The impact of Information Technology on Society and Business

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Abstract

Developments in information and communication technologies have had a significant impact on society and business. There is currently a revolution taking place based on information and communication technology. This revolution has not yet reached its climax but examining the trends in areas such as medicine, education, business and financial transactions, manufacturing, warfare, law enforcement and social networks shows there are patterns and themes that provide some insight as to the fourth wave of change for society and business. Information and communication technology is moving from information processing to knowledge processing as objects become smarter and virtualism and telepresence impact individual, group and organizational behaviors in conjunction with DWIM (Do What I Mean), Just-In-Time-Information (JIT), and location awareness. The Fourth Wave will be the Age of the Intelligent Agent as software agents perform thinking tasks for humans and businesses.

Keywords: Information and communication Technology, Society, DWIM (Do What I Mean), Just-In-Time-Information (JIT), Smart object, Location awareness

1. Introduction

The last 50 years have seen tremendous developments in communication and information technology and as part of those developments society and businesses have been dramatically impacted[2, 9]. In his book "The Third Wave", Alvin Toffler[14] described three waves of change. The first wave was the transition from a society of hunters and gatherers to an agricultural society where food was cultivated and animals domesticated under the control of humans. The second wave was the development of a power driven industrial society characterized by the mass

production of commodities. This is known as the industrial revolution. The third wave was the technological wave referred to as the post industrial society and also known as the information age. We are currently in the mist of another technological revolution. The current revolution is based on a combination of computers, telecommunication networks, digital information and intelligent software that allows levels of customization and individualization in the mass production of materials and services[11]. This wave has also resulted in new forms of communication, collaboration, coordination, integration, business processes and social relationships[3, 4]. The impact of these technological advances is the significant changes that have occurred and will continue to occur in society and business on a global basis.

The industrial revolution was based on the application of power technologies such as water power, steam power, the internal combustion engine, and electricity. Other important impacts made by advances in technology are the secondary and tertiary changes that have occurred in society and business. For example, factories and businesses grew in places where transportation such as rivers and roads allowed for the movement of raw materials and finished products. This led to a secondary impact such as the growth of cities. The industrial revolution also had an impact on society by creating a significant middle class. Unionization, specialization, new areas in education and standardization are tertiary impacts of the industrial revolution.For example, advances in technologies such as that of automobiles can be related to a number of secondary and tertiary impacts such as the:

- Growth of new industries such as petroleum
- Growth of the suburbs around cities,
- Mass construction of roads,
- Mass construction of parking areas and structures
- Changing family relationships,
- Compressing space and time for communication and transportation,
- Climate changes due to the proliferation of roads and parking facilities,
- Changes in law enforcement
- Changes in medical care,

- Etc.

The question facing society and business today is “what will be the secondary and tertiary impacts of the current technological revolution? “ Let us examine several critical areas in which communication and information technology has and will continue to have a significant impact and see if we can detect any patterns or themes that might indicate what the “Fourth Wave” of technological change might be based on communication and information technology.

2. Medicine

One of the largest costs to individuals and society is medical care and a large part of that cost is the creation, storage, maintenance, verification and retrieval of medical records. In the near future, it will be possible for an individual to carry his entire medical record on a storage device which will be the size of a credit card. It will also be possible for information sites on the internet to allow medical records to be stored centrally and downloaded on demand by medical personnel using digital certificates to protect the privacy of the data. The financial impact of a consolidated and standardized system for electronic medical records will have a significant impact on decreasing the cost of creating, storing, maintaining, verifying and retrieving medical records. It will also significantly increase the accuracy of those records over the hand written medical records used today. Communication with a physician has been significantly improved but can be made better. The results of an annual physical, or any tests a patient might be given, can be in their e-mail with analysis and comments before they get home from the doctor’s office. Prescriptions are sent to the pharmacy before a patient leaves the doctor’s office and the pharmacy electronically notifies the patient when it is ready or delivers it to the patient’s home. Likewise, databases of prescription interactions ensure safe prescriptions. Computer programs to detect cancer cells on slides of tissue reduce false positives and software that diagnosis patient diseases based on the results of test data, symptoms and medical history increase the probability of an accurate diagnosis. Robotic controlled surgical instruments are being used

to perform operations under the control of a surgeon which reduces the errors associated with surgery and reduces the length of hospital stays. Doctor visits to check a patient's blood pressure are eliminated by use of a $20.00 device used at home. A blood pressure monitor will communicate the results without human intervention based on a wristwatch type sensor on the patient's arm. Digital imaging has increased the capability of detecting tumors and other deformities which increase the early detection and treatment of diseases decreasing future costs associated with the treatment of advanced stages of the disease.

Medicine also provides an interesting environment for software agents in the ever expanding development of the digital infrastructure that can support software agents. Physicians interact with data about patients frequently and on a continuous basis. When a physician is dealing with a patient referred by another physician, he or she has to make a decision about whether to trust test results in the patient's record. Frequently, these tests results have metadata associated with them indicating who did the test, when the test was performed, what the make and model of the test machine was, when it was last serviced, what the conditions were that caused the test to be performed, etc. A physician can retrieve and read this data, but this is a time-consuming task which detracts from the care of other patients. But the test results could be processed by a software agent working for the doctor to determine if the test results met the doctor's standards for this patient's situation. The software agent would have three important functions. Initially, it would construct a database of decisions made by the doctor that would guide its decision about the validity of new test results. The second function would be a processing component that would compare new test results with the physician's database of past decisions for evaluating the test results and the third component would be a physician friendly interface that would show the tests that exist and the agent's recommendations[13]. Information technologies are also impacting medicine in the area of Brain Computer Interfaces (BCI) which is helping people see,

hear, walk and use hands and arms after a serious injury. The impact of information technology in medicine is not only the significant advances in healthcare quality but the potential to significantly reduce the cost of medical care

3.Education

Next to the cost of medical care, education is the largest single cost that many nations face for individuals and as a nation. Access to educational media such as the telephone, television, radio, computers and the internet is absorbing a significantly larger portion of discretionary income in many countries. Information technology is in its infancy in terms of its use for teaching and learning. Human computer interaction in primary education (grades 1 – 8) has become very individualized and interactive. Researchers have been building a model of the learner that helps to determine what needs to be done to individualize the learning process by individualizing the teaching process. Individually prescribed instruction (IPI) has been an area of active research and development in the field of education for nearly 40 years. IPI only works if there exists a map of the hierarchy of skills that lead to desired learning goals. This map provides a roadmap of the skills that need to be taught. A model of the learner has been developed that helps to determine what needs to be done to help a student learn effectively and efficiently. Information technology is being used to gather information about students and their performance. It gathers information about students such as:

- Do they need more background fundamentals?
- Do they need more and/or simpler examples?
- Do they respond best to auditory, visual, written presentations or a combination of these?
- Did they understand the initial example problems?
- Do they need more practice?
- Etc.

With a model of the learner and a model of the subject matter, it is possible to adapt the instruction to the individual student[8]. With the large amount of data collected from many users on the web, models of different kinds of

learners are being constructed. In the future, teachers will assume the role as coaches, mentors and managers and more of the direct instruction (teaching) will be moved to computer systems using models of the subjects and the students. Information technology also allows for the sharing of teacher expertise across time and distance so that the highly successful teacher can share their experience with other teachers as well as directly with students. Home schooling which is quite popular in the US can be improved by access to lessons developed by experts. The use of web cameras allows a telepresencewith other students as well as a teacher.

In some areas, higher education is most appropriate at a time in people's lives when they are changing jobs and need new skills. Believing that a first professional degree in any area will serve well for a lifetime of work is not realistic. In fact, some business schools require some amount of time in the workforce before admitting people to their graduate programs. As a result, there is a significant increase in the number of online professional graduate education programs. They are constructed in such a way that they make it possible for a part-time student who is working full time to be able to complete advanced study. Today, higher education institutions are experimenting with online courses made possible by the high speed network and the ability to easily capture and combine video and audio in an integrated stream.

E-education is not simply be about the use of technology, but about improving education via technology. It should be a better product produced more cost-effectively and delivered at a lower cost. Thus, information technology should be able to provide effective online education that is better, easier, faster, and less costly for both faculty and students. It should open new markets, or dramatically improve customer satisfaction. In order to effectively use information technology in education there are three things education is supposed to provide? Its first task is the transfer of knowledge and skills in a combined literary and oral format. The second task is to provide the learner with an opportunity to demonstrate what they have learned and give them feedback from someone qualified to assess

their performance. The third task is to provide certification that an individual has a certain level of knowledge and skills.

On-line courses will use computer programs and expanded student records to construct personalized materials for each student enrolled. Course associates will work to continually adjust courses to the particular needs and learning difficulties of the enrolled students. The impact is that students get a better education and the cost of education can be reduced because there will be a reduced need for buildings, teachers, support staff, student transportation, printed materials and it will dramatically change the role of both teachers and parents in the role they play in their child's education.

4.Business and Financial Transactions

Banking typically required a visit to the bank to perform financial transactions such as deposits or to write a check to pay for goods and services. These can all be done on-line with the result that:

- Transactions can be done anytime and at any place
- Banks need fewer cashiers and locations reducing their costs

In the last few years, incentives have been offered by many financial institutions to shift from hard copy to digital documents. In 2011, financial institutions began to make physical documents a cost item. Post-industrial societies are increasingly involved in the exchange, buying, and selling of information and ideas rather than commodities. Electronic commerce or e-commerce is the electronic exchange of information as well as the support for the exchange of other commodities (p-commerce). Some e-commerce companies – eBay, E*TRADE, Amazon, etc.—are engaged in the exchange of information. EBay, an auction house, is only involved in the buy and sell decisions, not the exchange of the physical entities; therefore it is an example of pure e-commerce. E*TRADE which provides for the buying and selling of stocks is also an example of a pure e-commerce organization. However, for most businesses, some portion of the exchange involves physical items. Amazon.com has an obligation and responsibility for physical storage and

shipping, as well as for managing returned items. Amazon.com can be viewed as equally divided between e-commerce and p-commerce. The trend appears to be that more pure e-commerce businesses will develop in the coming years[1]. Publishers of music, video and text are moving to electronic sales and distribution in a pure e-commerce mode.

The term e-business relates to business operations and associated functions[6]. An e-business may or may not be involved in e-commerce. E-business means that the business itself, the organization, is involved in the electronic processing of digital information to operate the various business functions. An e-business is an enterprise working via electronic means and many aspects of the business are being performed using information and communication technologies. The following business activities are ones that can be performed in electronic form.

- Recruiting of new employees
- Marketing, advertising and public relations
- Customer support and education
- Meetings and information resource sharing among employees
- Training of employees
- Intelligence gathering for strategic and tactical business planning
- Distributed inventory control functions
- Payroll and benefits management
- Finance

Many business functions that were performed by people are now being performed by computer programs. This includes:

- Accounting functions (Accounts Receivable, Accounts Payable, etc.)
- Order Taking
- Inventory Control
- Supply Change Management
- Customer Relations Management
- Marketing and Advertising
- Human Resources

The impact of e-commerce and e-business is the need for fewer employees, employees with different skill sets, and a cost savings for the company but it also involves an increased work load, responsibility and skill sets for the customer.

Manufacturing

Robotic devices, sensors, numerically controlled machines and laser technology are

used to manufacture raw materials such as steel and aluminum as well as finished products such as cars, appliances, food products, clothing, plastics and others. The nineteenth and twentieth centuries experienced the rapid development of mass production technologies. The use of design tools such as AutoCAD, numerically controlled machines, just in time Inventory (JIT), robotics and scheduling tools have reduced cost and time for manufacturing companies. The current state of manufacturing technology, using computer controls and sensory technology, allows for mass customization. Customer centric businesses, such as Dell Computers, that have a commitment to the "pull" approach also lead in customization. Whether it's an individually designed personal computer or custom jeans, many businesses make products that are manufactured in such a way that customization is possible. Arrays of companies provide simple forms of mass customization – such as photos printed on tee-shirts and coffee mugs. Others provide small batch production – energy bars, chocolate, and pet food. Still others provide custom jewelry, shirts, and shoes.

The impact of information technology on manufacturing is the need for fewer people on assembly lines, on telephones, and in mail rooms and more people with computer skills as well as higher quality and highly customized products.

Warfare and Law Enforcement

There have already been numerous changes in the complexion of the battlefield and law enforcement area. The global positioning system (GIS) was developed by the US Department of Defense in the 1970's and became operational in 1994. It allows for the precise location and navigation of weapons systems, vehicles and personnel. Many of the weapons and surveillance systems currently in operation arose out of the GIS program. This GIS program in conjunction with computer software has led to unmanned aerial drones and various robotic ground vehicles. The ground soldier now has a heads up digital displays that provides friend or foe identification and support for

different vision modes as well as an integrated digital communication system. Uniforms are advanced with better personal armor and science fiction like exoskeletons. Soldiers are kept comfortable with cooling and heating sensor systems embedded in their clothing with extensive sensor systems providing feedback on their health.

Law enforcement uses digital cameras to enforce traffic laws, detect criminal behavior and identify criminals with face recognition technology. Laboratory technologies aid in determining crime scene forensic evidence and national DNA databases uniquely identify an individual who has left the smallest of physical evidence at a crime scene. Computers and digital cameras in police cars provide information to officers about vehicles, people, firearms, and other physical objects as well as crime scene activities and behaviors.

The impact of information technology on warfare is the loss of fewer lives and improved tactical maneuvers. For law enforcement, the impact has been an increase in crime prevention as well as an increase in catching and prosecuting criminals. A side benefit has been that a few individuals falsely convicted of crimes have been freed because of the DNA technology.

Social Networking

Communication and social interaction have changed because of social networking sites like Facebook and Twitter. New social groups have formed on an international basis because sharing of multimedia information and knowledge on a global basis is possible via the internet and satellite technologies. New forms of coordination have become possible which have led to political upheavals and new forms of political processes. Such technology can have a negative impact such as revealing personal information that can lead to criminal activities. The way people perceive the world and people's actions are changing due to social networking[12]. There is some evidence that children who spend 3-4 hours per day using social networking technologies can not focus on problem solving tasks as well as those who do not use social networking. This age of immediacy has left people with little

patience and a different work ethic than previous generations. People – to – People relationships are changing due to a lack of face-to-face communications. In this merging age of immediacy, it is likely that the next big development will emerge out of these significant trends.

Virtualism and Telepresence

Two aspects of the current technology that will induce secondary change in society are virtualism and telepresence. Virtualism includes virtual organizations, virtual social groups, virtual networks, virtual machines, etc. It is possible that organizations can be composed of ad hoc sets of individuals gathered to form a virtual organization. Today, organizations need to maintain employees with specialized talents as whole units such as departments, whether or not their talents are needed on a continuous basis. Future organizations will find it more cost-effective to retain access to individual specialists who will share their talents across multiple organizations. The organizational model will look similar to the accounting model where the relationships for specialized services are stable, but purchased on a service basis rather than employed full time. These jobs will represent a form of outsourcing, but with the intent of long term "when required" relationships. With these kinds of employee relationships, it will not be necessary for people to live near where they work. Most organizational meetings will move to virtual forms. Virtual organizations will make use of communications technologies to run meetings where it is an acceptable substitute for face to face meetings. If a classroom lecture can be considered as a meeting then colleges and universities which provide access to lectures online are using virtual meetings as a new form of educational opportunity.

The use of texting, email, instant messaging, posts, blogs, Skype, and similar communication technologies have made a physical presence unnecessary but it is well known that face to face communications are critical for getting the full meaning of a communication message. There are varying levels of presence and we pay differential amounts for different levels of presence.

For example, for one thousand dollars I can travel from my home to New York City, rent a room for a night, and purchase tickets to an original Broadway show. For about a tenth of that, I can buy tickets for the traveling cast of that show at a local stage. For a tenth of that, I could go to a movie theater and share the experience of a telepresence view of that show with other movie goers, and for a tenth of that – about one dollar, I could rent the DVD from Netflix streamed to my home for personal viewing[13]. This and other communication techniques will allow for new forms of presence in many types of activities.

From Information Processing to Knowledge Processing

Language and the written word are supplements to human memory. Spoken language limited humans to being able to store and transmit information that could be memorized and transferred from human memory to human memory. Spoken language is subject to significant transmission errors and storage errors. Writing allowed a tremendous increase in our ability to extend memory and store information with fewer errors. Printing technology was a quantum leap in our ability to store and disseminate information. Telecommunications and computers have provided a "digital information infrastructure" which is an exponential step forward in the ability to capture, store, and disseminate both symbolic messages as well as non symbolic, sensory data.

How will this new "digital information infrastructure" impact our ability to accumulate, manipulate, record, integrate and disseminate information. There are indications that digital information is not only supplementing human memory but human thinking as well[5, 7]. Very early written records simply codified facts – Jim Williams has 14 acres of land. It was not long before processes were also recorded. This was followed by computer programs that executed process steps and algorithms that were previously considered the exclusive domain of human thought processes. For instance, the height of a structure may be calculated by taking a 3/4/5 right triangle and aligning the base with the base of the structure and the

hypotenuse with the top of the structure. The distance from the corner of the triangle to the base of the structure will be 4/3rds of the height of the structure. This can be programmed into a computer system and with the appropriate peripherals can be completely automated so that by simply pointing a camera at the object the calculation will be performed. What is occurring now with communication and information technology is not only storing and retrieving a factual record, but performing the thinking process itself.

In the future these technologies will accumulate knowledge and behavior from individuals and groups of individuals and act as a collective brain[10]. How would a collective brain function for an individual? How is it possible to take the accumulated knowledge of a group of individuals working on a set of closely related problems and make their knowledge accessible over space and time to someone who could benefit from the knowledge? As an example, a soldier on the battle field might access the collective knowledge of military personnel who have fought in situations similar to the one the soldier now finds himself in. Generals from Julius Caesar to Norman Schwarzkopf have provided commentary and analysis of battle field efforts. In the 1970s, the US military began to record after action reviews (AARs). AARs provided a mechanism for the analysis of what was intended, what occurred, why the actual outcomes were different from the planned outcomes and what was learned. We are finding better ways to organize, structure, integrate and use this information and associated knowledge. The knowledge system will identify the relevant information for a problem situation and bring it to the user at the right time in a process. Software assistants (agents) of this type are being built today for various purposes, and after action reviews (AARs) have moved beyond the military and into organizations that are conducting multi level analyses of their activities and developing knowledge management systems[12]. Many people believe that there are three possible advances that will generate another significant technological wave. They are: Do What I Mean (DWIM) technology, Just-In-Time (JIT) Information, and

Location Awareness in conjunction with advanced sensor technology.

DWIM – Do What I Mean.

Profiling human behavior and collaborative intelligence will allow the development of anticipatory analyses techniques that will allow systems to anticipate individual needs. For example, systems will find a vacation trip that an individual really wants to take based on what it knows about the individual based on previous activities, cost factors, income, preferences, family values, etc. and let the individual know where vacation spots exist that meet his or her profile. This same system may provide an individual with a list of contractors after a tornado or hurricane has moved through the area where the individual lives.

Just-In-Time (JIT) information.

Many forms of JIT information will be provided by the global information environment including many forms of sensory information such as video, sound, smell and touch. We will not have to search for information in advance of some activity, systems will emerge that will provide it to us exactly when and where we need it. This kind of information is made more possible by location awareness. For example, when an automobile tire starts to lose air pressure, the system will use the GIS system to locate a gas station or car dealership nearby and inform the driver that the tire is low on pressure and direct the driver to the gas station or repair shop to get it fixed.

Location Awareness.

As cell tower and GPS tracking systems evolve, there will be an increased delivery of information based not only on human profiles but on where the human is and what they are doing. For example, a tourist in Thailand can transmit a smart phone photo of a temple over an internet connection to a site that will use the GIS coordinates to determine what temple was photographed and give the tourist a description and history of the site.

Impacts

The trends of how communication and Information technology in conjunction with

knowledge engineering so far has impacted society and business are:

- Information is immediately available about events and processes
- Computers now perform types of tasks that require intelligence (thinking) that were previously done only by humans
- Social networks assert pressure on individuals, groups of people and governments that can cause social unrest.
- Many types of jobs have become obsolete because computers and networks have pushed the work to the customer or user.
- Customers have to perform more of the work that employees used to perform
- Customers need to have some computer skills

Some simple examples of the impact of information technology in our lives are:

- Today's car connected to the internet is able to deliver information about traffic, lodging, restaurants, gas stations, etc.
- Refrigerators have bar code readers and communications capability to order needed goods.
- Thermostats can sense human usage patterns making adjustments to the thermostat or setting it unnecessary.
- Lights are turned off and on based on motion sensors
- GPS guides you to your destination.
- Educational degrees can be earned without ever attending a classroom
- Meetings can be held without attendees leaving their home

Smart Objects

Objects continue to get "smarter."[13] When a car can park itself, determine a hazardous road condition, or determine that a part is malfunctioning, the device is demonstrating some level of "smartness". The combination of sensors, microprocessors, and actuators is making a lot of devices more intelligent. Smart devices are beginning to appear in homes as well. TVs, VCRs, game consoles and other electronic devices are increasingly smart and self analytic. Hooking up a TV or a VCR to a wireless network takes the input of a few numerical values because most of the process is based on simple assumptions about how a home networking works. Light switches can be installed in rooms that have motion sensors in

them to turn the lights on when someone enter the room and turn it off when several minutes have passed without any motion detected. Outdoor lights go on when night falls and turn off when day light appears. Microwaves ovens sense the steam put out by food as well as other chemicals to determine when food is done. These and other devices will only get smarter in the future. Refrigerators look like they may be the next device to get smarter. They are already good at controlling temperature and monitoring the state of water filters. All of these devices and many others in the home will be likely to build in sensors that detect imminent product failures. They will then make use of wireless networks to send mail to their owner or the vendor.

Communication and awareness are what most distinguish us as humans, and we strive to become more aware and more interconnected with each other.

5. Conclusion

If there is a repeating theme in the history of the evolution of computing, networking, and the web, it is that society will support and encourage the development of the communication and information technology in ways that better enable humans and machines to communicate and increase an awareness of the world and other humans. It is also apparent that society will also support and encourage the development of technology that supplements the human brain not only as a supplement to memory but as a supplement to thinking as well[15]. One of the characteristics of technological revolutions is that it takes many years of experimenting with different forms and uses of the underlying technological components before a situation occurs that causes the evolution to become a revolution. The internet is an example of a technology that had its start as a vision in 1960, was implemented in 1969 but did not become a revolution until the World Wide Web was available in 1992. It took 30 years of experimenting before the WWW revolution took place. The next wave of change will be the development and utilization of intelligent software agents which will profile individual and group behavior and take actions for individuals and groups when such actions are

required but without having to be commanded by a human to take such actions. The experimental stage for the current revolution is occurring but the revolutionary event is yet to come. **The "Age of the Intelligent Agent" will be the fourth wave.**

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