PART 1

The Mobility Age

CHAPTER 1

Technology Sets the Stage

The oft-repeated curse says "Those that ignore history are doomed to repeat it." I prefer the more positive twist: "If you want to know the future, understand how the past keeps repeating itself." Since this book is all about knowing the future, we will start by understanding how history continues to repeat itself. Time and time again, new technologies have been introduced and broadly adopted, resulting in dramatic impacts on society and the nature of business.

From a business perspective, a new technology can reduce a business's cost to produce a product or increase a product's value. In most cases, this improvement is relatively small but still worthwhile to the business.

Some new technologies introduce radical change to business. The reduction in cost or the increase in value may be an order of magnitude change—meaning that it is one-tenth the cost or ten times the value. These changes are so dramatic that they fundamentally

change the nature of the business, the nature of the product, and the reasons why customers buy the product.

When this happens, the rules of competition change. And the new rules typically favor competitors with different strengths than the old leaders. Sometimes the old leaders can adapt and survive. Sometimes they can't.

Stories of businesses that have been crushed because they have failed to believe and have denied the changes brought by technologies in the past will likely be repeated. Now powerful companies will be crushed in the future when they disbelieve and deny the changes being wrought by emerging technologies. However, the stories of businesses that have believed in the coming changes and have turned change into value for customers, employees, and owners will also continue to be repeated.

The Gutenberg Press Unleashes Reformation and Renaissance

It is almost impossible to imagine a world without printing. In fact, arguably, all of the other technology advances we will consider would have been significantly hindered in their development if economical printing had never been developed.

And we must remember that the impact of Gutenberg's invention was purely economic. Prior to Gutenberg, there were printed documents—many made by hand (manuscripts), but printing presses were also cranking out documents by the mid-fifteenth century as well.

The innovation that Gutenberg introduced was threefold:

1. Alphabetic movable type.
2. Thicker ink that would stick to the press.
3. Perfection of the materials to be used in making the type.[1]

The result was a dramatic improvement in the cost and speed of printing. In fact, printing a book became the first assembly line process—mechanically combining replaceable parts to produce a complex end product—predating similar industrial processes by 300 years.[2] These advantages were quickly recognized by others, and lacking patent systems to protect the intellectual property (and slow its adoption), movable type printing spread rapidly.

Gutenberg began work on his first product, a beautiful Bible, in 1452. He first sold the product at the 1455 Frankfurt Book Fair, introducing his innovation to the world. Approximately 50 copies of that original Bible exist today.[3] By the early 1470s, the printing press had spread to the major trade centers in Germany; and by the early 1480s it had spread across western and central Europe.[4] Within 50 years, over 1,000 publishers had printed over a million books using Gutenberg's technology.[5]

Prior to Gutenberg's invention, there was little reason for literacy to broadly develop within society. Books were so rare and expensive that it was meaningless for the average citizen to bother learning how to read. As Walter J. Ong noted, "Many of the features we have taken for granted in thought and expression in literature, philosophy and science, and even in oral discourse among literates, are not directly native to human existence as such but have come into being because of the resources which the technology of writing makes available to human consciousness."[6]

As a simple example, Ong relates that, prior to printing, most people never knew in what calendar year they were born. With no newspapers or calendars to regularly remind them of the year, such a number would appear to have no relation to anything in "real life."

Robert Logan claims that the characteristics of Gutenberg's press enhanced and multiplied the prior impacts of the alphabet "unleashing a powerful new force that completely transformed Western civilization, leaving in its wake the Renaissance, the rise of science, the Reformation, individualism, democracy, nationalism, the systematic exploitation of technology, and the Industrial Revolution—in short, the modern world."[7]

Bacon's Law

There are two key questions we must wrestle with for each of the technologies we examine. Why was adoption so quick and why did the technology have such an impact on society and business? In most cases, we'll find that there is a simple observation, a simple truth that explains why adoption and impact were unstoppable.

In the case of the printing press, the simple observation was made in 1597 by Sir Francis Bacon in his *Religious Meditations, Of Heresies*.[8] The observation, which has become known as Bacon's Law, is that "knowledge is power."

The printing press enabled knowledge, which had been a virtual monopoly of the church and the universities, to be distributed. As Bacon observed, with the distribution of knowledge came the distribution of power. The powerless hungered for the freedom that came with the new flow of information, and, of course, those who had horded knowledge were threatened as their hold on power became challenged.

Given this true observation, once the printing press existed, nothing could hold it back and its impact on society and business was clearly dramatic.

The Steam Engine Powers the Industrial Age

The first practical steam engine was invented by Thomas Newcomen in 1712. Newcomen introduced four key innovations that made the steam engine a practical source of power:

1. Techniques for generating a vacuum.
2. The managed use of pressure.
3. Means for generating steam.
4. The piston and cylinder for capturing the mechanical power.

Newcomen built his first steam engine to operate a mine drainage pump near Dudley Castle in Staffordshire. However, it is not Thomas Newcomen who is best remembered as the inventor of the steam engine; instead, it is James Watt.

In 1764, Watt was asked to repair a Newcomen steam engine owned by the University of Glasgow. In working on it, he realized there were a number of ways in which the design could be improved. The most significant of these improvements was the use of a separate chamber for condensing the steam back to liquid at the end of each cycle. This allowed more of the energy in the main cylinder to be retained, greatly improving the overall efficiency of the engine.[9]

Watt built the first working model of his new design in May 1765, and in 1768 he applied for a patent on the invention. However, Watt did not have the capital required to build a manufacturing business around

his invention, and therefore to meaningfully profit from it. He sought out investors and found them in John Roebuck and Matthew Boulton. To justify the large expense they would incur in establishing their business, the partners went to Parliament to get an extension to the normal patent to protect their intellectual property through 1800.[10]

The industrial factory predated Watt's steam engine. Water-powered factories were operational in England as early as 1721 (http://en.wikipedia.org/wiki/Industrial_revolution). But it was the steam engine that really accelerated the pace of change that became the Industrial Revolution. The first benefactor was coal mining. Pumps driven by steam engines enabled deeper and more productive coal seams to be mined, doubling British coal output between 1750 and 1800.

By 1800, cotton mills were the chief users as the steam engine provided reliable and continuous power for spinning. Up until 1750, agriculture had dominated the British economy. British agriculture was 2.5 times more productive than that of France, which itself was much more efficient than the rest of Europe. From 1750 on, three export sectors became increasingly important: coal, iron, and textiles. Cotton was insignificant as an export in 1750, but by 1810 had become 39 percent of exports by value.

In short, the steam engine radically changed the nature of business. But it also had a dramatic impact on all of society.

From 1750 to 1850 there were two dramatic shifts in the British population. The first was simple growth. Agriculture advances supported England's recovery from the Great Plague. In 1750, it is estimated that 5.8 million people lived in England.[11] By 1801, this increased to 8.3 million, and by 1851 it had nearly tripled to 16.92 million.[12]

The second shift was from country to town and to city. By 1801, about 30 percent of the mainland British lived in towns. By 1851, more than half the population lived in towns rather than in the country.[13]

London specifically reflected these shifts. In 1750, the population of London was about 700,000. By 1800, it had grown to over a million, and by 1850 it had more than doubled again to 2,362,000. London had rapidly shot past all the other cities in the world to become far and away the largest.[14]

These changes also dramatically changed the structure of society. In agricultural Britain prior to 1750, most of the farming land was owned by wealthy landowners who leased the land to tenant farmers. The farmers paid rent in the form of the goods they grew or produced. The economy was largely local, with specialized tradesmen making the nonagricultural goods needed by the community.[15]

The shift from an agricultural to an industrial economy created clear distinctions between work and home. Prior to the Industrial Revolution, most work was done in and around the home and often involved many members of the family. As work moved out of the home and into the factory, the men followed the work first, while the women stayed to care for the family and the home. However, in time, industrial productivity required even more workers, and women and then children were drawn into the workforce, creating tremendous social stress. The first child labor laws were passed in 1833 to bring the greatest dangers under control.

As referenced before, Watt's invention also sparked a new era of capitalism. The Industrial Age introduced business opportunities that required significant levels of funding. Notably, the London Stock

Exchange formally opened on March 3, 1801, reflecting this new era of capitalism.

The Second Law of Thermodynamics

As with the printing press, we must answer the questions of why the steam engine was rapidly adopted and why it had such an impact on business and society.

Bacon's Law observed the philosophical truths that answered these questions for the printing press. For the steam engine, the answer has a much more scientific foundation.

In 1865, Rudolf Clausius developed the classic statement that we know as the Second Law of Thermodynamics.[16] The statement is rather complex and is accurately quoted as "the entropy of an isolated system not at thermal equilibrium will tend to increase over time, approaching a maximum value." However, in practical terms this means that heat flows from hot places to cold places.

Big deal, right? Well, this simple truth that heat flows to where there isn't heat is what made the steam engine work and create motive power. The steam engine came onto the scene at the precise moment when mines and factories were ramping up their need for motive power. The dramatic increase in power produced by the steam engine then drove even greater productivity in industry, radically changing the shape of business and society.

The Telegraph Signals the Telecom Era

The telecommunications industry was born on March 2, 1791, in Brulon, France. On that day, brothers Claude and René Chappe

demonstrated the first practical optical telegraph system. Claude Chappe wanted to call the invention the tachygraphe—meaning "fast writer"—but instead the name telegraphe—or "far writer"—stuck instead.[17]

However, it wasn't until electric telegraphy, whose invention is broadly attributed to Samuel Morse based on work he completed between 1832 and 1838, that practical telecommunications actually began to significantly impact the world. In 1843, Congress approved funds to build the first telegraph line in the United States from Washington to Baltimore, and on May 24 of that year, the famous "first message" of "What hath God wrought!" was transmitted over the line opening the American telecommunications industry.[18]

A new company, the Magnetic Telegraph Company, was formed and completed its first link, between New York and Philadelphia, in January 1846. Before this line opened, the only telegraph in the country was the original 40-mile stretch. By 1848, this had grown to approximately 2,000 miles, and by 1852 there were over 23,000 miles of telegraph lines in operation, with another 10,000 miles under construction.[19]

Writing in 1852, Laurence Turnbull noted that the growth in capacity and traffic showed "how important an agent the telegraph has become in the transmission of business communications. It is every day coming more into use, and every day adding to its power to be useful."

In 1861, the transcontinental telegraph line was completed to California. This new communications link made obsolete the Pony Express, enabling the instant communication of information that previously had taken 10 days. The Pony Express itself had dramatically

improved the previous time of 20 days for a message to reach the West Coast.

International routes also began to be built. England and France were connected in 1851 and the first transatlantic cable was installed in 1858. Prior to these investments, international communications took as long as it took for ships to sail. A message from London to Bombay and back could take 10 weeks. But by the 1870s, a message from London to Bombay and back could take four minutes.[20]

The telegraph dramatically changed diplomacy, financial and commodities markets, and the news industry.

These changes in specific industries also had dramatic effects on all businesses. The telegraph effectively enabled the growth of very large businesses with centralized hierarchical command-and-control management styles. The increase in information flow also increased the pace of business decisions of all kinds and began the trend toward today's business pulse.

These changes, especially in the news industry, also dramatically changed how society looked at the world. Originally, all news was local. Local newspapers carried local news, and news only traveled to other places as the newspapers themselves were carried along. Timeliness of news was not a major focus, since it could be weeks or months before news reached distant corners of the country or world. As newspapers shifted to reporting on national and then global events, and as the news being reported increasingly was still happening (not an event already over), how people interacted with the news, and ultimately with the world, changed in the same ways as businesses. People became much more aware of places and events around them and the news of "now" really caught their attention.[21]

"Time Is Money"

Again, we must ask the question, "Why?" Why was the telegraph so rapidly adopted, and why did it have such an impact on business and society?

Writing in 1748, Ben Franklin made the truthful observation that answers our question and that should help us understand why any technology that helps us gain information and/or make a decision and/or complete a task more quickly will always be highly valued. He said, "Remember that time is money."

Businessmen using more recent information to outwit their competitors clearly learned how to use the telegraph to turn time into money. Newspapers could sell more copies of their paper with more timely news, proving that time is money.

The financial value created by telecommunications continues to this day, even as mobility enables information to reach us, and us to reach information whenever and wherever we go.

The Microprocessor Produces the Personal Computer (PC) Era

The ENIAC (Electronic Numerical Integrator and Calculator) is often credited as the first electronic computer. It was built in 1945 at the University of Pennsylvania under the direction of J. Presper Eckert and John Mauchly. The computer filled a 30-by-50-foot room, weighed 30 tons, and it took 150,000 watts of electricity to start it up. Instead of modern transistors, the ENIAC had 18,000 vacuum tubes and could store the equivalent of about 80 bytes of data.[22]

However, technically, the ENIAC was really only a big calculator. It could not store its own instructions. The first nonspecialized computer was the EDSAC (Electronic Delay Storage Automatic Calculator) built from 1947 to 1949 at Cambridge University in England under the direction of Maurice V. Wilkes. Although the machine included many concepts that we today consider standard for computers, few would confuse it with our modern products.[23]

No, the computer era, as we know it, had to wait for the invention of the transistor, followed by the integrated circuit, and finally the microprocessor.

While the Cambridge scientists were building the world's first computer, scientists at Bell Labs in Murray Hill, New Jersey, were inventing the transistor. During December 1947 and January 1948, William Shockley, Walter Brattain, and John Bardeen made the scientific breakthroughs that would be announced in June 1948 as the junction transistor. The transistor replaced the function of the energy-consuming, heat-producing, and failure-prone vacuum tubes in early computers with a tiny speck of semiconductive material.

A decade later, in 1958, Jack Kilby, working at Texas Instruments, and Robert Noyce, working separately at Fairchild Semiconductor, both figured out how to put multiple transistors and other components onto a single piece of silicon, giving birth to the Integrated Circuit and further miniaturizing the components of computers.[24]

Another decade later, Noyce was one of the founders of Intel. Through most of 1970, Intel's Ted Hoff worked to create an integrated circuit with all of the components for a complete computer on one slice of semiconductor. The first Intel "microprocessor"

was delivered to Intel's customer, Busicom in February 1971,[25] and later that year Intel introduced its first microprocessor product, the 4004.

By 1977, Intel was selling microprocessors for $300 that Bob Noyce compared to the ENIAC in a *Scientific American* article: "It is twenty times faster, has a larger memory, is thousands of times more reliable, consumes the power of a lightbulb rather than that of a locomotive, occupies 1/30,000 the volume and costs 1/10,000 as much."[26]

In 1974, the 8080 became the brains behind the first personal computer product, a mail-order kit called the Altair.[27] This new class of computers inspired many new entrepreneurs, some of whom are still dominant players in the computer industry, including Steve Jobs, who founded Apple Computer in 1976, and Bill Gates, who founded Microsoft in 1975.[28]

Apple Computer was the company that really proved the concept of a mass market personal computer. Their Apple II computer, although crude by modern standards, was approachable and usable by everyday people. The company was started literally in a garage with $1,300. The real key to Apple's success was the availability of the VisiCalc spreadsheet software, which was initially available only on the Apple II. Thanks largely to VisiCalc, Apple's revenues grew from $800,000 in 1977 to $48 million in 1979.[29]

However, both the community of independent developers of software and hardware products for personal computers and the growing mass of computer users were desperate for a standard operating environment they could bet on. As businesses became increasingly interested in using personal computers to improve productivity, this

need for a standard that would fit into a corporate environment became critical.

IBM stepped into this gap. In 1980, Bill Lowe, laboratory director of IBM's Entry Level Systems Unit in Boca Raton, Florida, sold IBM's senior leadership team on the vision of IBM bringing a personal computer product to market within a year. Upon gaining approval, Lowe handed the leadership of this Herculean task over to Don Estridge and a talented team, who achieved the nearly impossible. To meet the challenging timeline, the team had to work outside normal IBM operating principles, taking such innovative steps as introducing an architecture that was open to extension by non-IBM developers, using non-IBM parts and software (most notably Microsoft's operating system), and selling the product through non-IBM sales channels. Frank Cary, then IBM's chairman of the board, personally championed the personal computer effort and shielded it from IBM's otherwise smothering bureaucracy.

The resulting product, the IBM PC, was introduced on August 12, 1981 and was an immediate success. In the closing months of that year, IBM sold $43 million in PCs. By the end of 1984, the PC and related products were producing $4 billion in sales, enough to have ranked that division of IBM as number 74 in the Fortune 500 index if it had been a stand-alone company.

In time, IBM would stumble and be passed in PC leadership by more nimble startups, such as Compaq and Dell; however, the real winners were the people and businesses that adopted the PC. *Time* magazine recognized the impact of this product introduction, and for the first time in 55 years, instead of naming a "Man of the Year" or "Woman of the Year," they named the personal computer as the

"Machine of the Year." For the first few years of the 1980s, the PC market grew at 50% to 60% before leveling off to a respectable annualized growth of about 15% from 1985 on.

It is hard to imagine a world without the PC. Nearly every home in America has at least one computer, and virtually every professional uses a PC every day. So, the contrast with American business use of the personal computer less than 20 years ago is stark indeed. In 1980, fewer than 10% of small businesses in the United States were using personal computers, and within large corporations not even 3% of employees used personal computers on a regular basis.[30]

The PC and the software packages that made the computer useful were perhaps the first major example of a disruptive technology introduced from the home into the workplace. Before the PC, most technologies were first proven to be valuable at work, and then folks started using them at home. But not the PC.

Clearly, the PC unleashed tremendous power within corporations. Departments were able to make better decisions faster with fewer people. They could really get their hands on the data to run and rerun different scenarios to determine a range of possible outcomes and plan accordingly. Entire departments became obsolete overnight, including the word processing and data entry departments. And spending on big computers dropped precipitously.

But tremendous danger was also introduced. Many departments running their own analysis resulted in many, seemingly conflicting views of the "truth"—too much information became an impediment to decision making rather than an accelerator. Every white-collar worker became an untrained computer operator, searching frantically for the "Any" key. Critical data was lost when un-backed-up systems

failed or critical data walked out the door on floppy disks as employees left to join the competitor. PC spending at first was out of control and literally uncontrollable since it was scattered across virtually every departmental cost center. Companies' centralized management information systems (MIS) departments were ill-prepared to deal with the tidal wave of support requests involving technologies they'd never been trained in.

"Moore's Law"

Why did the PC have such a sudden impact on business and society? The answer really comes down to the fundamental implications of Moore's Law.

The April 1965 edition of *Electronics* magazine included an article by Gordon Moore. At that time, Moore was at Fairchild Semiconductor, but later he would be one of the cofounders of Intel. Within the article were the basic points that later would be codified as Moore's Law—the observation that every year or so chip density (roughly equivalent to processing power) doubles while the price shrinks by half. Although the microprocessor wouldn't be invented until the next decade, Moore's Law became most meaningful in terms of the cost and availability of computing power.[31]

In 1965, there were very few computers and they could be used only to perform very valuable tasks. However, the continuous doubling of power and halving of costs meant that, by the early 1980s, it was economically viable for companies to move computing power out of the carefully managed data center and onto the desktops of average white-collar workers. The trend hasn't stopped, so today computing

power exceeding that found in multimillion-dollar computers in the 1960s can now be included in cheap toys and everyday items.

The financial benefit of using this available power drove the rapid adoption of the PC by businesses and the embedding of computing power throughout society.

FROM THE REAL WORLD

Propaganda and Censorship

Throughout history, communications technologies have been powerfully used to bring about dramatic change in society.

As noted in this chapter, the Protestant Reformation is an excellent case in point—using the new power of the press to redraw the political boundaries across Europe, to reduce the power of the Church in society, and to encourage literacy and education. In today's terminology, we would probably call the reformers' use of rapid distribution of printed arguments ''propaganda.''

As can be expected, the Church in Rome (what today we call the Roman Catholic Church) was not pleased with the reformers' success in using the printing press as a tool to weaken their power. In fact, early in the history of the press, the Church attempted to gain control of the new technology, limiting the number of presses created and establishing editorial control over what would be produced. In 1487, Pope Innocent VIII commanded that all books had to be reviewed and approved by Church authorities before they could be printed.[32] Obviously, the rapid spread of printing and the relative ease with which new presses could be built, foiled those attempts at what we would today call ''censorship.''

Such uses and concerns over the power of communications technology did not begin with, nor have they ended with, the printing press. Going all the way back to the invention of writing, as great a thinker as Plato was philosophically opposed to the use of writing

From the Real World (continued)

technology. Ong notes ''one weakness in Plato's position was that, to make his objections effective, he put them into writing, just as one weakness in anti-print positions is that their proponents, to make their objections more effective, put the objections into print.''[33]

Controlling the impact of writing eventually proved relatively effective due to the inefficiency of reproducing manuscripts. In fact, the Roman Catholic Church successfully censored books for centuries leading up to the Protestant Reformation, so the Church's expectation that it could continue was not baseless.

The real problem that the Church faced with the printing press was that the danger of the technology was recognized, and there were ineffective attempts made to manage that danger, but the power of the press was not recognized. Perhaps, if the Roman Church had been as aggressive as the reformers in capturing the power of the press, its ability to win the hearts and minds of European Christians would not have been so badly compromised.

Since the printing press, virtually every communications technology has been similarly used for propaganda purposes and has attempted to be censored. As I write this, the current debate centers on what some call ''The Great Firewall of China.'' The government of the People's Republic of China recognizes both the power and the danger of today's equivalent of the printing press—the Internet. The government actively uses the Net to promote its positions while actively shutting down the use of the Internet—using technology and persecution—for promotion of opposing views.

Clearly, propaganda and censorship are powerful examples of the interaction of layer ten in the technology stack (politics) with all of the other attributes of new technologies. Politics and power can trump all of the financial, user benefit, and scientific arguments that can ever be made concerning the adoption of any technology.

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