Technology in the Throes of a Paradigm Shift

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Abstract – History tells a story of many of mankind’s exciting creations over the centuries. From prehistoric tool-making thru the Industrial Revolution’s manufacturing developments and into the innovations of the twenty-first century, the way-of-life of our societies has been advanced as a result of some remarkable inventions and discoveries. We now use a term, paradigm shift, to denote many of those profound changes in business or scientific developments. Truly, we have entered the new millennium with many radically changing ways of conducting our affairs. Most of these have occurred because of technological advances in computing and communications. The global economy is demanding that we respond with new ideas to address this ever-increasing, developmental demand. In response, changes are occurring in the business models for how software is being produced. Terms such as open technology development (OTD), collaborative development, and open source software are entering our technical lexicon to describe new ways of responding to the demands of our future. Educators in engineering and technical fields need to respond by providing graduates with many of these, and other new skills to meet the requirements of this new millennium.

Keywords: paradigm shift, open source software, open technology development, collaborative development

THE IMPACT OF TECHNOLOGY ON CURRENT BUSINESS MODELS

Throughout time, advancements have created many changes in society. When these changes are rapid and groundbreaking, they have dramatic effects on those societies. When we reflect on the historical changes of moving from an agrarian society into the Industrial Revolution, we recognize that many of those developments and inventions were in the areas of manufacturing machinery, electricity, and the internal combustion engines. Later in the nineteenth and twentieth century there were great strides made in transportation and communications. Today, there are other such developments that have altered how our society conducts its affairs. These developments include the many new technical devices that make our lives more productive, comfortable, and enjoyable.

In 1962, Thomas Kuhn [2] wrote the book, The Structure of Scientific Revolution, which popularized the term paradigm shift. Since Kuhn wrote his widely debated book, the term is most often used to describe radically changed, common methods of performing activities in business or science that occur over a short period of time. The events of the Industrial Revolution could be argued as producing a paradigm shift except for the phrase, “short period of time.” What is a short period of time? Does it mean the same today that it did in the eighteenth, nineteenth, and early twentieth centuries? Truly, we are in a much faster paced society today. The developments during these earlier time periods have had significant impacts on the business and scientific communities, but can they be termed a paradigm shift using our definition?

Developments in the Last 50 Years

Coming out of World War II, the economies of Japan, and most of Europe, were in a miserable condition. During this era, Dr. W. Edward Deming and Mr. Joseph Juran were writing and studying how management techniques could improve manufactured products. American manufacturers did not believe that they needed any help from people such as Dr. Deming. These manufacturers were justly proud of how they had been able to defeat the world using the strength of their manufacturing capabilities. They did not believe that they needed any academic types

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telling them how to succeed in the manufacturing business. In the 1950’s Dr. Deming and Mr. Juran, went to Japan and presented their ideas for improving the quality of products. In Japan, they found businessmen that understood the principles that they were teaching and saw the opportunity to create an economy based on quality products. Most Japanese credit Dr. Deming and Mr. Juran with helping to return their country to the status of a major world power.

Japanese products that were manufactured during the early years after World War II were the laughing stock of the world. The term “Made in Japan” meant that the goods were cheap and of poor quality. The impact of the work of Deming and Juran soon brought new products such as motorcycles and electronics to the American shores. The Japanese motorcycles were very successful and they quickly transformed our motorcycle community. Sony electronic products were quickly recognized for their quality. Before long, other Japanese electronics manufacturers became very competitive in the U. S. as Americans embraced these new electronic items. Soon the Japanese began shipping automobiles to the American shores. Automobile manufacturers, such as Honda, Datsun (now known as Nissan) and Toyota, began building a strong foothold in the U. S. with their reputation for quality. Today the work of Deming and Juran is highly respected by Japanese and American businessmen.

It can be argued that the marketing of Japanese products in the 1960’s and 1970’s was the beginning of the Global Economy. Because of today’s Global Economy, many manufacturers are forced to deal with smaller profit margins, shorter timeframes to get their products to the marketplace, and a shorter lifecycle for products. Society is now expecting the latest and the greatest features in all of our technical gizmos. Many of today’s current products, such as IPods and cell phones, are supported by embedded software. The global marketplace is requiring quicker development and production as well as more reliable and cheaper products. The pressure is on to innovate and quickly produce a range of new products and services.

Prior to the mid 1990’s, the economy of the United States progressed within a predictable growth range, but during the mid to late 1990’s sustainable changes in growth began occurring. Stiroh [Stiroh, 4] has reported that IT intensive industries began to experience significantly larger productivity gains than other industries. For many years, economists were expecting economic gains from the innovations of the computer, electronics, and chemical fields. This productivity rate increase did not occur until the late 1990’s despite widespread innovations during the three previous decades.

During the mid 1990’s most of the civilized world’s societies entered a phase where Internet use was becoming an even-present activity. Discussions about the “information superhighway” were common on television, newspapers, and magazines. Was it just a fad or did it have potential for improving lifestyles? The news often included stories about the latest Internet company that was going to be the next Microsoft. The sale of computers and computer services were skyrocketing. Suddenly there was trouble on the horizon. Many of the high flying Internet stocks were oversold. Questions were being raised about whether many of these companies, such as Yahoo, Cisco, and Netscape, to mention a few, could deliver value to their stockholders. We entered a period that has become known as the Internet bust.

A Paradigm Shift

At the same time as the Internet bust, we were entering a paradigm shift in how business was being conducted. How can we have a paradigm shift begin during the late 1990’s when we were in the midst of an Internet bust on the stock market? Was the beginning of this paradigm shift somehow outside of the realm of these technical industries? The answer to the second question is emphatically no. This paradigm shift is a change in the way that businesses were defining how they were going to provide their products and sales. Businesses began finding alternatives to luring the customers to their company locations or sending their salesmen out into the field. They were learning to contact customers in new ways. These changes were technologically based. It was quickly recognized by Wall Street that the Internet bust was not a pronouncement that the Internet had a limited future but rather that the stocks were oversold for the short term. This period allowed for a quick portfolio cleansing and some quick adjustments in how to make the Internet profitable. The marketplace was learning how to provide products and services via the Internet. The buildup of Internet activity prior to the Internet bust produced a critical mass that supported the on-coming activities. Now there were a lot of people with technology equipment in their homes. The number of homes with multiple computers, home networking, and broadband was on the rise. The number of small
businesses with IT operations was rising. The populace had an increasing number of technologically savvy people. Even grandma and grandpa were staying in touch with their grandchildren via email. This activity provided the fuel for rapid changes in the way business was conducted. More and more people were moving out of brick and mortar facilities and setting up shop in their homes or adding an “Internet backdoor” to their small business. Through the use of broadband services, entrepreneurs could create and manage a web site, create and manage an e-commerce web site, use an e-fax service, and use IP phones for low-cost communications. Entrepreneurs could be their own computer and telecommunication department right from their bedrooms or offices.

Just as important was what was happening in brick and mortar businesses. Professionals had already stopped writing drafts for their secretaries to transcribe. They now answer their own phones (or use voice mail), they write their own communications, and they use email to quickly stay in touch with business associates and customers. With the exception of upper management, a layer of support in business operations had been reduced in the last 10 to 15 years. The confluence of new technologies has also changed the way that businesses communicate internally and externally. The use of cell phones, WiFi, broadband, Blackberries, and the Internet has created expanded capabilities to stay in touch from anywhere. Business and sales people can be in contact virtually anywhere and anytime. No longer is business only conducted during the 8 to 10 hour workday. For many professionals, work is conducted via the new smart communications devices from their cars, at lunch, on the golf course, and after normal business hours. Email contact with colleagues or customers can now occur at the airport, in the hotel, or by the pool. This allows documents from the office to be carried on laptops, or downloaded from the company’s web site, and then updated and transmitted as needed while on the go.


- U. S. adults that used the web for News, Weather, and Sports
  - 7% in 1997
  - 40% in 2003
- U. S. adults that used the web to purchase products and services
  - 2% in 1997
  - 33% in 2003
- 31% of families with income less than $25,000 had access to the Internet.
- Email activity exploded between 1997 and 2003

The *Houston Chronicle* [1] also reports that Internet advertisement sales have increased 34% to a record $3.1 billion in the third quarter of 2005. It is also reporting that in 2006, advertisement revenue from the Internet is expected to be over 5.4% of the total advertisement spending. Businesses have quickly realized that they can reach a wider audience via the Internet, cheaper and more quickly. The traveling salesman has become less prevalent today than prior to the 1990’s. Even small businesses are being pressured into having a web presence. Financial institutions, real estate companies, directories, and EBay make up a short list of where consumers are finding products and services on the web.

These developments point to a common theme led by the Internet: high tech industry appears to be entering a vibrant, new phase of growth, upheaval, and innovation. The Web will continue to challenge traditional industries from Publishing to Telecommunications to develop new business models. The Paradigm Shift that has occurred is the change in the business models being used today to market products and services. We are now in the throes of radically changing events, and they are happening quickly.

Much of today’s business is transacted via some form of smart technology. Most businesses, especially medium to large companies that sell products or provide services, can benefit from an Internet presence. For example, an Internet presence is a must for banks and real estate operations. Brick and mortar companies, like Office Depot,
Best Buy and Wal-Mart sell large volumes of products through their “Internet back door”. Internet users that do not buy products and services on the Internet will often perform product research via the Internet. The most amazing part of the revolution is that it has occurred primarily within the last 10 years and its impact on the way that business is conducted has been taken in stride by consumers. These changes have become like air conditioning, power steering, and TV remotes. Users expect this smart technology to be available anytime and anywhere.

There have been three primary events over the last 20 years that have brought about our increase in productivity. They are: (1) businesses learning to operate with fewer people, (2) businessmen and professionals communicating more quickly and throughout more hours of the day, and (3) companies learning new ways to reach their partners and customers with information, products, and services. Most of this has occurred because of advances in technology, more specifically the Internet and telecommunications. The productivity gains and this paradigm shift are linked.

**Meeting the Needs of a Changing World**

Society is now demanding more consumer goods and businesses are being forced to innovate and produce more. The push of technology in our Global Economy, is forcing adjustments by many in the business world. Not only is the business world adjusting, but the academic world is likewise being forced to respond in new research arenas to provide new developmental methodologies. These methodologies, though radical in some cases, are not rapid enough to be called a paradigm shift themselves. Some hold a promise of being able to respond to our future software production needs.

The U.S. Bureau of Labor Statistics expects Computer Software Engineers to be one of the fastest-growing occupations from 2004 to 2014. There are serious concerns about our ability to provide the quantity and quality of engineers in many fields over the coming decade. When a shortfall in the availability of engineers occurs, new methodologies must emerge.

One of the most promising of new development methodologies is the concept of Open Technology Development (OTD), which refers to a number of practices for current and next-generation software production. These changes enabled by the explosive expansion of the Internet and related technologies allow distributed groups of programmers to collaboratively develop and manage code libraries in a decentralized manner. OTD is based on 1) Open Standards and Interfaces, 2) Open Source Software and designs, and 3) Collaborative and distributed online tools. There is a tendency to think of OTD as simply an Open Source Software initiative. It is that and more. OTD and Open Source Software are a concept whose time has come. There is much debate in the software field about topics such as software flaws and bugs, security risks, poor documentation, and vendor lock-ins. Open Source Software offers an opportunity to solve many of these problems.

Many of the successes of Open Source Software are well documented and known within the professional and academic ranks. UNIX variant developments are probably the best known. According to SourceForge.net, there are over 100,000 publicly available open source projects available, spanning most functional areas. SourceForge.net has over 1,000,000 registered users with access to a centralized resource for managing projects, issues, communications, and source code. It is the largest repository of Open Source code and applications available on the Internet.

A similar organization has recently been established for government environments. The National Center for Open Source Policy and Research (NCOSPR) is a non-profit organization established to promote the use of Open Source Software solutions within government IT enterprise environments. NCOSPR is administered by the Open Source Software Institute (OSSI) and hosted by The University of Southern Mississippi at Stennis Space Center. Just as SourceForge.net is a repository of Open Source Software, NCOSPR serves as a repository and collaborative development environment portal for governmental and public sector entities through GovernmentForge.net. NCOSPR has new initiatives underway to provide applications software for public entities.

Collaborative software development projects seem to be spawning their own cults and are becoming a powerful vehicle for change. How does this work? It involves user-to-user chats, email, bugzilla, RSS, and social software products such as weblogs, wikis, and data tagging. Distributed communities of interest have been
able to form and evolve in response to technical gaps. The resulting set of tools and conventions for agile software development have evolved into robust and well-documented methodologies.

OTD and its Open Source software/standards is not a niche of out-of-work social misfits. It has champions in such mainstream companies as IBM, Computer Science Corp., HP, Sun Microsystems, and Google to mention a few. IBM has committed in a big way with contributions to more than 120 projects. Proponents of the Open Software model usually list the following technical and administrative benefits offered by Open Source:

- virtual elimination of vendor lock-in,
- promotion of interoperability and open standards,
- increased security,
- reduced acquisition costs,
- longer product life cycles,
- increased program manageability,
- flexibility in choosing service providers

A new term, “collaboratory” [5], is being entered into our technical lexicon to represent research centers without walls. Brick and mortar facilities, such as, the Collaborative Software Development Laboratory in the Department of Information and Computer Sciences at the University of Hawaii, are appearing on university campuses. At USM, the topic of OTD is being introduced into the Information Technology’s Project Management course. This is a first step that will be expanded as more experience is gleaned from the locally sponsored NCOSPR. Software engineering and project management courses are excellent environments for introducing these rapidly evolving concepts. These courses can be structured to require not just teamwork but the use of the OTD toolsets for communications. These collaborative projects could offer an opportunity for universities to produce Collaborative Courseware. Perhaps, in the near future, ACM or IEEE may even sponsor Collaborative Development competitions similar to the current ACM Programming Contests.

The concept of collaboration and “open source” is not new. It is why conferences, such as the ASEE SE Section Annual Conference, are held. For centuries, universities and research communities have shared their work. Scientists publish new discoveries in journals. Mathematical formulas are distributed, improved, and redistributed. The scientific process has become one of the most successful areas of human endeavor due to its openness, the free exchange of ideas and the steady accumulation of knowledge available to all [13]. Is the concept of open source software creating another venue for the review of intellectual property?

REFERENCES

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Mr. Walters holds a Masters of Science degree in Computer Science from The University of Arizona. Mr. Walters’ career includes academic and professional appointments. He has experience working at the Johnson Space Center, with secure government contractors, and directing law enforcement database applications development. His interests are in programming, applications design, and project management. Most of his recent work has been with database applications.