

**WHAT TO DO
WHEN MACHINES
DO EVERYTHING**



**HOW TO GET AHEAD IN A WORLD OF
AI, ALGORITHMS, BOTS, AND BIG DATA**

**MALCOLM FRANK,
PAUL ROHRIG, AND BEN PRING**

WILEY

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Preface

We know what you might be thinking: When machines do everything, what am *I* going to do? It's a good question.

If machines can do everything, then how are *humans* going to make a living? How are we going to pay the rent or mortgage or put food on the table? How are we going to survive when software eats all the knowledge work?

Even if you have reached a stage in your career in which you feel safe from the rise of the new machines, how will your children thrive when computers can out-think, out-work, and out-manage them? What do they study? Where do they focus? And will they have any chance of living a life as good as yours?

At work, how should your company be structured when so much can now be automated? What will happen to all those middle-class, middle-management knowledge jobs that currently stand as the economic bedrock of our society?

These are all good questions—the right questions—for indeed, something very big is going on.

The rise of artificial intelligence is the great story of our time. Decades in the making, the smart machine is leaving the laboratory and, with increasing speed, is infusing itself into many aspects of our lives: our phones, our cars, the planes we fly in, the way we bank, and the way we choose what music to listen to.

Within the next few years, AI will be all around us, embedded in many higher-order pursuits. It will educate our children, heal our sick, and lower

our energy bills. It will catch criminals, increase crop yields, and help us uncover new worlds of augmented and virtual reality.

Machines are getting smarter every day and doing more and more; they will soon change our lives and our work in ways that are easy to imagine but hard to predict. So what does one do?

These are the questions that have been going through our minds for a while, too. Anyone with a casual interest in the future can see these issues swirling through the zeitgeist at the moment: in movies (*Ex Machina* and *Her*), on TV (*Black Mirror*, *Humans*, and *Battlestar Galactica*), in books (*Superintelligence* and *Rise of the Robots*), and in countless articles in the press. But we have more than a casual interest in the future.

As the leaders of Cognizant's Center for the Future of Work, it is our job to figure out how the future of work works. We engage with many of the world's leading companies, universities, analysts, technologists, and economists to make sense of the great change we are all experiencing as well as to fathom how work will be reimagined, reconfigured, and restructured in the years to come. We do this to understand how new technology will shape the opportunities we have and the threats we face and to foresee how man and machine will relate and coexist.

So we've spent the last three years thinking about what to do when machines do everything, separating the hype from the reality on the front lines of global business.

The book you're holding contains our answers to these questions.

The bottom line? It's going to be all right. In fact, better than all right, because AI is about to usher in a new industrial revolution that, for those who manage it properly, will generate significant economic growth.

Will the new machines displace many current workers? Yes. However, on a larger scale, new machines will also create work that is better, more productive, more satisfying than ever before. The new machines will raise living standards and usher in a period of widely distributed economic growth that will be far stronger than any we've seen in the Western world during the past 50 years.

But there's a catch, which is expressed in the "what to do" part of the title of this book.

You and the company you work for and represent must accept, embrace, and leverage the fact that, minute by minute, machines are doing

more and more of the work we perform today. That is the underlying assumption at the heart of this book.

This is where many people get stuck. They start tumbling down existential wormholes: Will machines need us? Who will control the machines? Will machines act in the best interests of humanity? Again, these are great questions that prompt fascinating discussions, all of which we like having as much as the next person, particularly with a glass of red wine on hand. But these discussions don't help you know what to do.

If you want to read about the big philosophical debates about what AI *might* do in the next 25 years, this is not the book for you. But if you want pragmatic advice on what AI *will* do in the next five years, then this is definitely the book for you.

While some have their heads in the sky, others have their noses to the grindstone. While some will ponder, winners will act.

This book aims to answer questions about the future of your business and your work in an era of intelligent machines. It explains how you as an individual and as a leader in your organization can survive and thrive in a world where machines do everything. This book explains what you should do, why, and what will happen if you don't.

We wrote this book because we are in an amazing time. Though we are professional students of the future, the three of us are students of history as well. Understanding the great shifts of the past provides a framework for understanding how change happens in the here and now. The rise of machine intelligence is such a moment of great change. Our children and grandchildren will study these times just as we study James Watt, Andrew Carnegie, and Thomas Edison.

It's time to build our own future, complete with a sense of optimism and confidence. When machines do everything, there will still be a lot for you to do. Let's get on with it.

1

When Machines Do Everything

Artificial intelligence has left the laboratory (and the movie lot) and is in your building. It's in your home. It's in your office. It's pervading all the institutions that drive our global economy. From Alexa to Nest to Siri to Uber to Waze, we are surrounded by smart machines running on incredibly powerful and self-learning software platforms. And this is just the beginning.

To date, we've been enjoying—without even really noticing—various forms of “weak” artificial intelligence (AI). It's how Amazon recommends just the right gift. How Netflix suggests the perfect film for your Sunday evening. Or how Facebook fills your newsfeed. These forms of AI have been welcome little helpers, making our days just a bit easier and more fun. Once we start using them we stop thinking about them. In just a few short years, these machines have become almost invisible to us in our personal lives.

Now AI is transitioning from being our little daily helper to something much more powerful—and disruptive—as the new machines

are rapidly outperforming the most talented of us in many endeavors. For example:

- **Games of intellect:** AI platforms can now out-compete us at some of our most challenging games—Jeopardy!, Chess, and Go. Google’s AlphaGo beat world champion Go player Lee Sedol by a score of 4–1 in March 2016.¹ This was a convincing win, but not a rout. Yet with the current rate of technological advancement, in just a few years it will be inconceivable for a human to beat the new machines in such games of the mind.
- **Driving:** The driverless car, while still relatively nascent, is already a better driver than the average person. According to a Virginia Tech study, human-driven vehicles are involved in 4.2 crashes per million miles vs. 3.2 crashes per million miles for the automated car.² This disparity in safety will undoubtedly grow considerably in the next few years, and driverless cars, which never text behind the wheel or drive drunk, may soon become mainstream.
- **Trading:** In 2015, six of the top eight hedge funds in the United States earned around \$8 billion based largely—or exclusively—on AI algorithms.³ The machine has already won in stock picking.
- **Health care:** In medicine, the new machine is quickly surpassing the capabilities of human radiologists. Researchers at Houston Methodist Hospital utilize AI software, which interprets results of breast X-rays 30 times faster than doctors and with 99% accuracy. By contrast, mammograms reviewed by humans result in unnecessary biopsies nearly 20% of the time.⁴
- **Law:** In the legal profession, AI-enhanced computer systems are conducting discovery and due diligence far better, faster, and cheaper than the most talented team of paralegals in a white-shoe law firm. Multiple studies predict that the vast majority of paralegal work can soon be automated. We may reach a point in the not-too-distant future when relying only on humans for discovery might be grounds for malpractice.

We could go on and on with many more examples, but the point is clear; the new machines have already surpassed human capability in many ways. Moreover, with the geometric growth in the power and sophistication of these platforms, this is only a preview of coming attractions.

Thus, this rapid expansion of AI leads us to ask some big questions:

- Will a robot take my job away?
- Will my company be “Ubered”?
- What will my industry look like in 10 years?
- Will my children be better off than I am?

In the coming pages, we will answer these questions in a structured and practical manner. Based on our cumulative 100 years of experience analyzing and charting shifts in business and technology, we are fully convinced that we’re now moving into a new economic era, one that will change the nature of work and the basis of competition in every industry. In this new economy, we will witness an expansion of what is possible and move from machines that do to machines that appear to learn and think.

Like It or Not, This Is Happening

What the World Economic Forum hailed in 2016 as the Fourth Industrial Revolution is now upon us: a time of economic dislocation, when old ways of production give way to new ones, and when those who can harness the power of the new machine will harvest the bounty of economic expansion.⁵ In the same manner that the First Industrial Revolution was powered by the invention of the loom, the second by the steam engine, and the third by the assembly line, the fourth will be powered by machines that seem to think—what we refer to in these pages as “systems of intelligence.”

This is leading to what we call the “know-it-all” business, in which leaders and managers can and should have a continuous awareness of all that is occurring in their company’s operations. Where we used to guess, now we can know. These new machines—always “on,” always “learning,” and constantly “thinking”—will soon challenge and enhance the intellect and experience of even the savviest professionals in every sector. There’s no way to escape the gravitational pull of these new machines and the business models that enable and leverage them.

As such, whether you are managing a large enterprise or just starting your first job, deciding what to do about the new machine—this new cocktail of AI, algorithms, bots, and big data—will be the single biggest determinant of your future success.

Digital That Matters

For the past decade, we've collectively enjoyed "digital that's fun." We've seen the incorporation of Twitter (2006), the introduction of Apple's iPhone (2007), and Facebook's IPO (2012). These companies, along with others, such as Google, Netflix, and Amazon, have been able to generate unprecedented commercial success in terms of customer adoption, daily usage, and value creation by changing how we communicate and socialize. Yet, history will note that we started the digital revolution with the amusing and the frivolous: Facebook posts, Twitter feeds, and Instagram photos. We are using the most powerful innovations since the introduction of alternating current to share cat videos, chat with Aunt Alice, and hashtag political rants. However, that's just the warm-up act, for we haven't yet begun to fully realize the potential of the new machines.

Technology writer Kara Swisher summed it up best when she said, "In Silicon Valley, there's lots of big minds chasing small ideas."⁶ Well, we're entering an era of big brains focused on *big* ideas—*digital that matters*—using these technologies to transform how we are educated, fed, transported, insured, medicated, and governed.

While companies such as Facebook, Amazon, Netflix, and Google (sometimes known as the FANG vendors) seem to have established themselves as the presumptive and eternal winners in this space, history will likely remember them as the precursors to a much more momentous and democratic economic shift. The next wave of digital titans probably won't be characterized by start-ups from Silicon Valley; instead, it will be made up of established companies in more "traditional" industries—in places like Baltimore, Birmingham, Berlin, and Brisbane—that figure out how to leverage their longstanding industry knowledge with the power of new machines.

We're starting to see this play out as we collectively work to apply systems of intelligence to help address some of our most vexing societal ills in areas where digital technology is not just entertaining or convenient but also life-altering. Certainly, many of our institutions—the pillars of our society and our everyday lives—are ripe for improvement.

For example, worldwide we lose 1.2 million lives to car accidents annually, with more than 94% of these accidents a result of human error.⁷ In the United States alone, these wrecks cost society over \$1 trillion. This is

nearly one-third the amount the U.S. federal government collects in individual income taxes.⁸ Driverless cars promise to save countless lives and heartache.

One-third of all food produced in the world goes to waste. The food wasted in rich countries alone is almost enough to feed all of sub-Saharan Africa.⁹ By instrumenting the supply chain and applying AI, we could literally feed the world.

Medical misdiagnoses could also plummet. Right now, 5% to 10% of trips to the ER results in a misdiagnosis.¹⁰ More than 12 million diagnostic mistakes contribute to 400,000 deaths caused by preventable errors each year, and that's just in the United States.¹¹ Applying data to the diagnostic process could dramatically improve patient outcomes.

The United States spends more per student on secondary education than most other countries in the world but generates mediocre results. In a recent international study, American students achieved scores far below those in many other advanced industrial nations in science, reading, and math.¹² By tailoring lessons to the individual learning style of each student through technology, we could make the education process radically more productive and effective for both students and teachers.

These are the sorts of big things that we can address with the new machine. It's digital with purpose and digital that matters, and the big brains bringing these innovations forward will not necessarily reside in Silicon Valley or an MIT dorm room. They may well be sitting in an office down the hall at your company.

For example, McGraw-Hill Education is applying new technology to help teachers and kids improve learning with a system called ALEKS. The artificially intelligent **A**ssessment and **L**Earning in **K**nowledge **S**paces system uses adaptive questioning to quickly and accurately determine exactly what a student knows and doesn't know in a course. ALEKS then instructs the student on the topics he or she is most ready to learn. As the student works through a course, ALEKS periodically reassesses the student to ensure retention. All of this results in more flexible, one-on-one instruction for students, which boosts student success. And for teachers, ALEKS helps take over some of the more routine—and, let's say it, boring—work to allow them to focus more intently on working with students. Discovery, one of South Africa's leading insurers, uses its Vitality platform to provide economic incentives—discounts on travel, entertainment, healthy food, gym

memberships, sports equipment, health products, and the like—to its members based on whether they participate in healthy behaviors. Members earn points by logging workouts with connected fitness devices and purchasing healthy food (also logged by swiping their Vitality card). The insurance sector may not be known as a hotbed of innovation, but Discovery has built a thriving business based on the value derived from the new machine.

Playing the New Game

Another area ripe for reinvention is managing our money. Jon Stein doesn't look like a Wall Street Master of the Universe—just the opposite, in fact. In his mid-30s, dressed in blue jeans and a mildly tattered shirt, he works not in a financial citadel but in a relaxed loft-like space. His language is not full of bravado and bombast but is casual, considered, and humble.

Yet Stein is turning his corner of the banking world, personal wealth management, on its head. His company, Betterment, has rapidly become one



Figure 1.1 Jon Stein, CEO and founder of Betterment

of the world's leading "robo-advisors," leveraging AI platforms to rewrite the rules of the financial advisory business. Betterment provides highly personalized, curated wealth management services 24x7. His system of intelligence is doing the work of hundreds of people and is doing it better, at a fraction of the cost.

Millions of investors—millennials, Gen-Xers, and baby boomers alike—are flocking to the platform. From the beginning of 2015 to mid-2016, Betterment's assets under management grew from \$1.1 billion to \$5.0 billion^{13,14} and for good reason. Betterment has created a bigger pie for wealth management services because it can attract new customers that traditional banks wouldn't touch. Traditional "bulge-bracket" investment banks (e.g., Goldman Sachs, Morgan Stanley, Credit Suisse, etc.) often do not offer personalized wealth management services to anyone with less than \$1 million in assets; the margin isn't there, given their one-to-one advisory business model. So where does that leave the other 99.9% of the population that is interested in having their money professionally managed?

Betterment started by focusing on HENRY (*high earners, not rich yet*). These are young professionals in their 20s and early 30s: lawyers, doctors, and managers starting their careers armed with great educations . . . and the associated student debt.

Traditional wealth managers won't touch HENRY, but Betterment welcomes anyone with money to invest. And as each new customer comes on the platform, the system gets smarter, providing better value to each individual participant: on the spot, empirically based, unspun counsel on investment strategy, portfolio allocation, and tax management.

Robo-advisers, collectively, have more than \$50 billion in assets under management today (and are estimated to have over \$250 billion under management by 2020) and are taking aim at the \$20 trillion worldwide that is currently being managed by 46,000 human financial advisors at traditional banks.¹⁵

Now, we don't know whether Betterment will ultimately emerge as the long-term winner in this new form of financial advisory services, but the company does demonstrate how new machines are disrupting traditional ways of work. Such widespread adoption is creating shock waves in both the financial services and technology industries.

Stein, and others who have figured out the new game, are nothing short of the Henry Fords of our time. They understand today's new raw materials

(big data). They have built and now operate the new machines. And, most important, they have surrounded these new machines with business models that generate remarkable growth and profitability engines while expanding the overall market.

The story of robo-advisors in wealth management is about to be replayed a thousand-fold across all sectors of our economy. So the question becomes: Will you play, or stand on the sidelines?

But Will I Be Automated Away?

We have already proven that we love to consume AI-based products (with our rabid usage of the FANG vendors' offers on our smartphones). And, through digital that matters, the new machine is poised to transform the primary institutions of our society for the better.

Yet once we get over our initial awe of the new machine, we start to wonder how it will impact jobs. What will happen to all those bankers, drivers, radiologists, lawyers, and journalists? What will happen to . . . me? Will a robot take my job?

Many of us don't know whether this Fourth Industrial Revolution is very good or very bad. It all starts to feel like a capitalist's dream . . . but a worker's nightmare. And the uncertainty is creating a palpable sense of anxiety, for at a personal level, many of us don't know what to do about it.

Some see only the dark side of this shift, and indeed, many of today's headlines forecast a grim future in a "jobless economy" as robots take over our livelihoods. But the coming digital boom and build-out we describe in the next chapter will be highly promising for those who are prepared. In fact, it will usher in once-in-a-century growth prospects as we reengineer our infrastructure, our industries, and our institutions. Similar to the prior three industrial revolutions, this one will steamroll those who wait and watch, and will unleash enormous prospects and prosperity for those who learn to harness the new machine.

All of this depends on what *you do now* to prepare for an era when machines can potentially do nearly everything related to knowledge work.

Will many jobs be "automated away" in the coming years? Yes. However, for the vast majority of professions, the new machine will actually enhance and protect employment. We don't think, for example, that a single

teacher or nurse will lose their job due to artificial intelligence. Instead, these professions will become more productive, more effective . . . and more enjoyable. Workers in such professions will come to view the new machine as their trusted colleague. Just as one wouldn't think of driving across London today without an AI-based GPS, or researching a subject without referring to Google and Wikipedia, most workers in the coming years would not consider approaching their daily tasks without a "bot" at their side.

Additionally, entirely new professions will be created, driving employment in fields we can't currently envision (imagine trying to describe a "database administrator" to somebody in 1955). We have much to look forward to *if* we understand exactly what the new machine can and cannot do and how it will impact the future of work. Some very clear patterns for success have emerged, and we'll spend the rest of the book framing what's going on and providing tactical guidance on how to win in the new digital economy.

Getting AHEAD in the Age of the New Machine

We've written this book to provide you with a roadmap, a guide to success for this time of transition. First, we will outline what the machine actually is: how it's built, what it can do, and what it *can't* do. We will then look at where it can best be used today and tomorrow. What industry problems can it solve? What new customer value propositions can it create? Third, and most importantly, we will give you a structured approach for moving forward with our AHEAD model, which is based on our work with Global 2000 companies at the vanguard of the digital transition.

Briefly, AHEAD outlines the five distinct approaches for winning with systems of intelligence. The acronym stands for:

- **Automate:** Outsource rote, computational work to the new machine. This is how Netflix automated away the Blockbuster retail store and how Uber is automating away taxi dispatching.
- **Halo:** Instrument products and people and leverage the data exhaust they generate through their connected and online behaviors (what we call Code Halos) to create new customer experiences and business models.¹⁶ General Electric and Nike are changing the rules of the game in their industries by instrumenting their products, surrounding

them with halos of data, and creating new value propositions and customer intimacy.

- **Enhance:** View the computer as a colleague that can increase your job productivity and satisfaction. The GPS in your car currently enhances your driving, keeping you on the fastest route, alerting you of road hazards, and ensuring that you never get lost. In the coming years, entire vocations, from sales to nursing to teaching, will be revolutionized with the power of computer-based enhancement.
- **Abundance:** Use the new machine to open up vast new markets by dropping the price point of existing offers, much as Henry Ford did with automobiles. In the way that Betterment is using AI to bring financial security to the masses, which market offers can be greatly democratized and expanded in your industry?
- **Discovery:** Leverage AI to conceive entirely new products, new services, and entirely new industries. As Edison's light bulb led to new discoveries in radio, television, and transistors, today's new machine will lead to a new generation of discovery and invention.

These are five specific approaches—*plays*, if you will—for winning with AI, each with its own set of approaches and tactics. In the coming pages, we will utilize this model to demystify the application of the new machine in your business.

The first play—to *automate*—is the one most prevalent in today's zeitgeist. Automation has been the initial step in each industrial revolution, as one loom replaced 40 textile workers or one steam engine had the power of 50 horses. Today, automation will be a similar necessary “evil,” because it's how you will deliver at the “Google price” in core portions of your company. However, what most market observers miss is that the next wave of automation will pave the way for invention and economic expansion through the four subsequent plays.

This one-two of efficiency plus invention will manifest itself across all industries. Banking will become more efficient and personalized. Health care will become more transparent and effective, generating much better outcomes. Manufactured goods will become more interactive, intuitive, and reliable. Our food system will be less wasteful and produce higher quality goods. Education will be enhanced and individualized, and government services will be upgraded and more cost-effective. And, as outlined previously, much of this shift will not be driven by companies that were started last year or even 10 years ago but by companies started by our grandparents. This

is because those companies have access to the richest lodes of data, the “fuel” for the new machine.

Much has already been said and written about the potential impact of the new machine on society. We wrote this book not for policy wonks and academics but rather for people in organizations large and small that are trying to make the best decisions possible for their businesses and their own jobs. We aren’t naïve to the fact that business happens in a wider context, but we can’t all sit around waiting for politicians to improve education or to pass huge spending bills to enhance infrastructure or enact a universal basic income. We need to act *today* in the world as it is. You can rest assured that if you don’t act now, others will.

The title of this book is *What to Do When Machines Do Everything*. This may sound a bit hyperbolic, and clearly machines will never do *everything* and nobody really wants them to. But in the next few years the new machines will continue to amaze, will be embedded most everywhere and in most everything, and will increasingly do more and more of the work people do today.

Technology is no longer the domain of the few but the province of the many. As such, those who win in the next phase of the digital economy are not those who can create the new machines, but those who figure out what to do with them. This book is your field guide.

2

From Stall to Boom

We've Been Here Before

Many of us feel stalled. Growth, both for our companies and for us individually, seems increasingly difficult to attain. There is plenty of evidence of the structural weakening of our economy: stagnant wages, rising debt levels, and anemic productivity growth. It seems the major trends are all working against us: increased global competition, a winner-take-all economy driving massive income inequality, the steady erosion of privacy and security, start-ups worth billions emerging while legacy firms crumble, and technology taking our jobs. It's clear that the old rules of work and business no longer apply.

We (the authors) work with a lot of people excited about the opportunities that lie ahead in the digital economy, but their optimism is often tempered by the news of the day. The headlines all too frequently seem to foretell a pending jobless nightmare of breadlines and robot overlords. And some feel as if there's a party being thrown—in Silicon Valley, New York, and London—that they're not invited to.

Yet within the malaise there is good news. We have weathered similar storms before, and the shape and pattern of our current situation is actually a

harbinger for a period of technology-fueled growth. This seems counter-intuitive; after all, how can economic stagnation signal future growth and opportunity?

It's because our current stall fits within a well-established pattern that shows up during every major shift in business and technology, when the economy moves from one industrial revolution to the next. In short, we are currently in an economic "stall zone" as the Third Industrial Revolution is (literally) running out of gas, while the Fourth Industrial Revolution—based on the new machine—has yet to grab hold at scale.

This situation creates a dissonance in which we marvel at the computers that surround us, and all they can do, while we search in vain for greater growth prospects for our companies and career security for ourselves.

The good news, which we will explore in this chapter, is that we are coming to the end of the stall zone and entering a time when the economy can break out for those who harness the power of the new machine. We refer to this as the coming "digital build-out," in which the fruits of digital technology move from Silicon Valley to the entire economy. This value migration will be of a scale similar to the industrial build-out of the last century and will move much faster. To fully understand this transition, it helps to take a look back at the impact of new machines on work in previous periods of tumultuous disruption.

When Machines Do Everything, What Happens to Us?

People have been worried about "new machines" and their effect on the human condition for centuries. Only the machine has changed; the concerns remain the same.

Back in the early 1800s, during the First Industrial Revolution, the Luddites in northwestern England responded to the introduction of power looms by smashing them. They recognized that their textile jobs were at risk. It turned out that they were right; the machines *did* take over their jobs. Then the same thing happened in agriculture. At the beginning of the 19th century—when the Luddites were smashing looms—80% of the U.S. labor force was working the land. Today, less than 2% of U.S. workers are in agriculture.

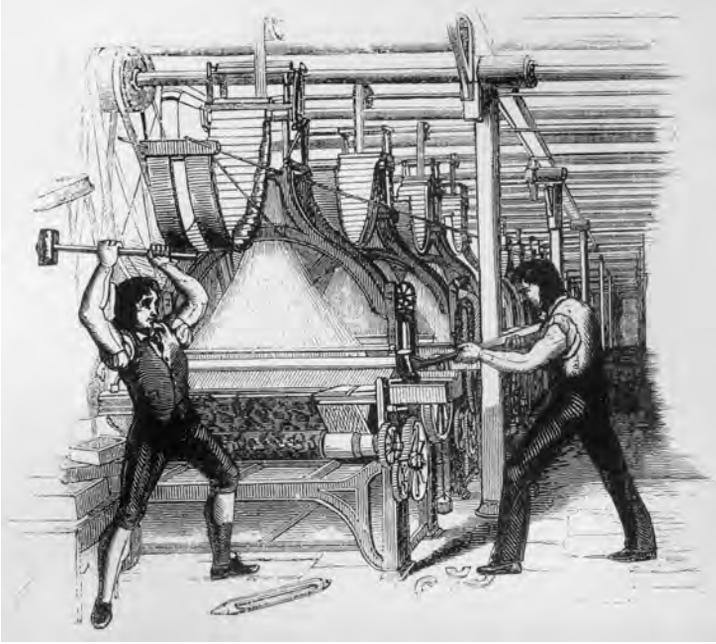


Figure 2.1 Luddites in the early 1800s

When the steam engine enabled mechanization during the Second Industrial Revolution, experts openly worried that “the substitution of machinery for human labor” might “render the population redundant.”¹ As assembly lines made mass production possible, the economist John Maynard Keynes famously warned about widespread unemployment, “due to our discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor.”²

Today, many of us feel that same sense of trepidation as we read increasingly foreboding accounts of how new machines based on artificial intelligence will displace us. A widely cited Oxford University study estimates that nearly 50% of total U.S. jobs are at risk from the new machines during the next decade or so.³

But Haven’t Our Computers Made Us More Productive?

In spite of this doom and gloom, some of us, being ever-optimistic, will argue, “Maybe so. But all of these computers are having a broad positive

effect as they are making all of us more productive.” However, the data doesn’t support this argument either.

In spite of the billions spent on enterprise technology (think of all those Cisco routers, SAP applications, Oracle databases, and Microsoft-based PCs, combined with the recent explosion in consumer technologies such as smartphones and apps) worker productivity and associated G7 industrialized nation GDPs haven’t budged much. For example, from 1991 through 2012 the average annual increase in real wages was a paltry 1.5% in the UK and 1% in the United States (which was approximately half the level of wage growth from 1970 through 1990), and these were the *leaders* in wage growth in the industrialized world.⁴ Similarly, GDP growth rates in the United States and Western Europe during those two decades were *below* the GDP growth rates of the previous two decades.⁵

How can this be? How is it that we are merely treading economic water in spite of massive technology investments? Isn’t this a technology golden age?

Ask yourself: Have your PC, smartphone, e-mail, and instant messaging platforms shortened your work day? Ours neither.

Carlota’s Way

The good news amid the gloom is that our current stall zone fits a historical pattern that foretells future growth. Indeed, the signals of fear that the new machine will take our jobs usually appear at the cusp of technology-led economic booms. In fact, if the Fourth Industrial Revolution doesn’t generate widespread economic expansion along with associated job growth, we will have broken with history. Why do we have confidence in such a prediction? A Venezuelan-born economist will help guide us.

Carlota Perez is an award-winning economics professor at the London School of Economics. Her most important work focuses on what happens *between* the end of one era and the beginning of the next. She describes it like this:

History can teach us a lot. Innovation has indeed always been the driver of growth and the main source of increasing productivity and wealth. But every technological revolution has brought two types of prosperity.

The first type is turbulent and exciting like the bubbles of the 1990s and 2000s and like the Roaring Twenties, the railway mania, and the canal mania before. They all ended in a bubble collapse.

Yet, after the recession, there came the second type: the Victorian boom, the Belle Époque, the Post War Golden Age and . . . the one that we could have ahead now. Bubble prosperities polarize incomes; Golden Ages tend to reverse the process.⁶

Perez describes a coming Golden Age, the digital build-out that's just in front of us. But we're getting ahead of ourselves. How and why can this emerge from our current economic stall? The patterns of history provide us with the guide.

Riding the Waves

When we look back at the invention of the cotton gin, the internal combustion engine, and alternating current, we might sometimes think that one day there was an invention and the next day everything changed. But that's not how the world works. In virtually every case, there was a long and bumpy road connecting one era of business and technology to the next; the evolution of each industrial revolution follows the path of an *S-curve* (as shown in Figure 2.2).

Why an S-curve? Historically, upon the introduction of new technologies, associated GDP does not rise for decades (the bottom of the S-curve).

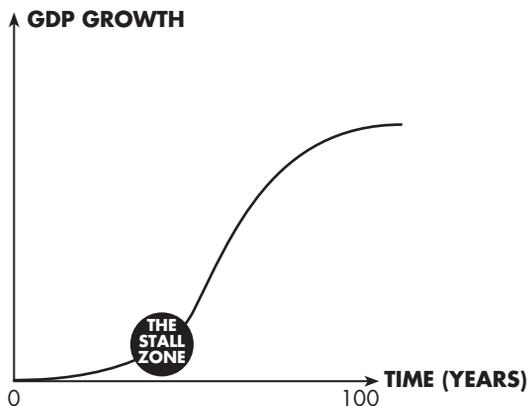


Figure 2.2 The S-Curve and the Stall Zone

Select individuals and companies might get rich, but society overall does not. Yet once the technology fully grabs hold, usually 25 to 35 years into the cycle, GDP experiences near-vertical liftoff (the middle of the S-curve). All current members of the G7 nations have experienced this previously—for example, Great Britain rode the steam engine to massive GDP growth in the 19th century, and the United States did the same with the assembly line in the 20th century.

Over time, as the technology is fully adopted and finds its way into most every industry and part of the globe, GDP growth wanes (the top of the S-curve). This is where we are today with the industrial economy of the Third Industrial Revolution. The model of production is well understood, widely distributed, and commoditized. (Consider, for example, the nearly 23 million motorcycles produced in China in 2013.)⁷ This top-of-the-curve, flattening-out is what's behind our current economic malaise.

This S-curve pattern of innovation, stall, rapid expansion, then maturity has occurred with the previous three industrial revolutions, and to date it's playing out in the early stages of our computer-driven Fourth Industrial Revolution (as shown in Figure 2.3.)

Currently we find ourselves at the end of the stall zone and are entering rapid expansion. But this situation of being between stages is also why we

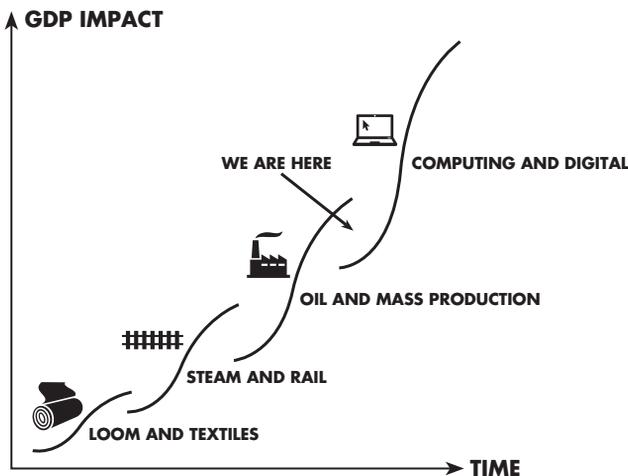


Figure 2.3 S-Curves and Industrial Revolutions

have such confusion in today's markets between the optimistic technophiles and the pessimistic economists. Both groups are right *if* their aperture is focused on the past 20 years (which, for most observers, is often simply based on their own personal experiences). However, in expanding the view over a broader arc of economic history it becomes very clear as to where we are, where we have been, and (most importantly) where we are headed.

To reinforce this point, let's take a closer look at recent history and how these periods fit within Professor Perez's model.

The Burst of Innovation (1980–2000)

The advent of the PC, Steve Jobs's original Mac, Bill Gates becoming the world's richest person, the Internet explosion, the wiring of our corporations. It was all so very heady. It was "the time of the great happiness" as remembered in the technology industry, at least until it all ended in tears with the dot-com bubble and bust.

Similar bursts of innovation have occurred at the beginning of each industrial revolution, paving the way for the great fortunes of titans such as Cornelius Vanderbilt, Andrew Carnegie, and John D. Rockefeller. But this wealth was highly concentrated, because the new technologies and their associated business models were understood and implemented by only a few. The public at large would marvel at the new machine of its age; it would garner lots of press and capture the collective imagination, yet its reach was still limited and highly concentrated in a few industries and geographies. Invariably, when too much capital would start chasing too few implementers, financial bubbles would result.

The Stall (2000–2015)

The Internet bubble burst around the turn of the millennium. Then, roughly seven years later, the financial crisis hit. And we've been stalled for a decade and a half. While it all felt new and unpleasantly surprising to us, our recent busts and malaise have also fit closely with the historical pattern.

This stall zone, while painful to experience, is an important period of change. Think of it as the gestation period of a new technology, the larva in the cocoon before it becomes a butterfly, during which the broader economy takes time figuring out how to best leverage the new machine and business models catch up with technology innovation.

This is why the FANG vendors, along with unicorns like Dropbox, Airbnb, and Betterment, are so important; they have provided examples of combining the new machine with new business models. Probably more important is to look beyond the FANG vendors to the industrial leaders that have recognized the shift, such as Siemens, Nike, and Progressive Insurance Corporation. These enterprises are making moves that will take time to come to full fruition but will ultimately set them up for success in the digital build-out phase that will follow the stall. In the coming pages, we will decode many of the important lessons to be learned from both FANGs and well-established corporations who are successful early adopters of new machines and business models.

The Build-Out (2015–2040)

This is the phase when innovations move from the radical fringe to the mainstream. It is the time for the “democratization” of the innovation, as new ideas, which are initially implemented in very concentrated areas, become much more widely disseminated.

This will occur over the next few decades, when industries and institutions that serve as the pillars of our society—banking, insurance, health care, education, transportation, law enforcement, government—leverage the power of the new machine and begin to base their operating models on digital technology.

OK, enough of the economic theory. We took this brief trip through history and economics (summarized in Figure 2.4) in order to set the stage for what’s happening to all of us currently and to point out that all of the available evidence reveals us to be on a path not to the end of times but to the Fourth Industrial Revolution build-out. Every previous industrial revolution has followed this same basic cycle of innovation bubble, stall, and boom. The digital revolution is no exception, and there are three big reasons for why we are about to transition to widespread, digitally driven growth.

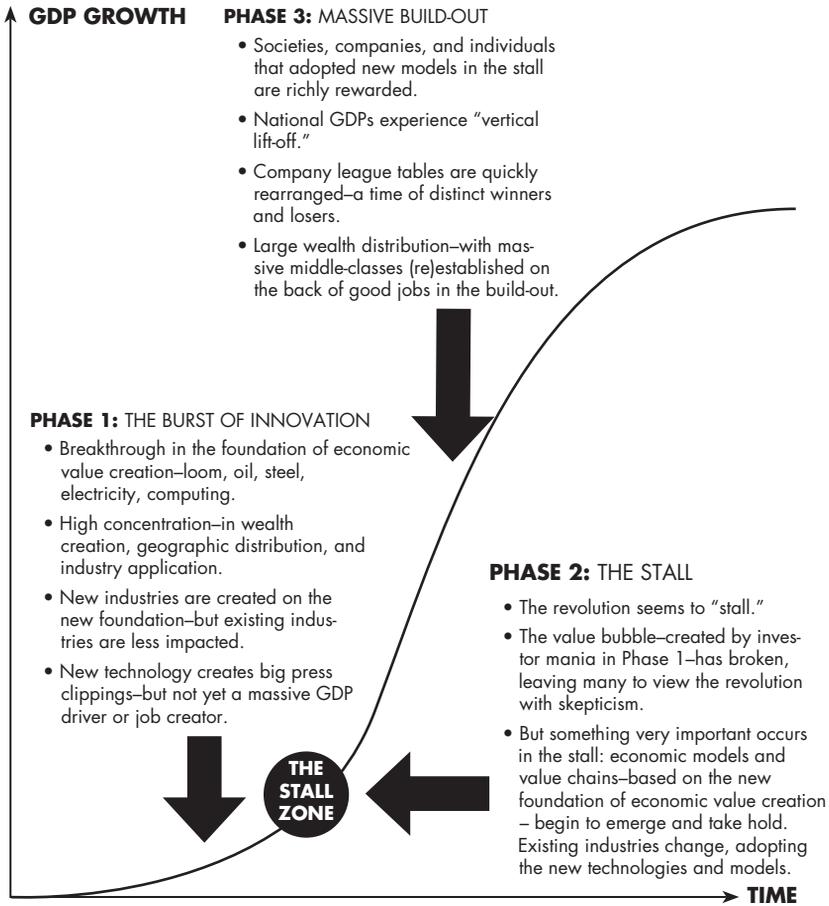


Figure 2.4 The Three Phases of the S-Curve

Three Big Reasons Why a Boom Is About to Occur

As we see it, the transition to the build-out phase will be driven by three parallel large-scale trends:

- **“Ubiquitech”—technology embedded into everything.** As the Internet of Things (IoT) comes to life, almost everything will become tech-infused, connected, and intelligent. When tech is everywhere, transformation can come from anywhere.
- **By 2030 standards, we stink.** In 2030, we will look back at many aspects of today’s society and wonder, “How did we tolerate that?” We

have big problems to solve with the new machine, and in the process massive new forms of demand will be generated.

- **Becoming digital—mastering the Three M’s (raw Materials, new Machines, and business Models).** Enterprises are “becoming digital,” organizing their people and processes around the capabilities of the new machine. Increasingly, the winning new business models are emerging out of the stall zone, leading to the rearranging of league tables in industry after industry.

Now let’s explore all three of these.

“Ubiquitech”—Technology Embedded into Everything

In the next decade, most everything around us will become tech-enabled and connected. The “Internet of Things (IoT)” is the catchall phrase that describes the embedding of computing capability into devices and objects that have previously not had such capacity, and then the connecting of them to the Internet. Think of your shoes, thermostat, or hair dryer; your town’s streetlamps and parking meters; and the multiple key components of a jet liner, an assembly line, or a power grid.



Figure 2.5 Our Connected World

In some cases, this digital “enchantment” is relatively limited.⁸ For example, a light bulb can now contain a sensor that tells the bulb when it is dark, and thus it turns itself on. In other cases the “thing” is much more sophisticated. An entire house can be wired so that, in effect, it becomes a networked computer—a “smart home.” Not only the lights but also doors, windows, temperature, security features, entertainment systems, and kitchen appliances can all be programmed to do things automatically. Further, they all can be controlled when the home owner is five feet—or 5,000 miles—away from home.

The spread of this capability—making every *thing* Internet Protocol addressable—is happening at breakneck speed; the scale of the explosion of the “thing” universe is staggering, and even hard to fully comprehend. For example:

- Cisco Systems estimates that the number of connected devices worldwide will rise to 50 billion by 2020.⁹ Intel goes even further, suggesting that over 200 billion devices will be connected by then.¹⁰
- McKinsey forecasts that global spending on IoT devices and services could reach \$11 trillion by 2025.¹¹
- With “wearables” constituting an important sub-element of this market, IDC expects global wearable-device shipments to surge from 76.1 million in 2015 to 173.4 million units by 2019.¹²
- The smart-home scenario, mentioned above, will be a significant growth area; according to Harbor Research and Postscapes, it generated \$79.4 billion in revenue in 2014 when it was just in its infancy.¹³ That number is expected to increase to \$398 billion as mainstream awareness of smart appliances rises.¹⁴
- The auto industry is becoming “smarter” by the day. Even before cars become fully autonomous (i.e., “driverless”) they will become more like increasingly connected rolling data centers. By 2020, 90% of cars will be online, compared with just 2% in 2012.¹⁵
- General Electric estimates that the “Industrial Internet” market will add between \$10 trillion and \$15 trillion to global GDP within the next 20 years.¹⁶

Of course, these are all just estimates and should be treated with some degree of cool skepticism. But whatever the actual numbers turn out to be, there is little doubt that the trend lines strikingly point in only one direction. The next generation of smart devices will be hugely significant for nearly every kind of business.

In reality though, we've only scratched the surface of this "smart" wave. We can already see texts and our heart rate on an Apple Watch; sure that's cool, but why can't it do a lot more? Why can't Amazon Alexa manage our whole home? Why can't Nest smart thermostats monitor the house for leaks and other insurance risks? In due course, all of these things will happen, and millions of other similar "smart scenarios" will stop being science fiction and will become, simply, our reality.

But improvements in entertainment and domestic life won't impact the wider economy enough to transition us from stall to boom. What is starting to happen and does have the potential to raise all our boats is the application of IoT ideas to mission-critical parts of the economy, such as health care, transportation, and defense. Such a development has begun to radically change *work that matters*.

We'll look at many more examples of smart devices in Chapter 8; for now, just recognize that soon your default position should be to instrument all of your operations, products, and customer experiences.

By 2030 Standards, We Stink

Just as we tease our parents and grandparents about the outhouse in the backyard, black-and-white television sets, and the cars without seatbelts that were common in their day, our descendants will rib us about how rudimentary and odd our tools still are today. They will look back on us and wonder, "How on earth could they live like that?"

If you have very young children, imagine sitting at dinner with them as teenagers 15 years from now, describing the world they were born into. After their giggles over Justin Bieber, the Kardashians ("What was *that* all about?"), hipster beards, and hashtags, the conversation may move on to more pedestrian issues. For example, you may describe to them what you had to go through to get your car fixed.

You know the scenario, when you go to the service department of your car dealership: you sit there with a dozen strangers, sipping the stale coffee, watching CNN on a TV that's playing about 10 decibels above comfort level. Your mind starts to wander: "How long will this take? Will I make it back to the office in time? And do I really trust what the mechanic is about to

tell me about the extent and cost of the repair?” Ten years from now, your car will self-diagnose exactly what is wrong with it, will give you an estimated cost of the repair, and then will schedule itself for an appointment at the dealership based on your calendar. Then, as your car drives itself out of your office’s parking lot to get itself repaired, you will start to think of how much we tolerated, and the opportunity costs that abounded, in our pre-digital era.

In 2030, those 15-year-olds will wonder how we didn’t know days in advance that we would be coming down with a cold. That every student at school didn’t have a highly pixilated understanding of their personal learning style and a supporting individualized curriculum to maximize their development. That when patients arrived at the emergency room they first had to spend time presenting their insurance card and then sitting in the waiting room instead of having their personal health history, as well as pictures and videos of their injury, sent ahead so a team of well-prepared doctors was awaiting them at the door.

Our current industrial-age inefficiencies may feel terrible now, but anyone with an entrepreneurial bone in their body sees problems and friction as business opportunities to *fix* these gaps. New machine-based digital solutions such as these—multiplied across all industries—will address myriad societal problems, in the process generating enormous economic value. Rather than presaging the end of the middle class, technology will help drive massive financial expansion.

The key point is this: in thinking about digital solutions and artificial intelligence, we often focus on the impact of the technology *on the world that we know*. Many critics thus go straight to the “How many jobs will the machine destroy?” question, yet the question is really about “What can this technology improve?” The answer is “a tremendous amount,” for in viewing things from a 2030 perspective, it’s clear how much is about to change.

To better understand the scope and scale of this opportunity, Cognizant’s Center for the Future of Work, together with economists from Roubini ThoughtLab (a leading independent macroeconomic research firm founded by renowned economist Nouriel Roubini) studied 2,000 companies across the globe to understand the economic impact of the new machine. Our study, conducted in early 2016, focused on several industries

that are central to our economy but have yet to become truly digital (i.e., retail, banking, insurance [health and property & casualty] manufacturing, and life sciences), which collectively generate over \$60 trillion in revenue today (roughly 40% of world GDP).¹⁷

Respondents reported that approximately 6% of that revenue was currently driven by digital but that the figure will nearly double during the next three years to 11.4%. To put this in perspective, this means the “Republic of Digital,” if it existed as a separate country, will soon be a \$6.6 trillion economy, making it the third largest economy in the world behind the United States and China and roughly equal to the economic horsepower of the 2015 economies of Germany, the UK, and Austria, combined. As work that matters becomes more fully digitized, leveraging the new AI machines, huge economic expansion is set to occur.

Becoming Digital: Mastering the Three M’s

In looking at the digital economy, the consensus view seems to be that recent start-ups shall inherit the earth. After all, who can stop the momentum of relatively young yet already rich and massive companies like Amazon, Google, Facebook, and Uber? Where does this leave the 100-year-old companies, or even the 40-year-old companies? What about them? Actually, in a very good place . . . if they move quickly.

In our view, long established companies are extraordinarily well-positioned for the digital build-out. This is because they already have advantages for taking the steps required on the next leg of the journey in delivering digital that matters. They understand their markets, products, and associated regulations better than anybody. And, per the IoT section, they have all the assets to instrument in order to gain proprietary insights into their operations and markets. Still, to get there they must align the Three M’s.

The Three M’s refer to (raw) materials, (new) machines, and (business) models. Further along we devote individual chapters examining how each of these elements is necessary for winning in the coming digital boom. For now, the key point is that these three elements have to be *integrated* and *aligned* to create value. Why? Let’s look at how the combination of these three elements has driven every major business and technology shift that’s come before.

How the Three M’s have historically related to each other is illustrated in Figure 2.6.

RAW MATERIALS	MACHINES	BUSINESS MODELS
1800s COAL		
1900s OIL, STEEL, ELECTRICITY		
2000s DATA		

Figure 2.6 The Three M's in Major Business and Technology Revolutions

In our current context, the Three M's are:

- **Raw materials:** the data generated from IoT devices and instrumentation of all people, places, and things.
- **New machines:** systems of intelligence that combine hardware, AI software, data, and human input to create value aligned to a specific business process or customer experience.
- **Business models:** commercial models that monetize services and solutions based on systems of intelligence.

Perhaps the best example of aligning the Three M's comes from a company that is well over 100 years old.

Today, many mythologize Henry Ford as having invented the car. He didn't. When Ford launched the Ford Motor Company it was actually his *third* car company (the first had failed and the second became Cadillac), and

he had dozens of competitors in Detroit alone, including Oldsmobile, Packard, and Buick.

What Henry Ford did invent, his great gift, was the alignment of the Three M's of his time, with a primary focus on the third; he created a business model based on the assembly line, which completely changed the price and quality points of the automobile. Aligning the Three M's allowed Ford to mass-produce cars (turning them from a toy for the rich into a necessity for the masses), win his competitive battles, reshape transportation, and reshape society.

In subsequent chapters, we'll discuss how the Three M's will impact your organization and your work in more detail.

New Business Models Take Shape in the Stall Zone

The stall zone is vitally important because materials and machines are understood long before the associated business models can adapt.

The starting point for a truly digital business model, or for the specific business process or customer experience in question, should not be "How do we make it better/faster/cheaper by adding new technology to it?" Instead, the question should be "If digital technologies were available when we designed this process, would we have structured it differently?" The former lens gives you Blockbuster, which put Internet e-commerce on top of a retail chain network. The latter lens yields Netflix, which designed core processes as digital from the ground up.

General Electric currently stands out as an industrial leader that is undergoing the hard work of reconfiguring itself around the Three M's for the digital economy. Incorporated in 1892, GE is the oldest company listed on the New York Stock Exchange, so you couldn't find a better poster child of an old-school industrial company. It retains its leadership in manufacturing power turbines, jet engines, lighting, and locomotives, but it is currently becoming so much more.

GE CEO Jeff Immelt recognized the need to combine data, systems of intelligence, and new business models to win in the digital industrial economy. He noted, "If you went to bed last night as an industrial company, you're going to wake up this morning as a software and analytics company."¹⁸

Leaders at GE are taking tactical steps to make the shift to the Fourth Industrial Revolution happen by creating what they refer to as “the world’s premier digital industrial company.” In recent years, they have jumped fully into ubiquitech, putting sensors into nearly every “thing” they make to generate the new raw material. GE has invested in building an IoT management platform (Predix), which is the company’s system of intelligence. And GE hasn’t overlooked new business models. It is now selling insights based on the raw material, opening up entirely new lines of business. In fact, GE now has a software business earning more than \$6 billion in revenue, making it one of the world’s largest software companies.¹⁹

Another example of a 100-year-old industry realigning itself around the Three M’s model, and leveraging the new machine, is education, which certainly is a pillar of society where progress is badly needed, long overdue, and finally coming into focus. We met with Joel Rose, co-founder of New Classrooms Innovation Partners, whose work is a leading indicator of a Three M-aligned future. Rose is trying with new tools, machines, and attitudes to reinvent a hidebound industry and mindset seemingly unchanged since long before many of us were in school.

Developing People of Intelligence with Systems of Intelligence

The notion of “reinventing education” has a long and bumpy history that predates the advent of the computer but has certainly accelerated since PCs found their way into schools during the late 1970s. Space prohibits us from revisiting too much of that history here, but suffice to say most of it ends badly!

Launched in 2011 by teachers, education administrators, and technologists, New Classrooms is essentially leveraging the power of data to tailor teaching individually and thus break the long-established educational norm: a teacher standing in front of a class of 30 students, all of them learning the same material at the same time. That traditional teaching model is literally an *industrial* model. Large-scale public education dates from a time when workers were pouring into factories and

mills, and it mirrors the production-line mentality that was key to efficiency and productivity within those then-new technology spaces.

In a New Classrooms school, students equipped with laptops or tablets are placed in groups of typically between 5 and 20, and work through assignments and projects where they undertake different “modalities” of learning at “stations” within the classroom; some modalities have the kids collaborate in teams, some directly with a teacher, some “virtually” with online software programs. At the stations, teachers interact with the group, answering questions, setting challenges, or posing new questions. After each interaction, the group moves on to another assignment and visits new stations. Whereas a traditional school will have one group of 30 kids interact in one room with one teacher, a New Classrooms school will have between two and six teachers as well as additional team educators in a large space or several classrooms with between 60 and 80 kids circulating amongst the stations (see Figure 2.7).

All the lessons are online (though it should be noted that not all the teaching happens exclusively through a computer). Most of the



Figure 2.7 A Typical New Classrooms Learning Environment

grading is done automatically and in a fraction of the time a human teacher would require, and by 6 A.M. the following day, each student, along with the associated teachers, receives a fully individualized learning plan for the day ahead. This outline is based on the software's analysis of the student's progress: what needs a do-over, what needs reinforcement, and what new input can be added to stretch and engage the student.

New Classrooms co-founder Joel Rose says the main issue with the *industrial* teaching model is that in a class of 30 students, the three brightest kids will be bored to death, the 10 least academically gifted will be hopelessly lost (and perhaps prone to causing mischief), and the kids in the middle will muddle through, some doing well through inclination (or with the help of parental carrots and sticks) and some drifting in and out of the process. In a New Classrooms school, steered by data and machine learning and platforms, the “no back rows” philosophy of a private academy is made available to students in a public school environment; no students fall through the proverbial cracks. The New Classrooms model is thus bringing the concept of the “democratization of luxury” to life in an arena that is vital to us all, individually and societally.

The team at New Classrooms is all too conscious of the inertia surrounding them, but they report the growing numbers of principals, teachers, boards, and parents who are open to the radical reengineering of both the physical classroom and the “workflow” of learning.

From Stall to Boom, a Time of Optimism

The three of us have been working at the cutting edge of business and technology for years. If you ask people who know us, we could hardly be accused of being naïve or irrationally exuberant about any specific technology. Even so, we have a sense of optimism based on what we see happening in the market, among our customers, and from our research. Essentially, this is what this book is about: getting *you* to the prosperity found in the coming digital build-out. The primary thing you need to take away from this chapter is the necessity of (a) understanding the new machine and (b) situating it in the right business model. This is the heart of our thesis, and in the coming

chapters we detail (and demystify) each of the Three M's in today's success formula and explain how they must be activated to move ahead.

But before we get to that we need to address “the elephant” in our book, the great concerns we've mentioned that many have about the impact of AI and automation on jobs.

WHAT TO DO WHEN MACHINES DO EVERYTHING

Artificial intelligence has left the laboratory (and the movie lot) and is in your building. It's in your home. It's in your office. From Alexa to Nest to Siri to Uber to Waze, we are surrounded by smart machines running on incredibly powerful and self-learning software platforms.

And this is just the beginning.

Minute by minute, machines are doing more and more of the work we perform today.

When machines do everything what are you going to do?

- Will a robot take your job away?
- Will your company be "Ubered"?
- What will your industry look like in 10 years?
- Will your children be better off than you are?

The rise of artificial intelligence is the great story of our time.

Those who succeed in the next phase of the digital economy are not those who can create the new machines, but those who figure out what to do with them.

This book is your field guide.

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