication this analysis can go to.[36] *Dragon Age: Origins* was a large game. With over 800,000 lines of dialog, more than 180 areas to explore, greater than 300,000 lines of scripted code, 18 different character design options, and more than 300 abilities, the game was simply too large to exhaustively test and analyze. Rather than guess, they decided to track player usage patterns during the development cycle, using those insights to better inform game design.

To aid design, they tracked over 1.1 million play sessions across 1,141 machines, generating over 250GB of data across approximately 38 million data points. When analyzed, this helped them to identify movement patterns, boring points, and even pacing issues, helping them to design a game that was eventually a critical success.

This isn't a one-off example; similar techniques are used at organizations such as Bungie (the creator of *Halo*, another blockbuster franchise), Microsoft, and Sony.[37] The value of this data is immeasurable; in some cases, it can make the difference between a game that makes a profit and a game that bankrupts the company.

A similar story is playing out elsewhere. LG was embroiled in a PR disaster in late 2013 when it emerged that regardless of consumer preferences their smart TVs would upload viewing patterns back to LG for analysis within their "LG Smart Ad" offering.[38] Designed to enable more relevant advertising, this data included what channels people watched, the name of the channel, and even the names of any media files watched. The public backlash to this involuntary data sharing was understandable.

Regardless of industry, having access to low-level behavioral data is invaluable. By necessity, telecommunications carriers need to be able to triangulate and communicate with every phone on their network. Without this information, they can't get a signal to the phone. This metadata can be similarly captured and stored, along with whom one communicates with and for how long. It can be used to identify influence, understand preferences, and allow real-time location-based advertising. Relevancy becomes more than just the right product at the right time; it extends to include the right place and even the right mindset.

Access to this information can make or break companies. Being denied access to data can shift the balance of power between partners so significantly that failure can become a very real threat. In the high-risk market of game development, a single failed game can be enough to bankrupt a studio. Control access to data and the barriers to entry can become insurmountable. Gain access to data and barriers to entry may even evaporate.

There's a hidden battle taking place right now, one that involves aspirational magnates jockeying for position. Exclusive control over unique data can generate differentiation in its own right. They're even enough to break otherwise strong partnerships.

Much was made about Apple's poor-performing Apple Maps application when it launched. Previously, Apple had included Google's Map product as a bundled application, broadly perceived by the market as the better application. Despite this, Apple decided to part ways with Google when it launched iOS6, setting its own application as standard and forcing Google to resubmit its application through the Apple App store.

The decision had repercussions. Apple weathered a great deal of negative publicity over the change, largely due to the poor-quality data within its internally developed application. One of the most glaring omissions was the lack of a Statue of Liberty on Liberty Island! Given that Apple *must* have known that there would backlash, why would the company do it?

The decision to part ways was made for many reasons, Google's interest in having more branding visibility within the app being a particular sticking point, according to insiders. However, it was more than that. Without access to high-quality geospatial data, it's impossible to even think about offering geographically targeted services to customers or suppliers. Being locked out of such a significant channel becomes a real threat to customer engagement. And, the only way to gain entry is to source and improve the data somehow.

Even though they still had a year left on their contract with Google, Apple recognized that it had no choice in the battle between the two titans. Mapping is hard. It requires tremendous amounts of accurate data, continually updated. And, Google had a head start. In 2004, the company acquired ZipDash, Where2, and Keyhole Inc., all companies focused on geospatial data collection, analysis, and distribution. In 2006, Google acquired Endoxon; in 2007, ImageAmerica; in 2010, Quiksee. Google "got" the need for data early in the picture and Apple was caught out.

The only answer was to take the punch. Apple's lack of foresight cost them a great deal of customer loyalty. The damage was so great that Tim Cook, the CEO, ended up publicly apologizing for the lack of quality in their homegrown application. Building equivalent data takes years and Apple was caught on the back foot.

Even today, the battle continues. As of mid-2013, Google had just acquired Waze for US$1.1 billion, an Israeli mapping company focused on crowd-sourced traffic analysis based on social data. This was Google's single largest acquisition after Motorola, DoubleClick, and YouTube. Google's latest acquisition of Nest in early 2014 for $3 billion is seen as a gambit by many to start collecting data from *inside* our homes, using smoke alarms and thermostats to understand how we live and behave when we're alone.

On their side, Apple quickly acquired Locationary, a crowd-sourced local data company, and HopStop, a city-navigation app. In late 2013, Apple also acquired Embark and Broadmap for undisclosed sums. Without the ability to generate, analyze, and deliver geospatial information to their customers, each would be left with a significant chink in their armor. In this arms race, the best weapon is data.

Like a gold rush, this *knowledge rush* is seeing organizations try to get a head start over their competitors by buying exclusive access to data. Like spice, gold, or oil, information is the latest disruptive asset. Given enough effort, technology can be replicated. Data, however, cannot—it requires a rich set of historical activity and behaviors. By gaining exclusive rights to data, either through express ownership or negotiated licensing arrangements, organizations can lock out their competitors, sometimes indefinitely. These titans move globally, setting up sites and acquiring data in the same way Standard Oil once gained horizontal and vertical control over their industry segment. Information is power and influence, and those who don't move quickly will rapidly find that they have neither.

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Systematized Chaos

> The emergence of increasingly complex systems will create management structures and operational systems that are inherently brittle and prone to failure. Leaders will need to become comfortable with managing systems that are inherently unmanageable through the use of crowdsourcing, back-ended operational analytics, and complex adaptive systems.

One of the biggest drivers behind *the age of uncertainty* is complexity. Simple rules can lead to surprisingly complex systems. Somewhat counterintuitively, they can also sometimes be the solution.

Consider, for example, an insect. Individually, an ant has a brain smaller than the head of a pin. This size comes with a significant cost: processing power. On average, an ant has approximately 250,000 neurons, a rather unimpressive statistic. The average honey bee is an intellectual giant in comparison with approximately a million neurons.[39] For comparison, a typical human has between 19 and 23 billion neurons.[40]

Despite having.001 percent of the cognitive processing power of a human, ants don't get an easy ride. They lead a challenging life. They need to forage. They need to communicate with the colony. They need to feed themselves as well as the queen. And, they need to survive. Nature is cruel; there are no freebies for the weak.

Adversity, however, breeds innovation—in the face of overwhelming challenges, life finds a way. What the individual can't overcome, the collective can sometimes solve. Ants, bees, and other hive-based creatures have evolved a tremendously innovative and efficient solution: crowdsourcing.[41] Energy isn't cheap for a creature as small as an ant. Brainpower is costly. However, reproduction *is* cheap; while it's expensive to develop a brain and survive, it's cheap to replicate. Rather than try to develop the intelligence to handle complex solutions, in some situations it's more efficient to act locally and rely on the wisdom of crowds.

From an ant's perspective, the world is infinite. In the three to six months most ants live, an ant running full speed all day every day might potentially cover over 600 kilometers. Allowing time to rest, breed, and eat, seeing the world would take hundreds of generations. Memory and intelligence, in that context, is worth little; when life is short, passing on one's experience does little to help the next generation.

And yet, hives are tremendously complex and efficient systems. Anyone who disagrees needs only to leave out a cup of sugar-water for a day or two. Despite having limited intelligence, negligible communication abilities, a short lifespan, and minimal opportunity to develop experience, ants somehow coordinate a system involving thousands of actors in dynamic conditions to sustain the entire colony. They do it through *systematized chaos*.

Ants face a variety of threats. One particular species, *Temnothorax rugatulus*, live in crevices across the United States and Europe. Red and approximately a quarter of a centimeter long, their colonies are relatively small with between 50 to 150 ants. At some stage, whether it's through overpopulation or the clumsy interactions of an overly interested animal, the colony needs to move. Emigration is fraught with danger—colonize the wrong place and the colony is sure to be short-lived. The risk is tremendous.

In picking a new site, the ants face two major challenges. First, they are totally decentralized. With no controller to make decisions, there's no clear hierarchy nor coordination. Yet somehow, the colony needs to build consensus before it moves. That leads immediately to the second problem: ants are, sad to say, not very smart. They can communicate, but their vocabulary isn't big enough to have a measured debate.

Despite these limitations, these ants have evolved a tremendously efficient solution. Through a process called *quorum sensing* and the use of a few simple local rules, they coordinate what is otherwise a highly a complex and chaotic system to a new stable and relatively optimal equilibrium.

As soon as their nest cracks open, a small proportion of ants are sent out as scouts to hunt for a new nesting site. These scouts follow a few simple rules. They each set off in a direction different from their peers. As soon as they find a potential nest, they evaluate it based on a few criteria. They search for other dead ants, evaluate the size of the interior, and consider the number of openings as gauged by available light. After their evaluation is complete, they return to the now-unsafe nest and wait. If their potential nest was high quality, they wait a relatively short time. If they judged it to be of poor quality, they wait a relatively long time.

After waiting, they engage in "tandem running." They grab a partner and lead them to the potential site. This new scout also evaluates the site and makes up its own mind on whether it is high or low quality. They both then return to the original nest and, if the second ant considers the new site to be of a high enough quality, the process repeats with both ants waiting before recruiting new scouts. Otherwise, the second ant waits to be grabbed by a new partner or, failing that, sets

off exploring on its own.

In a relatively short period of time, these scouts will probably inspect and compare multiple locations. More important, though, no single ant will likely see every location; comparisons are made on local experience, not global knowledge. Eventually, the best sites will see the greatest back-and-forth traffic. Because the ants that inspect that site wait the shortest period of time before recruiting other followers, the number of ants visiting the best available site will tend to increase the fastest.

At some stage, the proportion of ants visiting the best site exceeds an arbitrary threshold. At that point, they make a collective decision to move the entirety of the colony. Once a quorum has been achieved, they rapidly carry the brood, queen, and even other workers to the new nest. Scouts still searching are recruited through tandem running and merged into the collective.

Despite never making a global comparison of all potential sites, the colony makes a collective evaluation through local comparisons. By trusting the imperfect wisdom of crowds and a complex adaptive system governed by local rules, the colony rapidly makes the best decision it can in an efficient and relatively parsimonious manner. And, it does so despite lacking intelligence, communication skills, or even a central decision maker.

Coordinating the mass emigration of hundreds (or even thousands) of people without being able to speak, write, vote, or even make an official decision might seem impossible. And yet, through six simple rules, these ants do it effortlessly. To see how simple such a system can be, consider the following rules:

1. If the nest is destroyed, randomly nominate 20 percent of workers to be scouts.
2. Each scout should set off in a different direction for a maximum of five minutes.
3. On finding a potential site, give it a score between 1 and 10, taking into account security and size.
4. If maximum time has expired and no site has been found, return to the nest.
5. On returning to the nest, if a potential site has been found with a score of 9 or 10, immediately recruit a follower and return to the nest. If it had a score of 6 to 8, wait 30 seconds before recruiting a follower. If it had a score of 3 to 5, wait 2 minutes before recruiting a follower. If it had a score of less than 3, wait up to 5 minutes to be recruited. If, after those 5 minutes you have not been recruited, return to step 2 and repeat process.
6. If, on returning to the nest, you encounter more than 20 percent of the nominated scouts during your waiting period, follow them to the nominated site.

In classically hierarchical decision-making systems, processes become dependent on specific individuals. Broken links can derail everything. And yet, quorum sensing is entirely ant-independent; even if specific ants are eaten or otherwise lost, the colony will seamlessly adapt and find a way. It's a measure of how powerful this bottom-up approach to managing complexity and uncertainty is that it's evolved not only in ants but also bacteria, honeybees, and other social insects. In some ways, this distributed approach toward intelligence may even reflect the higher processing powers of more advanced evolutionary systems.[42]

Simple steps can give rise to surprisingly complex and robust systems.[43] The theory behind these systems has been around for decades. Often called *cellular automata* or *agent-based models*, they've been a solution looking for a problem.[44] In the *era of uncertainty* with its resulting complexity, their time has come.

This *systematized chaos* is a perfect example of how local rules and crowdsourcing can help manage the increasingly complex systems we are developing. And, lest one think that this is futurism at its finest, Amazon is already doing so to manage its highly complex supply chains.

In 1998, Amazon faced a crisis in its supply chain.[45] During an otherwise-ordinary Thanksgiving, Amazon faced one of the worst things a successful retailer can experience: more orders being placed than being shipped. In an "all-hands-on-deck" mandate, employees were required to work graveyard shifts across multiple warehouses, executives included.

One particularly bad backlog happened in Amazon's distribution center in Georgia. As unfulfilled orders continued to mount, the SWAT team finally identified the culprit: a missing pallet of Jigglypuffs, a toy from the Pokémon franchise. Amazon immediately mobilized a scouting team to find the missing pallet and they set off on their expedition. Hyperbole aside, this was no small task; it involved searching a 74,000-square-meter warehouse, an area roughly equivalent to almost 400 houses! It took three days to find but the lesson was invaluable: even the most complex and intelligent systems are useless

when they're fragile.

Today, Amazon uses a system it's branded *chaotic storage*.[46] Classic warehousing systems involve having a fixed space for every product. Storage is managed through checking in and checking out products via barcodes or radio-frequency identifiers (RFID). Volumes are dynamic but position is static; the same products will always be located in the same place in the warehouse.

In relatively simple situations, this approach is easy to manage. Consider going shopping at the supermarket. While there's an entry cost in learning where everything is, once you know your way around it's easy and efficient to shop. The unfortunate trade-off is that to be efficient, every shopper needs to have the intelligence and experience to know the unique layout of the shop they're browsing. Otherwise, they lose products and need to go into a manual search, much like how Amazon's search teams needed to track down Jigglypuff.

As designed, this system offloads the complexity onto the individual. Without adequate training and experience, the system is only as strong as its weakest link. It also can't scale; what works well for a few hundred products on shelves in an area as large as a few houses becomes almost totally unmanageable when used in one of Amazon's gargantuan distribution center. If one can't find a tin of baked beans in the supermarket, it's simply a five-minute search. When it came to the missing pallet of Jigglypuffs, it was a three-day expedition.

Much like the ants, Amazon turned the model on its head. Rather than holding location static, Amazon made it dynamic. Both the product *and* the location would be scanned on receipt and fulfillment. Rather than place similar items together, packers would be free to place anything anywhere as long as they registered where they'd put it. By taking this approach, Amazon preserved the benefits of chaos but systematized it.

At any given point of time, an outside observer would have no hope of knowing where any given product would be at any point of time. For those inside the system though, the system works efficiently. Products held can be placed in the first available holding bay, giving the workers the opportunity to self-optimize. Finding any given package is easy through having access to the system that keeps track of what product was placed where. Rather than having to learn the system, new employees simply need to learn to follow simple instructions. The geography and landmarks are irrelevant; all that's important is learning the navigation system.

The system works. In 2010, Amazon picked and shipped 13 million items in 24 hours. In 2011, Amazon picked and shipped 17 million items, and this is across more than 80 different fulfillment centers globally.[47]

Complex and chaotic systems are inherently unmanageable. Top-down management approaches rarely work well; they are brittle and tend to collapse. Today and tomorrow's world is unlikely to become simpler. Instead, complexity will be the norm. Not only will organizations need to come to terms with uncertainty, but they'll also need to understand how best to leverage crowdsourcing and complex adaptive systems to systematize chaos.

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