

X-ray Technology

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Emerging technology has the potential to reshape our lives and the world in which we live in. These relentless technologies have been unfolding in different fronts, including advanced genomics, autonomous vehicle, and the internet. Not every emerging technology has the potential to alter the social and business landscape. However, some do have the power to disrupt the status quo, rearrange value pools, and change the way human beings work and live. New technology in medicine has revolutionized the way patients receive care and the way caregivers work. Disruptive technology in the field of medicine has had a significant impact on the traditional method of doing things. One such technology in the field of medicine is the X-ray technology. The invention of the X-ray machine has led to significant growth and efficiency in diagnosing and treating anomalies in one's body (Moore, 2009). The invention of X-ray technology has not only revolutionized the health sector, but also had an impact on jobs, economy, and manufacturers.

X-ray Technology

X-ray rays are a form of electromagnetic radiation that can pass through objects and body. Medical X-rays are similar to visible light. However, they possess high energy and pass through bodies to generate images of structures and images inside the body. The new invention led to the emergence of radiography which is an imaging method that uses X-rays to create a picture of the internal images in the body. To create an image, the part of the body to be imaged is placed between an X-ray detector and X-ray source. The X-ray equipment is turned on, and the rays travel through the body and are immersed in the body organs in different concentration. The rays pass through the body organ and are captured behind the body organs by an X-ray detector.

The X-ray technology brought immense changes in the field of medicine. It gave rise to the Radiology; a medical specialty that led to radiation therapy and other forms of medical imaging technology (Moore, 2009). Before this technology, doctors had to perform surgery to identify any issues in the body. This involved unnecessary and invasive surgery that at times were not helpful. With the invention of the X-ray machine, doctors were able to see the images of the brain, human heart, and other body organs (Borisov & Podberezskaya 2012). This technology was easy to adapt and use since it is less invasive than surgery. It allowed the doctors to perform a noninvasive medical test that diagnoses and treat diseases.

Even though X-ray technology discovery was by accident, it was the basis of ideas and inventions in the field of medicine (Kermeliotis, 2004). The inventions and ideas include the Magnetic resonance Imaging (MRI) scan machine, radiation therapy, digital mammography, ultrasounds, computed tomography scan, and cancer treatment. The use of the X-ray to view different organs in the body allowed for medical investigations and experiments that created a cure for diseases discovered through the use of X-rays (Borisov & Podberezskaya 2012). On a personal level, X-ray technology has increased the lifespan of human beings and other animals. This is attributed to the fact that the technology allowed many untreated and unknown diseases to be contained.

History of X-ray

The X-ray technology was invented in 1895 by a German scientist known as Wilhelm Rontgen. Wilhelm Rontgen accidentally discovered a glowing fluorescent screen while he was experimenting with cathode ray tubes (Röntgen, 1896). During the investigation, Wilhelm Rontgen discovered the cathode rays were hitting the glass tubes leaving an invisible ray. He

later discovered that the invisible ray could penetrate through objects such as wood, aluminum, and copper, and at the same time could travel over long distances compared to other rays (Röntgen, 1896). Wilhelm Rontgen performed his first X-ray on his wife's hands as shown on figure 1 (Woods & Woods, 2006).

Wilhelm Rontgen decided to call the "invisible rays" X which is a mathematical symbol used to denote an unknown symbol. The public and scientists were excited about the discovery of rays that could penetrate the human flesh, making it possible to view the bone structure. In the year 1896, Wilhelm Rontgen wrote about the discovery, which he called a medical miracle. After Wilhelm Rontgen published his findings, tests were carried out, and within eleven months X-rays were used in therapy and diagnosis and became part of medicine. The discovery and exploitation of X-rays won Wilhelm Rontgen a Nobel Prize in 1901. Currently, X-ray technology is not only part of medicine, but also security making it an important part of modern life

Displacement

Before the discovery and use of X-ray technology, treating a patient was more of a guessing game. The doctors could only examine a patient physically, and the patients had to pay for the use of such crude methods. Tumors, broken bones, and bullet locations were diagnosed through guesswork and physical examination (Siraisi, 2009). These methods involved physical examinations as noninvasive as touching the body to identify any injuries, bullets, or tumors to exploratory surgery, which involved cutting the patient and observing with the naked eye for the bullet or broken body part. The exploratory surgery caused pain and infection in the patients.

Patients had to pay the price of unnecessary wounds and treatment if the doctor did not find a bullet or a tumor. The unnecessary wounds, pain, and infection were the price patients had

to pay before the invention of this helpful technology (Woods & Woods, 2006). The existence of diseases and conditions in the body that were hard to detect resulted in the death of many people as most people would go to the hospital only if they had an emergency. This means that one could be suffering from a tumor in the stomach, but since the doctor, through physical examination, could not tell what it is and the harm it may cause, most patients would just stay at home hoping the pain and tumor would die down. The only advantage of this method of treatment was that people were not exposed to harmful X-ray radiation.

After the discovery of X-rays, exploratory surgeries stopped increasing the survival chances of every patient. The X-rays allowed the doctor to see inside the body, helping them figure out the best way to treat a patient. For instance, an X-rays of the chest reveal to the physician whether the patient has serious lung conditions such as lung cancer or Tuberculosis. The X-rays allowed the caregivers to detect and treat any life-threatening conditions early before the patient could show the symptoms. By catching life-threatening diseases early, it resulted in saving millions of lives. Rays passing through the body meant that no guesswork or any exploratory surgery, reducing the chances of infection and pain in the patient's body. Surgery became easier as the physician could identify the right location of a bullet or tumor and make an incision at the exact place (Woods & Woods, 2006). The use of X-rays technology was adopted in most fields of medicine includes dentistry among others.

Impact on Jobs

The discovery and utilization of the X-ray machine led to the creation of many jobs. The usefulness of the invention made it be adopted in the every hospital creating a variety of jobs in the field of medicine. Before X-ray, the radiology department did not exists. After its discovery

and widespread use, every major hospital now has a Radiology department. For a patient to get an image scan of their body, they must seek the services of a radiologist. The radiologist works in the radiology department. The Radiology department is a significant part of the health care system that offers imaging services. Other departments in the hospital depend on the Radiology department for patient images before they can diagnose and treat the patient. The widespread use of X-rays technology created jobs for those working in the Radiology department. The creation of a whole new department in the field of medicine led to the creation of a number of positions such as X-ray technician and radiographer.

Besides, creating a whole new department, the technology created indirect jobs through the expansion of companies manufacturing radiography and X-ray equipment. The widespread use of X-ray in every hospital and other sectors of the economy created a huge demand for the machines. The medical imaging sector provides over a million jobs around the world, from assembly workers to hospital technicians, from glass and metal suppliers to administrators, retail workers, and accountants (Dunham & Associates, 2015). To meet the huge demand, companies such as Phillips, Siemens Healthcare, Hitachi, Toshiba, among others created departments that focus on manufacturing of imaging devices. The company created direct and indirect jobs for thousands working in the department. The manufacturing companies have invested millions of dollars in the manufacture, study, and research and design of manufacturing imaging equipment. One of the most significant impacts of X-ray technology on the society has been the creation of jobs. Millions of job opportunities in the manufacture of imaging devices and specialists working in the Radiology department has created a pool of resources that improved the living standards of those involved directly and indirectly with X-ray technology.

Impact on Economy

The X-ray technology is a significant contributor to the world economy. This technology has the direct impact on the economy and the supplier impact on the economy (Table 1). The X-ray technology has a direct impact on technology through the manufacturing of X-ray technology devices and the corporate activities related to it. The supplier impact on the economy is through suppliers that supply the manufacturing firms with parts such as molds, forms, machinery, parts, tools, and any material required in the manufacture of medical imaging equipment. These companies act as suppliers to the manufacturing firms resulting in millions of dollar transaction between the firms. The vendors also provide services such as transportation services, consulting services, financial services, personnel services, and advertising services. This is through the creation of medical imaging technology that is available in hospitals in every state and worldwide. For instance, in Pennsylvania, there are over 1,340 care facilities and hospitals that use the medical imaging technology (Dunham & Associates, 2015). The hospitals and other medical facilities create a high demand for the medical imaging technology that sustains the medical imaging manufacturing companies around the world.

The result of the direct impact and the supplier impact on the economy is pumping billions of dollars into the economy. A good example is the state of Pennsylvania. Is home to the largest number of medical imaging equipment manufacturing companies, there are over 34 such manufacturing businesses in the state of Pennsylvania that are responsible for generating over \$2.8 billion in the state (Dunham & Associates, 2015). The firms in Pennsylvania are responsible for creating over 4,800 full-time jobs resulting in over \$404 million in revenue (Dunham &

Associates, 2015). This is just one state that reflects on the impact X-ray technology has had on the economy of countries such as China, India, Russia, and others in the world.

Impact on Manufacturers

The invention of X-ray technology did not displace any manufacturers since no existing technology was interrupted or replaced. Wilhelm Rontgen discovered the “invisible rays” in 1895. This period was before any breakthrough was discovered in the medical field, meaning the doctors and other caregivers used traditional and non-mechanical methods in their working procedures. Instead, the discovery did lead to the restructuring of manufacturing firms. In the 1900’s, the X-ray technology was adopted in the main hospitals, creating demand for the X-ray detectors and other equipment. The demand led to manufacturing firms that were set up to manufacture products such as railway cellphone, computers, to create divisions that invested in research and development of medical equipment. For instance, Siemens, the mobile company, created Siemens Healthcare that focused on creating innovation in the healthcare sector and imaging equipment. Instead of displacing manufacturers, the X-ray technology did create new manufacturing companies and encouraged competition and huge investment in the imaging technology, resulting in breakthroughs that have made the diagnosis and treatment easy.

Conclusion

The invention of X-ray technology has not only revolutionized the health sector, but also had an impact on jobs, economy, and manufacturers. Wilhelm Rontgen accidental discovery of “invisible rays” was what the medical profession needed. Before its invention and use, doctors had a hard time diagnosing patients, the use of the feeling around the infected area did not present an accurate picture of what was going on in the patient’s body. However, through

beaming the X-rays on the patient's body parts and recording it on the X-ray detector, physicians were able to tell what is wrong and perform surgeries that were successful. This increased the survival rate of people suffering from life-threatening conditions. Besides, it also affected the job market and the economy. It created the radiology department, which allowed caregivers such as dentists and doctors to perform their job efficiently. The direct impact was through creating jobs for the X-ray technician and radiographer. It creates indirect employment and investments through the manufacturing companies that invested in the manufacture of imaging technology equipment. The jobs in the manufacturing sector and the investment in the manufacturing sector are responsible for pumping billions into the economy. Lastly, it affected manufacturing companies that had to diversify their investments and focus on the healthcare sector.

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Appendix

1. Table 1

Table 1
Summary of Economic Impact of the Medical Imaging Sector in Pennsylvania

Direct Economic Impact	Jobs	Wages	Output
Device Manufacturing	2,712	\$324,719,400	\$1,333,034,800
Hospitals and Medical Facilities	2,121	\$165,557,600	\$324,018,200
Total Direct Impact	4,833	\$490,277,000	\$1,657,053,000
Supplier Economic Impact	3,648	\$271,994,500	\$713,736,300
Induced Economic Impact	3,265	\$161,060,800	\$455,890,300
Total Economic Impact	11,746	\$923,332,300	\$2,826,679,600

2. Figure 1



was developed, it showed an image of the bones in Bertha's hand. That photograph was the first X-ray picture. News about X-rays spread like wildfire. Doctors around the world began using X-rays to see inside the body.

A Window on the Body

X-rays allow doctors to see inside the body—literally. An X-ray of a

Roentgen's first X-ray of his wife Bertha's hand. Bertha's hand bones and wedding rings are visible.