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thesis entitled

Comparison of THE NEW YORK TIMES'S, THE TIME OF LONDON'S, SCIENCE'S AND NATURE'S Coverage of the Birth of Modern Atomic Theory: 1896-1922

presented by

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has been accepted towards fulfillment of the requirements for

Master's degree in Journalism

Major professor

Date August 28, 1992

COMPARISON OF THE NEW YORK TIMES'S, THE TIMES OF LONDON'S, SCIENCE'S AND NATURE'S COVERAGE OF THE BIRTH OF MODERN ATOMIC THEORY: 1896-1922

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

School of Journalism

1992

ABSTRACT

COMPARISON OF THE NEW YORK TIMES'S, THE TIMES OF LONDON'S, SCIENCE'S AND NATURE'S COVERAGE OF THE BIRTH OF MODERN ATOMIC THEORY: 1896-1922

By

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Qualitative and quantitative assessments of the content of early nuclear coverage in The New York Times, The Times of London, Science and Nature showed that the coverage was continuous over time, but the patterns of coverage did vary. The coverage was found to be mostly neutral and positive for all publications, but voices of caution were present from the very beginning. The coverage also broadened and became more comprehensive across time.

The journals often were the first to break new developments in atomic science, but were also seen to cite newspapers as original sources.

The newspapers had broader coverage both in tone and categories presented than did the journals, with Science having the broader coverage of the journals.

Finally, many mentions were found about scientists who were concerned with how they and their work were being received by the public. Some of these concerns were mentioned even before WW-I, in what is historically thought of as a low point in the interaction between science and the public.

ACKNOWLEDGMENTS

I would like to thank Dr. Steve Lacy, for his constant encouragement and help in guiding my work, Dr. Lucinda Davenport, for her aid in brainstorming and formulating the scope and basis of the study, and Dr. Phil Shepard for his critiques and fine editing. I would also like to thank Helen Fordham for her patience and caring.

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CHAPTER ONE

INTRODUCTION

The genesis of the modern science writer can be traced back to the birth of the second scientific revolution at the turn of the 20th century. This was the period in which William Roentgen revealed the mysterious power of his X-rays, and Marie and Pierre Curie told the world about two radioactive elements, which they called polonium and radium. These discoveries, and the ones that followed, rapidly changed how scientists viewed the materials that make up the universe, but this growth in knowledge was not limited to "ivory tower" scientists and scholars.[1]

As knowledge of the atom and its great power grew, through scientists' work with radioactivity and X-rays, more and more of these debates and discoveries were put being put on the front page of the world's newspapers. Writers, philosophers, scientists and doctors alike were caught up in the possibilities of harnessing the atom's great power for areas such as energy supply and medicine. During this period of possibilities, H.G Wells wrote of humanity's having discovered an energy source able to power the way to a scientific utopia, while newspapers and science journals carried debates about the atom's secrets, sometimes in language similar to that of the ancient alchemists. Similar to those before them who had sought to turn lead to gold, scientists such as Frederick Soddy, Ernest Rutherford and Sir William Ramsay wrote of the possibilities that radioactivity could indeed transform one element into another.[2]

These scientists' and others' exploration of the atom's energy, as an agent of healing and power, began in a landscape of gaslit streets devoid of automobiles where communication was primarily by mail and telegraph, but scientific and technological advances were quickly changing this world. Improved technologies relating to the automobile, electricity, telephone and others were giving Europe and North America greater control over their environment as well as shrinking the distances between the continents. Similarly, scientific and technological advances in the laboratory were leading physical scientists to reevaluate their mechanistic views of matter, views cemented during the first scientific revolution of the 17th century.[3]

As the powerful secrets of the atom were slowly being unravelled--to a culture which more and more cast an optimistic and hopeful eye on science and technology--newspapers and magazines increasingly began to publish stories about these and other scientific discoveries. The media that covered these revolutionary events were themselves in a state of transition, as they began to leave behind the years of yellow journalism, where sensationalism had been prized more than objectivity.[4]

The purpose of this study is to assess the images presented in the print media concerning atomic science during this era of transition for both science and journalism. Media accounts of how radium rays cured a cancerous tumor carry a much different image and impression than tales of an X-ray physician's hands being amputated because of radiation induced tumors. While images do not necessarily create public opinion, they do make up tints in the social canvas. Studying how selected publications covered the emergence of modern atomic theory around the turn of the century will blow the dust from a few more of the early brush strokes in modern culture's canvas--which paradoxically depicts the unleashed power of the atom as being both savior and slayer--a depiction that ultimately affects current views of the role of science and technology in society.[5]

To assess the images presented in selected publications, the study will measure the balance and pattern of media coverage concerning modern atomic theory during this period. The balance of science coverage will be analyzed in terms of the number of stories, categories of stories, story tone and sources used to construct the story. These quantifiable factors of balance will be supplemented with qualitative analysis of the evolution of the language, metaphors and trends presented in this coverage, as well as the historical time frame encompassing early atomic science coverage. All factors will be traced over time to mark changes in the pattern and nature of atomic coverage.

Analyzing the factors in this way will provide a clearer understanding of the images presented about the nature of the atom. The analysis will also consider how the media presented early discoveries in atomic science and technology. Unearthing these early building blocks of science journalism will allow an assessment of the genesis of values that underlie today's science coverage.

The assessment will be accomplished by comparing coverage of the birth of modern atomic theory during the early transitional years from 1896 to 1922 in the United States and England. The content of two elite papers, The New York Times and The Times of London, and two science journals, Nature and Science, will be analyzed.

Eighteen ninety-six was selected as a starting date for the analysis because it was the first year in the selected publications to contain coverage of Roentgen's 1895 discovery of the X-ray--often viewed as the doorway into the inner workings of the atom.

Nineteen twenty-one was chosen as the subjective endpoint because it was the year that Edwin W. Scripp's Science Service began full operation under the editorship of Edwin Slosson. The Service was a press syndicate aimed at translating science plainly so that all Americans might understand. It can be seen as a marker of a change toward a more comprehensive and popular coverage of science, and therefore sets off the preceding years as a period of early growth in the media's coverage of science. Nineteen twentytwo was included in the study solely to see if and how coverage changed after the watershed year of 1921.[6]

Further reasons for supporting 1921 as an endpoint are that it is also the year of Marie Curie's historic visit to America. During her few months here, she received a number of awards and elicited a good deal of interest in radium across the country. Her trip can be seen as a coming together of science across the continents. Finally, 1921 was deemed an appropriate end marker because this study concentrated primarily on the press coverage of non-quantum and non-relativistic topics of nuclear science and technology. Quantum mechanics and relativity were being discussed during this time, but not to the extent that they would later be. The primary interest of this study was the early period of nuclear discoveries, in which there is less detailed communication research than of the discoveries that occurred from the mid-twenties to current times.

Because of this primary interest in early nuclear discoveries the terms "nuclear" and "atomic" are used interchangeably in this study. It is noted though that in their current scientific usage, "nuclear" would deal much more with radiation emitting materials and "atomic" with the elemental and particle function of matter.

To assess this early period, the styles and manner of atomic science coverage for the two papers will also be fully explored and analyzed in terms of their balance and patterns of change. The papers were selected because they were both concerned with high quality coverage, both having made commitments to cover international news during this time, yet they were also in two seemingly different transitional periods in their histories. The New York Times, under new ownership, was thriving while the more established Times of London was experiencing a sort of mid-life crisis. Through quantitative and qualitative analysis the study will compare, The Times of London's science coverage during its fall from grace with that of The New York Times during its rise.

Comparing the data on each newspaper with that on the science journal from its respective country will expand the studies scope by allowing examination of the balance and pattern of images being presented from different types of publications during this period. The period from 1896 to 1922 presents an interesting transitional period of circulation battles, pseudo-journalism, scientists' distrust of journalists and revolutionary scientific discoveries. During this transition the two members of the elite U.S. media to be studied presented the birth of a new science and technology to a burgeoning industrial America, while the two members of England's elite media covered the same revolution for a scientifically and historically more established British society.

Because this study is primarily exploratory in nature and based on content analysis, it cannot provide direct data explaining what governmental, cultural and organizational decisions led to each periodicals' editorial choices about science coverage. It also cannot determine how the media affected the public's attitude toward nuclear technology and science, but it will provide a clearer picture of the types and patterns of images that were presented by the four periodicals across time and the Atlantic.

Historical Perspective

--Newspapers--

At the turn of the century, newspapers like The New York Times, the New York World, and the New York Journal were locked in grand circulation battles, a major part of which consisted of printing sensationalized versions of science or pseudo-science discoveries and events.[7] Pulitzer's World had been printing pseudo-science pieces as early as 1883, but when the yellow journalism wars between the World and Randolph Hearst's Journal began to really heat up in 1892, the quantity of unusual and sensational science stories increased, especially in the papers' Sunday issues.[8]

The newspaper giants continued their no-holds-barred circulation battle on the streets of New York until the First World War, but along the way they did reevaluate their journalistic practices somewhat, especially when the floundering New York Times changed ownership in 1896. According to journalism historian Frank Mott, shortly after Adolph Ochs took over The New York Times in 1896, Pulitzer began to distance himself from the big talking yellow journalism. At the same time, many other papers began to change toward a more investigative style of journalism, called muckracking.[9]

Muckracking picked up where the sensationalism of yellow journalism left off around the turn of the century. Journalism historian Robert Miraldi notes that muckrakers,

> moved freely between conflicting journalistic ideals. On the one hand, their muckraking writing was dramatic, fictionlike and literary, with an emphasis on human interest....On the other hand, the muckrakers were obsessed with dispassionate investigation, with the search for the facts that would inform public opinion....Thus, while the story ideal urged the muckrakers in one direction, fledgling objectivity, pushed the movement in another direction.[10]

This trend of newspaper crusading started to wane around 1910 and eventually ended along with the Progressive era in 1915--the eve of the Great War. The big story during the period just before WW-I was the coverage of the Spanish-American war. The war effort was being lead by Teddy Roosevelt, the same man who had coined the word "muckraker" to air his disregard for the scandal seeking journalists.[11]

Many of the practices of today's newspapers were developed during this period, all in the name of increasing circulation and thus advertisement revenue. In addition to the tried and true coverage of wars and great disasters (such as the 1912 sinking of the Titanic) newspapers increasingly began to use specialists such as sports writers and foreign correspondents. Comics, editorials and columns also came into popularity during this time, along with improvements in printing technology. This era of great change in newspaper history was also marked by the strengthening of labor unions as well as the development of schools to teach the craft of journalism.[12]

The New York Times rode this wave of change high and hard, and emerged at the beginning of the jazz journalism period of the 1920s with a daily circulation of 330,000 and 500,000 on Sunday. But two decades of steady growth didn't allow the paper to rest easy. The Democratic Times entered the 1920s facing new competition from sensational tabloids, such as the newly formed New York Daily News. The brassy tabloids embodied the 1920s, the period of blind-pigs, the Tea Pot Dome Scandal and Mayor Jimmy Walker's laissez faire handling of New York City. By 1929 the Daily News would reach a circulation of 1,320,000.[13]

The New York Times chose to fight the tabloids by continuing its reputation for comprehensive coverage of important domestic and foreign issues. Some of this coverage focused on scientific discoveries and technological developments. Since its early days, The New York Times had always focused more coverage on science than any other New York paper. Just nine years after it began, the paper had given broad coverage to the 1860 meeting of the American Scientists Association and later that year included a long piece on Charles Darwin's "The Origin of Species."[14]

This tradition of science coverage stayed with the paper after Och's purchase at the turn of the century. Meyer Berger states in his book Story of The New York Times that The New

York Times's managing editor Carr Vattel Van Anda and E.W. Scripps of the Scripps Howard newspaper chain,

> were the first modern editors to recognize the value of science news, and were the first to give it any considerable newspaper space. Before they put qualified reporters on the science beat, the man in the laboratory shied away from the daily journal. Scientists had been hurt too often by clownish reporters who sought to amuse readers by treating scientific discoveries lightly, when they noticed them at all.[15]

Van Anda was instrumental in The New York Times's coverage of the Royal Astronomical Society's testing of Einstein's theories in 1919--a story that The Times of London gave only brief coverage, because it thought it to be too difficult for the average reader. Van Anda also sent reporter Alva Johnston to cover the 1922 meeting of the Association for the Advancement of Science. There Johnston wrote stories about evolutionary theory, Einstein's quantum theory and Rutherford's smashing of the atom with alpha particles. Later that year, Johnston won the Pulitzer Prize for his excellent coverage; the AAAS meetings have been covered by great newspapers ever since.[16]

The New York Times's science journalism innovations continued in 1927 when Och's hired Waldemar Kaempffert as science specialist and science editorialist. Berger wrote that "Kaempffert was probably the first man on any newspaper editorial board anywhere to devote himself exclusively to this subject."[17] He was joined in 1930 by William L. Laurence, a reporter exclusively of science, who would eventually take over the beat covering the Manhattan Project and the testing of the atomic bomb.[18]

To further The New York Times's science coverage, Van Anda sometimes formed partnerships with papers across the Atlantic. He was responsible for developing his paper's partnership with the historic Times of London in 1922 to get exclusive North American coverage of the unearthing of Tutankhamen's tomb in the Valley of the Kings. In the deal The New York Times got the sole rights from The Times of London to all future Tutankhamen stories in New York as well as the distribution rights to all other North American papers interested in the story.[19]

Like The New York Times, The Times of London also treated the uncovering of the tomb as a big science story. The story occurred shortly after the paper had changed ownership, recently having been purchased from Lady Northcliffe by the Astor family, after a long ordeal following the death of her husband. The Tutankhamen story and other exploration stories highlighted the London paper's coverage during the decade of the 1920s, which was a period of renewed stability for the elite paper after the rocky transition following the death of its influential owner, Lord Alfred Harmsworth Northcliffe, in 1922.[20]

Northcliffe had bought the Times of London in 1908, while it was rebounding from a low circulation of 32,000 in 1904, down from 62,000 in 1877. This earlier decline of The Times of London up to the turn of the century had been due in part to the arrival of a popular press in England, aimed at the lower middle classes, combined with changing tax laws and poor management. (In contrast, during this same period, a rejuvenated New York Times climbed in circulation from 9,000 in 1896 to over 100,000 by 1901.)[21]

After his purchase of the paper, Northcliffe was widely credited with saving the paper from failure by, among other things, cutting its cost to 1d (1 shilling or about one U.S. penny) in 1914. He was also instrumental in reshaping the paper in 1919-22 by adding modern elements such as photography and the picture page, changes the paper had previously resisted.[22]

Change not limited to Newspapers

While The Times of London was experiencing a decline from glory, and while Ochs was attempting to print "All The News That's Fit to Print," radical changes were also going on in the world of atomic physics and other sciences. To keep up with these changes the institution's of science were growing both in Europe and America. Just as The New York Times's circulation jumped during this period, membership in the American Association for the Advancement of Science climbed from 1,925 in 1900 to more than 8,000 by 1914.[23]

The AAAS was founded in 1848 based on its older counterpart in England, the British Association for the Advancement of Science, established in 1831. One sign of the upstart AAAS's transition and growth during this period, was the inauguration of the scientific journal Science in 1883.

It was to be the U.S. competitor of the premier British science journal Nature, begun in 1869 by Sir Norman Lockyer.

Nature, in stark contrast with its newspaper counterpart The Times of London, entered the 20th century as the "leading international weekly scientific periodical" and the "the main vehicle for the prompt publication of recent advances in science."[24] Lockyer used his journal to awaken a sleeping, colonial Britain on the brink of decline into "increased endowments of higher education and research and the utilization of scientific methods in all branches of administration equal to those at the disposal of competing nations."[25]

Like Nature, the BAAS was also undergoing functional changes during this time. It was beginning to take on more of a role of science popularizer, in order to maintain its place in a world of increasingly specialized science societies.[26]

While the media and science societies transformed to keep up with the changing times, the English empire was at a watershed point in its history. Under Victoria, the empire had recently added 2,500,000 square miles of new territory. Still, while poised at the edge of a changing world marketplace, England remained a leader in world politics and world science, though it often shared the glory of scientific discovery with France and Germany. As the colonial empire adjusted to its changing role during this time, British scientists such as Lord Kelvin (1824-1907), Sir William

Crookes (1832-1919), Sir William Ramsay (1852-1916) and J.J. Thomson (1856-1940) led the empire's exploration of the intricate world of the atom.[27]

CHAPTER ONE

NOTES

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CHAPTER TWO

EARLY HISTORY OF MODERN ATOMIC THEORY

Before Roentgen's 1895 discovery of the X-ray and the subsequent discoveries of the electron, the Zeeman effect, and radioactivity, the atom was generally perceived by scientists to be an indestructible ball supported in an unknown force called the ether. Everything from atoms to planets were believed to operate either magnetically, electrically, gravitationally or like light. Much of the framework for studying the nature of matter still followed the mechanistic rules set down more than two centuries before by Isaac Newton. Consequently, much of the research in the last half of the nineteenth century had dealt with measurable phenomena such as discovering atomic weights and molecular formulas, not with determining the make up of the atom. During this time, the existence of the divisible atom was still doubted by many competent physicists, most of whom felt that the universe's main mysteries had already been satisfactorily solved.[1]

A statement made in 1894 by Albert Michelson, an American physicist famous for his work in precision measurements, reflected this commonly held belief that all major discoveries in physics had already been accomplished.

> While it is never safe to affirm that the future of Physical Science has no marvels in store even more astonishing than those of the past, it seems probable that most of the grand underlying principles have been firmly established, and that further advances are to be sought chiefly in the rigorous applications of these principles to all the phenomena which come under our notice....An eminent physicist has remarked that the future truths of Physical Science are to be looked for in the sixth place of decimals.[2]

Roentgen's X-rays and the discoveries which followed were to radically change Michelson's vision of the future of physical science--along with the vision of many others. Much of this change in thought would center around understanding such natural phenomena as the nature of light. Throughout the centuries since Sir Isaac Newton, the debate had raged whether light was wave or particle. In late nineteenth century, it was determined that light traveled as a transversal wave (its oscillations perpendicular to the direction traveled). Etienne Louis Malus and Michelson among others experimented with the nature of light waves through out the century, but at the same time experiments into the nature of particles had not been all together forgotten.[3]

In 1894 Pieter Zeeman and Hendrik Antoon Lorentz proved, through the use of a diffraction grating, that light was emitted by charged particles moving in the atom. Then on November 8, 1895, Wilhelm Conrad Roentgen expanded physical science's knowledge of particles and light even further, when he realized that his powerful cathode ray tube emitted "new rays" from the point where the particle rays struck the wall of the glass tube. These new rays could pass through the flesh of the hand making an image of its bones on a photographic plate. His discovery raised excitement all over the world, and because of it, Roentgen ultimately received the first Noble Prize for physics in 1902.[4]

Roentgen accomplished his discovery using a cathode ray tube, which is an evacuated glass tube through which a negatively charged cathode emits cathode rays. The rays travel through the tube's vacuum hitting the opposite side of the tube, making it luminous. At the time, the same old debate raged whether cathode rays were particles or waves.[5]

By March of 1896 Henri Becquerel, working with uranium to explore the relationships between phosphorescence and X-rays, discovered that uranium emitted radiation that could blacken photographic plates in the same manner as X-rays. Shortly after this, in 1897, J.J. Thomson proved that cathode rays were uniform and carried a negative charge. He had discovered that cathode rays were indeed particles, which we now call electrons, but his discoveries were over-shadowed somewhat by the work of a pair of French scientists.[6]

Marie and Pierre Curie took Becquerel's radiation work with uranium a giant step forward by isolating the radiation producing elements found in ore and pitchblende. Marie named the two radiation emitting elements polonium and radium; she then developed the term "radioactive" to describe elements with this characteristic. The Curies quickly found that radioactive matter disappeared spontaneously, reducing itself to one half in a characteristic time they called half-life.[7]

Early on both Becquerel and the Curies also learned that radiation could burn human flesh. Doctors soon began to experiment both with it and X-rays to help control tumors and other medical maladies. In addition to such commercial and medical value, discussion also began about the uses of radium's potential power and their possible ramifications. Pierre Curie spoke of this potential power in his 1903 Noble Prize speech, a prize which the couple shared with Becquerel.[8]

> It is conceivable that radium in criminal hands may become very dangerous and here one may ask whether it is advantageous for man to uncover natural secrets, whether he is ready to profit from it or whether this knowledge will not be detrimental to him. The example of Nobel's discoveries is characteristic, explosives of great power have allowed men to do some admirable works. The are also a terrible means of destruction in the hands of the great criminals who lead nations to war. I am among those who believe, with Nobel, that mankind will derive more good than evil from new discoveries.[9]

Physics historian Emilio Segre notes that Curie's words indicate how even at this early time in atomic discovery, the optimism in the supreme good of science was falling from its earlier heights.[10]

Still, atomic science continued to grow. Ernest Rutherford and P.V. Villard among others continued to learn about the powerful and mysterious nature of X-rays and radioactivity. In 1898, Rutherford realized that two kinds of radiation came from uranium: alpha and beta rays. Meanwhile in France, Villard discovered a third more penetrating radiation, called gamma rays. Alpha rays were known to be positively charged, but other than that they remained a mystery. Beta rays were much lighter and negatively charged, indeed they were cathode rays or electrons. Gamma rays were found to be very similar to X-rays. They were neutral in charge and came to be viewed as quanta of electromagnetic radiation called photons.[11]

Later in 1898, Rutherford moved from the Cavendish Laboratory in England to McGill University in Montreal. At McGill, Rutherford discovered that radioactive substances also gave off radioactive gases or emanations as well as the three kinds of radiation. He began to work then with the chemist Frederick Soddy, and together they discovered transmutation of elements. Transmutation refers to the ability of one atom to change into a different atom. Rutherford and Soddy among others were cautioned for this early work into the nature of transmutation because it sounded too much like alchemy.[12]

Yet, because of their work and that of others such as Sir William Ramsay and Otto Hahn, the nature of isotopes was eventually understood. Isotopes are chemically identical elements but with different radioactive properties. Every time these early researchers discovered a new radioactive substance they thought it to be a new element. We now know, through understanding isotopes, that these new substances were just different atomic states of the same elements such as thorium, radium and actinium.[13]

Rutherford continued his work with atomic theory through out his entire life, winning the Nobel Prize for Chemistry in 1907 for his work with alpha particles, and ultimately proved, in 1919, that the mysterious alpha particles were helium nuclei--the protons and neutrons of a helium atom's nucleus. His work with alpha particles also helped scientists to come to some understanding of the shape of atoms. By bombarding gold leaf with alpha particles, Rutherford demonstrated how Lenard's 1903 suggestion--that atoms were mostly empty space--fit with Thomson's ionic theory of 1898, which states that negatively charged electrons were balanced by a positively charged sphere in which they were imbedded--like plum pudding.[14]

By bombarding the gold leaf, Rutherford proved that the few positively charged alpha particles that were deflected off their path (1 of every 8000) were repelled by positively charged particles in the gold leaf (like charge repels like charge). But the low proportion of deflections led Rutherford to observe that the positively charged portion of the atom was much smaller than Thomson had theorized in his plum pudding model. This was crucial because of the large size of the alpha particles. Rutherford's worked helped to show that the atom's nucleus, containing the positively charged alpha particle (a helium nuclei) turned out to be only 1/100,000 to 1/10,000 the diameter of the atom, even though the alpha particle was "7350 times as massive as an electron" and four times the size of a hydrogen atom.[15]

It was then understood that the small electrons orbit this massive nucleus, so that most of the atom's diameter is made up of an empty space orbited by electrons--an electron cloud, just as Lenard had proposed.

Physical scientists worked with electrons throughout this period and ultimately realized that because the smaller electrons were much easier to deflect or dislodge from the electrical bond of the atom, they, not the positively charged particles (protons), were ejected when light hit metals. This is also why heated metal filaments emit electrons not protons. Because of this relative ease of removing electrons from atoms, they were not a reliable measure of atom size. Thus the size of the more stable nucleus became known as the defining characteristic of elements. This meant a method was needed to measure the different sized nuclei to help determine atomic size. Physicists returned to the X-ray to do the job.[16]

By this time it was known that X-rays were made by the slowing down of the cathode ray particles when they passed through the end of the glass tube. The deceleration of the negatively charged particles produced electromagnetic radiation in the form of X-rays. It was quickly learned that stronger X-rays could be made by slamming the cathode rays into denser and denser metal plates, called anticathodes. The denser the material the quicker the deceleration of the speeding electrons, and the greater the radiation emitted from braking the electron. Thus, the higher the atomic weight of the element producing them the harder the X-rays produced.[17]

But this method of determining the size of atoms was imprecise, and so a more precise instrument of measurement of atomic weight was derived using the uniform structure of crystals.[18] Once the "distance between the planes of atoms [of crystal] was known, the wavelength of X-rays made from different elemental anticathode could then be calculated." In this way it was learned that hydrogen had a +1 charge on its nucleus and was then given the atomic number of 1 followed by helium with a +2 charge and atomic number of 2 and so on up the periodic table of elements.[19]

These early discoveries helped physicists and chemists realize that nature could not be described and predicted by using only mechanical, electromagnetic and thermodynamic models. Mechanics and electromagnetics are characterized by predictable and reversible actions such as tossing a ball into the air or bending an electric current with a magnet. Classical thermodynamics are governed by 1) the conservation of energy and 2) systems naturally move toward randomness or entropy.[20]

A conflict arose between the reversibility of mechanical and electromagnetic phenomena and the irreversibility of thermodynamic entropy when looking at the universe as a whole. Statistical mechanics was developed by Robert Maxwell and L. Boltzmann, among others, to help bridge the gap between elementary phenomena and macroscopic phenomena. They refined the second law of thermodynamics to describe not absolute phenomena but rather one of high probability. Thus on a macroscopic level it would take longer than the age of the universe to wait for an exception. Statistical mechanics also raised tough paradoxes concerning the nature of matter, as did the blackbody problem.[21]

"A blackbody is a body that completely absorbs electromagnetic radiation falling on it."[22] The power emitted from a blackbody is dependent only on the temperature and frequency of the energy and not on the material the blackbody is made of. Max Planck discovered the formula to explain blackbody radiation, and thus discovered quantum physics by defining the energy content of the blackbody as E=hv, where v is the frequency of radiation and h is a proportionality constant, thus E became a "finite amount, a quantum of energy."[23]

Einstein built on Planck's work and in 1905 published the beginning of his work on special relativity. He would ultimately show that light is quantized using Planck's formula and that light exhibits a dual nature of both wave and particle, as well as postulate the speed of light. Einstein's work ultimately led to understanding the balance of energy in both an atomic bomb and the sun, thus providing clues to resolve the paradox between classical thermodynamics and mechanical phenomena.[24]

The structure of the atom became further understood with the work of Niels Bohr in 1913. Bohr further investigated Planck's quantum theory, namely that "any object which is converting kinetic energy (energy of motion) into radiation ought to radiate energy in whole quanta (packets of light or photons) only."[25] Through his work he proved that electrons have a ground or rest state in the electron cloud closer to the nucleus, but also have many levels of excited states further from the nucleus. Thus to release light, an electron must release its built up energy and return to an orbit closer to the nucleus. Likewise if the electron absorbs light it moves to an orbit further from the nucleus.[26]

Work into the structure of the atom continued throughout the period both on the theoretical and experimental level. On the experimental level, during the 1920s Rutherford continued to work with particles, "almost single-handedly" creating the field of experimental nuclear physics with his work in firing alpha particles into the atomic nucleus.[27]

On the theoretical plane, Einstein would win the Nobel Prize in 1921 for his work explaining the photoelectric effect using the concept of the photon. Light is made up of photons, which in turn have characteristics of both particles and waves. This is also the same year that Scripps started his science news service, in the attempt to educate the people as to the revolutions going on in science.[28]

A Brief History of Science Writing

Communication of new scientific and technological discoveries is not an easy nor new enterprise for the media. In her thesis "A History of Science Writing in the United States and of the National Association of Science Writers," Carolyn Hay labels Ben Franklin one of the early science writers, because of his ability to describe his own scientific experiences in easily understood articles.[29] Indeed medical stories were running in North American papers as far back as 1721, when Ben Franklin's brother James argued against smallpox vaccinations with the Puritan Rev. Increase Mather in issues of the Courant. And of course Ben's Poor Richard's Almanac, contained folk remedies and agricultural news as well as his personal accounts of experiments with lightning and such.[30]

Franklin's Almanac contained many of the same article types: medical, agricultural and pseudo-science, that made up much of 18th and 19th century science coverage. In 1847 Joseph Henry, physicist and first secretary of the Smithsonian Institution, addressed the importance of providing science information to the public by stating, "In carrying out the spirit of the plan, namely that of perfecting men in general by the operation of the Institution, it is evident that the principal means of diffusing knowledge must be the press."[31]

Press coverage of science often consisted of large discovery and milestone news events, such as the laying of the Trans-Atlantic Telegraph Cable, Darwin's theory of evolution and Robert Fulton's steamboat trips. These stories suited the battling newspaper giants' hunger for sensational and culturally important stories, which in turn attracted more readers. The publishers ran them along with occasional large scale adventure stories, such as the search for Dr. Livingston.[32]

In the 1870s and 1880s scientists themselves helped the media to popularize science through books, articles and lectures. Lectures by British scientists Thomas Henry Huxley and John Tyndall were popular both in England and America. A special edition of the Tribune containing Tyndall's 1872 physics lectures in New York sold more than 50,000 copies. English scientists and science were very often well received in the states.[33]

A journalist speaking at Dartmouth college in 1873 said of English science:

> ten or fifteen years ago, the staple subject here for reading and talk ... was English poetry and fiction. Now it is English science. Herbert Spencer, John Stuart Mill, Huxley, Darwin, Tyndall have usurped the places of Tennyson and Browning, and Matthew Arnold and Dickens.[34]

This active involvement of scientists in the communication of their research diminished at the turn of the century, according to journalism historian David Rhees. Rhees shows how scientists felt the coverage of their stories was too often sensationalized and exaggerated. Another factor, in the lessening of popular science was the professionalization and increasing specialization of the sciences. As scientific knowledge grew during the second scientific revolution, both non-scientists and scientists in different specialties were increasingly unaware of what was happening in the new laboratories.[35]

In 1906, one year after Einstein published his theory of relativity, the Nation declared their dismay at the perceived loss of scientific literacy:

> Today, science has withdrawn into realms that are

> hardly [intelligible]....Physics has outgrown the old formulas of gravity, magnetism, and pressure; has discarded the molecule and atom for the ion, and may in its recent generalizations be followed only by an expert in the higher, not to say the transcendental, mathematics....In short, one may say not that the average cultivated man has given up science, but that science has deserted him.[36]

Rhees adds that:

> By the time of the First World War...popular science had reached a serious state of decline. A new generation of scientists had arisen which clearly preferred the privacy of the laboratory to the public lectern, and popularization lost its status as a respectable sideline of the well-rounded scientific man.[37]

This decline in scientists involvement with the media changed during the war when scientists from differing fields were forced to work together for the war effort. Rhees notes that an increase in government money for research was another change induced by of the war. Previously, most of the research money had come from university or private industry sources.[38]

The public also saw how scientific advancement had helped them during the war. One example of this help was the development of "synthetic substitutes for raw materials whose supply was cut off during the war."[39] Books on science sold well during this period, but most papers didn't give science matters high priority. The media landscape was changing though and in 1919 the American Chemical Society started the first scientific public relations department. It was established to help get ACS members' news to the media.[40]

Similarly, attempts to organize non-industrial science writing came about in 1921 with the start of the first official science news organization, the Science Service, founded by E.W. Scripps. Scripps saw the Science Service as a translator of scientific concepts for the masses, so they might form intelligent opinions on matters of national importance and thus further democracy.[41]

Scripps described his desire to educate the public in science:

> it's useless to think of making the world safe for democracy without thinking of making democracy safe for itself. And the only way of making democracy thus safe is to make it more intelligent. But since to be intelligent is utterly impossible without having much of the knowledge, method and the spirit of science, the only way to make democracy safe is to make it more scientific.[42]

Scripp's service closed in 1929. Rhees appraised Scripp's brief attempt to connect scientists with the public thus:

> While Science Service should be regarded as a first, significant step toward the development of such an institution, in the 1920s it fell far short of establishing a genuine rapprochement between science and the public...So intense was his [editor Edwin Slossen's] vision of a world remade by science, and so fervent was his desire to implant that vision in the mind of the "multitudes," that the popular science of Science Service under Edwin Slosson came remarkably close to resembling the sermons of a former chemist.[43]

Five years after the Science Service closed The National Association of Science Writers (NASW) was founded by 12 science writers who wanted to carry on the business of disseminating accurate science news. Its credo stated:

> This organization shall foster the dissemination of accurate information regarding science, through all media normally devoted to informing the public; and shall foster the interpretation of science and its meaning to society, in keeping with the highest

standards of journalism.[44]

Over the next three decades science and science coverage continued to evolve together. The Second World War, just like the First World War, produced great developments in science and technology and highlighted their importance to the public. The number of science journalists grew as the public became more and more interested in these developments and what benefits they might produce. The launching of Sputnik and the ensuing space race of the 1960s prompted another explosion in science and science coverage, as well as, the beginnings of in-depth scholarly research into the character of this coverage. By 1969 the NASW had grown to more than 270 active members.[45]

The journalist, of course, is not the only participant in this evolving relationship between science and the public. While scientists around the turn of the century kept most of their research within their circle of their peers, today, when so much scientific funding comes from private and public grants, scientists are much more eager to have their research publicized. This study will look back to the genesis of the relationship between modern scientists and journalists, to a time of revolutions in both science and media.[46]

CHAPTER TWO

NOTES

1. A. E. E. McKenzie, The Major Achievements of Science (New York: Cambridge University Press, 1960), p. 338; Isaac Asimov, The History of Physics (New York: Walker and Company, 1984), p. 245; Segre, p. 6.

2. Albert A. Michelson, "Some of the Objects and Methods of Physical Science," Quarterly Calendar 6 (August 1894): 15, as quoted in Robert H. Kargon, The Rise of Robert Millikan (Ithaca: Cornell University Press, 1982), pp. 43-44.

3. Asimov, pp. 306, 321, 331.

4. Segre, pp. 22-25.

5. Ibid, p. 22.

6. Ibid., pp. 15-19.

7. Ibid., pp. 29-42.

8. Ibid.

9. Ibid., p. 42.

10. Ibid.

11. Ibid., pp. 50-51.

12. Ibid., pp. 50-58.

13. Ibid., p. 58.

14. Asimov, pp. 536-541.

15. Ibid., pp. 538-540.

16. Ibid., pp. 536-540.

17. Ibid., pp. 541-544.

18. Atomic weight is the number of protons and neutrons in the nucleus, with neutrons not being discovered until 1932,

by the English physicist James Chadwick, as an uncharged particle in the nucleus with similar mass to a proton.

19. Asimov, pp. 541-544, 598.

20. Segre, p. 63.

21. Ibid., pp. 61-66.

22. Ibid., p. 67.

23. Ibid., pp. 66-67; Asimov, p. 371.

24. Segre, p. 80.

25. Asimov, p. 555.

26. Ibid., pp. 555-556.

27. Introduction to Ernest Rutherford, "The Chemical Nature of the Alpha Particles from Radioactive Substances," in Jefferson Hane Weaver, ed., The World of Physics, Vol. 2 (New York: Simon and Schuster, 1987), p. 41.

28. Introduction to Albert Einstein, "The Fundaments of Theoretical Physics," in Weaver, Vol. 1, p. 77.

29. Hay, p. 10.

30. Willard Grosvenor Bleyer, Main Currents in the History of American Journalism (Cambridge, Mass.: Houghton Mifflin Company, 1927), pp. 52-53, cited by Hillier Krieghbaum, "American Newspaper Reporting of Science News,: Kansas State Bulletin, Vol. XXV (August 15, 1941), pp.17-18, cited by Hay, p. 6, n. 3.

31. Quoted in Nelkin, p. 134.

32. Mott, p. 417.

33. Rhees, p. 4.

34. Frank Luther Mott, A History of American Magazines, 4 vols. (Cambridge, Mass.: Harvard University Press, 1939-57), 3:105, cited in Rhees, p. 4, n.5.

35. Rhees, p. 3-7.

36. "Exit the Amateur Scientist," The Nation, 83 (Aug. 23, 1906), p. 160, as quoted in Daniel J. Kevles, The Physicists (New York: Alfred A. Knopf, 1978), p. 98, n. 3.

37. Rhees, p. 7.

38. Ibid, pp. 9-11.

39. Ibid., p. 14.

40. Ibid., p. 17; Nelkin, p. 134.

41. Rhees, p. 24.

42. Charles R. McCabe, ed., Damned Old Crank, A Portrait of E. W. Scripps (New York: Harper and Bros., 1951), pp. xiv-xv, 10-11, 231, as quoted in Rhees, p. 24, n. 50.

43. Rhees, p. 88.

44. Hay, p. 3.

45. Ibid.

46. Nelkin, p. 7.

CHAPTER THREE

THEORETICAL FRAMEWORK

The questions and format for this study evolved in part out of two separate studies by Ed Caudill and Spencer Weart. In 1987, Caudill published a study in which he compared the amount of coverage given Darwin's Theory of Evolution in both The New York Times and the American Journal of Science. He concluded that The New York Times's and the Journal's patterns of coverage were similar and were both influenced by the newsworthiness of the issue over time, with the Journal presenting slightly more consistent coverage.[1]

Weart, in his comprehensive book Nuclear Fear, traced the evolution of American nuclear images across the span of the century. In developing his main conclusion, that "the images we cherish have a greater role in history than has commonly been thought," he made specific observations about the press and its early coverage of the nuclear issue. Analyzing headlines related to nuclear issues in the Readers' Guide to Periodical Literature, he "found very little negative language" from 1900 to the middle 1920s. Almost three quarters of the titles from 1900-1940 were neutral with the majority of the rest being hopeful.[2]

Weart attributed the mostly neutral and positive coverage of early nuclear topics to the public's commonly held belief that few people were hurt or damaged by radiation, while many medical patients benefited from the technology. Interestingly, he points out that during this time the public knew that radiation was undetectable by the senses, but still did not see it as something excessively harmful. He notes that this fact seems to refute the suggestion, sometimes made today, that people fear radiation because of its elusive and unknown nature. At the same time, Weart notes that though people accepted the mysterious aspects of the atom, fear of these same mysteries was beginning like "a minute twitching in a seemingly confident patient with a hidden neurosis."[3] He attributes this fear to the underlying feeling of many people that to view the "forces of nature in general and life-forces in particular" was to glance upon forbidden secrets.[4]

A previous study by this author of The New York Times and the journal Science mostly supported Weart's findings. Negative stories made up only 12.2 percent of the 123 The New York Times stories coded from 1896 to 1922; 40.65 percent of the stories were neutral and 47.15 positive. This deeper content analysis of just the print content, however, revealed changes in coverage in the types and number of sources used over time. An increase in points of view was also found as well as fluctuation in the tone of the coverage for the period.[5]

A more detailed analysis of these publications and extension to two more publications, The Times of London and

Nature would be useful. A broader and more comprehensive study can provide a clearer picture of this period of transition in the press' coverage of science/technology and more fully explore the balance of media content concerning early atomic theory.

Weart analyzed headlines of stories as one indicator of the print media's images of content, and combined this with analysis of the literature and movies of the time. This study, however, is interested in more fully assessing the images present in the print media. In doing so it will expand upon the early analyses of the media, building upon Weart's headline analysis by looking at lead and overall story as well as headlines. It will approach assessment of images by combining assessment of tone with Caudill's method of analyzing the pattern of media coverage over time. By combining these two methods, a clearer picture of the types of images contained in early atomic coverage in the print media can be obtained, and thus make it possible to more fully assess this period of parallel development in nuclear science and technology and early science journalism.

Literature Review

Communication research indicates that the mass media of print, radio and television are today the general public's source of pro's and con's about technological and scientific issues such as nuclear bombs and the "greenhouse effect".[6] Not surprisingly, the corporate operators of these important information windows, are increasingly aware of the growing market for science news.[7] In 1956 The New York Times had three science writers on its science beat compared to ten full-time writers in 1991.[8] More than ever universities and science associations are offering programs to train science writers to better perform the difficult task of relaying science news to the public.

Gaye Tuchman locates the importance of understanding the media's functions in the large impact that their message can have. In "telling stories of social life, news is a social resource. A source of knowledge, a source of power, news is a window on the world."[9] Robert Stallings adds, "By selecting events to report, by interviewing and quoting experts who interpret those events, and by assembling and distributing news products, news organizations create an important component of public discourse."[10]

The media's selection of stories deemed "important enough to cover," plays a part in setting the public agenda. According to media researchers Maxwell McCombs and Donald Shaw, as an agenda setter the media has the role of presenting to the public those issues deemed important. "In short, the mass media may not be successful in telling us what to think, but they are stunningly successful in telling us what to think about."[11]

The obtrusiveness or importance of an issue, such as the ramifications of a poor economy, is also important in determining what issues remain on any one communities agenda even without media input. Still, there remains a correlation between media selections and public agendas. The question sometimes being which came first, the story or public interest.[12]

Two criticisms of agenda setting research are that it focuses too much on the political and not enough on the specific issues, and that it doesn't take into account the nature of the issues analyzed. It doesn't look deeply enough into the implications or public reaction to certain important events such as the disaster at Chernobyl.[13] Aware of this, agenda-setting researchers are beginning to explore media coverage of science, environmental issues, and disasters to help understand the media's agenda setting role.[14]

It is known that the public takes notice of what the media portrays about technological disasters. Stanley Rothman and Robert Lichter note that since the 1960s the public has demanded more governmental control over scientists' and industries' handling of potentially hazardous technologies, because of what the public has learned from the media. "[S]cientists employed by industry have less credibility than either Ralph Nader or scientists who are members of public interest groups."[15]

Rothman and Lichter offer three explanations for this change in the public's attitude toward science and technology in the past two decades: 1) Accelerated technological change since WW-II has produced technics with greater capacity to injure large numbers of people; 2) Business practices operate on profit and quick technological fixes more than protection of people or environment; 3) Extreme environmentalism is a reaction to the loss of traditional social values.[16]

In their study of the perception of the risks of nuclear power, Rothman and Lichter concluded that fears concerning new technologies such as nuclear power plants arose from real problems which deserve attention. The researchers qualified this conclusion by stating that these fears were heightened by "conflict among various leadership groups, a weakening of the social fabric of the society, a social mistrust that dates from the early 1960s, and a shift in the loci of influence and power in the United States."[17]

In terms of the media's coverage of the nuclear issue, Rothman and Lichter found that journalists' skepticism toward safe nuclear power affected how they reported the stories. Because of this, they concluded, U.S. public opinion has probably been influenced by the manner in which new technologies were reported in the media. However, in concluding this they assumed that the press was a vehicle of the left, and noted that some of the negative portrayal of new technologies had come from groups and individuals who "are partly seeking surrogates for a more direct attack on the dominant values of U.S. liberal capitalism." As evidence, they cited how the political left in France can still directly attack the existing political and social order without a surrogate issue such as the environment.[18]

This assumption that the press is an agent of the left is called to question by other studies. One, for example, revealed that the percentage of journalists leaning to the left has substantially changed from 1971 to 1983, with many becoming more middle of the road politically during this period.[19] However questionable this assumption, Rothman and Lichter's study is right to suggest that risk information must be communicated competently by the media, if the public is to select the proper uses for science and technology.

With the media's power to showcase science and technology issues come also the abilities to confer status, to form perceptions, and to provide selected information about complex societal issues.[20] Oene Wiegman and fellow researchers analyzed the important role that the mass media plays in shaping "personal images, perceptions of reality and habits concerning well-being and health."[21] A major component of this agenda and image setting role of the media is the reporter's choice of news source. Attributing facts and statements to an "expert" or eye witness allows the reporter to take on an objective role by appearing to be removed from the story.[22]

Dan Schiller traced the origin of media objectivity back to the 1830s, when using news sources was seen as an efficient and cheap way of gathering news. Objectivity was:

> nurtured by the climate of "Baconianism" pervading contemporary American science, and through its scientific deference to fact, the commercial newspaper stood aloof from the progressive relativization which eventually affected other modes of thought. If science served an ultimate public good, the commercial newspaper served both.[23]

Donald Shaw, in looking at early telegraph news transmissions, notes that since the 1880s there has been a steady increase in the number of attributions in news stories, and a growth in objective reporting.[24] Michael Schudson counters that while attributions began to rise in the 1880s, objectivity as common practice didn't come about until after World War I. He argues that objectivity arose out of what journalists viewed as the need for common practices for writing the news that could counter the propaganda practices that came out of the war.[25] Robert Miraldi answers Schudson, declaring that "one can find numerous examples of how the rituals of objectivity had already begun to be practiced" before WW-I by the muckrakers.[26]

While the debate over the time frame of the evolution of objective reporting continues, much current media research has focused on objective journalism's dependance on institutional sources--so called experts. Such a dependance often leads to the establishment of the beat system, where reporters have to rely on regular governmental or other institutional cooperation to get a story. This can be seen both on the cop beat and the science beat.[27]

The science writer's dependance on experts is affected by the inherent differences between academic and journalistic writing.

> To the Academician, the language of the reporter is excessively casual, trivializing, and simple minded, if not downright wrong or silly. To the journalist, the language of the academicians is excessively passive, technical, and complicated, if not downright wordy or pompous.[28]

This difference in purpose and methods can lead to criticism of the science journalist's work. Carroll Glynn says of experts and others who criticize science writing:

> One of the main problems cited by these critics is the tendency for reporters to 'sensationalize.' Yet, news personnel must rely on excitement and color in many of their news stories to capture 'reader interest.' In the mere act of trying to sell newspapers, the professional newsperson flirts daily with annoying if not scandalizing the scientific community.[29]

The audience of the story also comes into play as part of the differing standpoints between journalists and their expert sources. Conrad Storad said of the difficulty in reporting scientific news,

> The science writer is confronted with three basic problems which must be overcome if the transmission of an understandable message is to be accomplished. The science writer must know what his audience is like, how much the public understands and wants to know about science, and how he can transmit his information most effectively.[30]

In line with this concern to better transmit information, much of the current research into science journalism issues has centered around the notion of effective communication. The research has looked at such factors as accuracy, completeness, comprehensiveness, subjects covered, sensationalism, readability, and balance of coverage--which will now be reviewed in that order.

Science media researcher Bruce Lewenstein, in a 1991 study of media coverage of cold fusion, summarized current research on science coverage that found science coverage accurate in presenting scientific facts, and attributed inaccuracies to an absence of sufficient detail. Science coverage tends to be incomplete, fragmented, providing bits and pieces without enough context.[31] "This often shows up in a focus on 'the news' without much emphasis on the continuing process of science or scientific development."[32] The type of issue covered is determined mainly by the number of people the issue is perceived to affect. For example health and environmental issues are covered much more often than stories of basic research.[33]

Lewenstein noted that many studies have shown that science journalism "is rarely considered sensational." Readability issues are complex, but can be boiled down to the fact that readers and viewers want to see more science stories, indicating that the stories are readable and desired. Scientists and journalists often blame one another for the shortcomings of science journalism, but it is more likely the divergent standpoints of science and journalism that lead to poor coverage.[34]

Lewenstein states that issues of balanced coverage are difficult because scientists view balance in terms of a "logical analysis of the evidence and rejection of unsupported" positions, while journalists view it as presenting all sides in a controversy. Research indicates that the media does present balanced coverage of the many sides of an issue, but is more ambiguous in terms of "scientific" balance. The media tend to focus on one part of a story at a time then move on to "another part of the story."

This tends to create scientifically balanced coverage more over time rather than at any one moment.[35]

Given the consensus on what makes up the objective nature of science coverage, Lewenstein and researchers such as Lee Wilkins call for more research into the context and value systems that affect science coverage.[36] Wilkins argues:

> If journalists are to begin to cover the greenhouse story through an agenda that is truly developed within the journalistic, as opposed to the scientific, profession, then they must first acknowledge the values that help to define and report the news. For example, the greenhouse effect can be covered in terms of social, as well as hard, science.[37]

Journalism ethicist John Merrill writes, "Journalists, at least those concerned with lasting value, are going to have to recognize the great importance of their own values, not only when they are interpreting the news, but also when they are deciding what it is and how they will play it."[38]

Merrill brings up the debate between interpretive and spot news stories. According to John Demott, an interpretive news story more frequently contains extensive background and/or exposition on the topic than spot news stories. Interpretive stories also contain more detailed descriptions of people, places and opinions of cause and effect related to the issue, as well as speculations about the future. This increased use of reportorial opinion was seen as the best differentiator of interpretive news.[39]

Demott, though, raised the question whether interpretive news decreases credibility of the media.[40] The issue of interpretive versus spot news, seemingly takes us back to the debate raised over muckracking journalists by the likes of Teddy Roosevelt, and more recently to the debate over such "new journalists" as Hunter S. Thompson and Tom Wolfe. Does a journalist's inclusion in a story of his perceptions and views of an issue detract from the value of the piece?

By looking at journalism's historical landscape of muckrakers, new journalists and interpretive reporting, it can be seen that while the nature of journalism and indeed science coverage has evolved through out this century, in many ways the same tough issues persist. Cole found that, "newspapers have performed the watchdog function in reporting science news more in 1971 than in 1961 or 1951. More controversy was reported in 1971 sampled science articles and the controversies were reported across a much broader subject matter."[41] But Dorothy Nelkin notes that current science journalism practices have returned to the pre-1971 pattern of verbatim, non-interactive reporting.[42]

How does this verbatim reporting of science coverage fit in with the media's responsibility in communicating the many fine points of science and technology issues? Media research has shown that coverage of individual environmental issues and events affects what the public views as important. "Thus, it may be possible to extend the agenda-setting hypothesis to detailed levels of information about a single issue."[43] The media are the liaison between the researcher and the public that often funds research.

As a liaison with such a high potential for setting the public's agenda concerning science and technology issues, the media have some responsibility to provide accurate and comprehensive coverage of highly complicated and evolving theories and technologies. In the course of communicating these issues, each discipline must in someway interact with the other.

This study will look back to the birth of nuclear technology and science, to assess how this evolving relationship between modern media and science began. It will examine patterns and types of images presented during this early period of growth for science journalism, images that may have shaped early public understanding of nuclear science and technology. To get a better understanding of the early patterns of coverage given to atomic science the study will assess the tone, amount of coverage and sources cited. In addition, the metaphors used will be considered as representations of early interactions between a revolutionary science and an evolving media.

While conducting this research two points were kept in mind. First, as Neal Hines wrote about the relationship between the media and nuclear physics:

> Many times since August 1945 the newspaper has been termed the primary agency for mass education in the field of atomic energy. The scientists have turned repeatedly to the press....And the newspaper itself has reflected the nation's bewilderment at the release of fundamental force.[44]

Hines study highlights the importance of nuclear coverage in science writing history, but the second point is as David Burkett noted:

> It would be easy to believe that public interest in science began with the atomic bomb. To do so, however, ignores thousand of years in which mankind has struggled to understand the physical world and man's place in it.[45]

This study will endeavor to place journalism's contemporary role in shaping public perception of nuclear science in the larger perspective afforded by examining its genesis early in this century.

CHAPTER THREE

NOTES

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10. Robert A. Stallings "Media Discourse and the Social Construction of Risk," Social Problems, 31 (February 1990), as quoted in Sharon M. Friedman, Kara Villamil, Robyn Suriano and Brenda Egolf, "Alar and Apples: Newspaper Coverage of a Major Risk Issue," (Paper Presented at the Association for Education in Journalism and Mass Communication annual convention, Boston, Massachusetts, August 1991), p. 3, n. 18.

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eds. Maxwell E. McCombs and Donald L. Shaw (St. Paul, Minnesota: West Publishing Co., 1977), p. 5.

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16. Ibid., p. 384.

17. Ibid., p. 399.

18. Ibid., p. 397.

19. David H. Weaver and G. Cleveland Wilhoit, The American Journalist (Bloomington, Ind.: Indiana University Press, 1986), p. 29.

20. Nelkin, pp. 11-12.

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CHAPTER FOUR

METHOD

Four periodicals were selected for assessment of their coverage of early atomic issues. The periodicals were The New York Times, The Times of London, Science and Nature. Their coverage was assessed in terms of tones, patterns and images used to communicate scientific and technological developments during the period from 1896-1922.

All story formats in the publications were included in the analysis to get a handle on the balance of messages and images being conveyed about nuclear science and technology.

To help prevent a biased sample across the time period, article selection was done using a random numbers table. The numbers generated were applied to a numbered list of indexed stories. A sample was then selected proportionately for each year, creating a random proportionate representation for each year. The sample was stratified by year so that the years with more stories indexed would also have more stories coded.[1]

The New York Times sample was approximately 16 percent of the total indexed stories, The Times of London--33 percent, Science--44 percent, and Nature--9 percent. Years where the proper yearly proportion amounted to less than two but not zero had two stories coded.

A stratified random sample of 125 stories was derived from 763 articles, editorials and letters to the editor identified in The New York Times Index for the period from 1896 to 1922. A similar sample of 130 stories was developed from the 394 articles, editorials and letters indexed for The Times of London.

Articles drawn from The New York Times Index were found under the key words atomic, cancer, energy, medical, photography, radium, radioactivity, X-ray and all cross references listed in the index. Articles in the two indexes for The Times of London were found under the headings of radium, Roentgen, radioactivity and science. The indexes were the Palmer Index to The Times from 1896-1905 and The Official Index to The Times from 1906-1922.

In the journal Science, a random sample of 62 articles was generated from the 139 stories coded from the journal's index. The sample for the journal was increased by percentage per year to help create a larger sample for comparison with that of the other publications. The index was not up to the standards of the other indexes, however, so the whole index was searched for articles concerning nuclear issues. Most were found under the headings of atomic and radium.

In the journal Nature, a random sample of 174 articles was developed from the 1,943 stories found in the journal's index. Most of the articles were found under the headings of Roentgen's rays, radiography, radiation, X-rays, radium and Curie.

The New York Times's index was by far the best in terms of readability and lack of repetition of articles. Science's index was the least well organized and thus the whole index was scanned for articles. The Times of London's indexes often had more than one reference to the same article, because of its format of individually citing the sources involved in the pieces. Nature's index was quite thorough, but difficult to count accurately because it listed many abstracted articles on the same page, some by the same author.

After review of the periodicals it was decided that in counting article numbers in both The New York Times and The Times of London, article references in the index that appeared to be from the same article were only counted once. In contrast, all of Nature's indexed pieces were counted, because it was observed that it listed co-authored articles under one listing. In spite of the difficult nature of accurately counting the indexes, the numbers cited are an accurate representation of the total articles concerning nuclear categories in the selected periodicals.

The sample articles were then coded for the five categories: discovery and theoretical, medical, price and supply, energy, and military (these are defined in the Appendix). The categories arose from a pre-reading of a small sample of articles and fit the majority of stories encountered. Stories that did not fit solidly into one of the five categories were listed in either of two additional categories, "multiple" or "other."

An example of a "multiple" story was one in which both the medical benefits of radium were discussed as well as the difficulty in mining uranium ore.[2] An example of an "other" story was one about a boy who was said to have X-ray eyes. He was reported to have been able to see where pools of oil lay miles beneath the surface of the earth.[3]

Length of articles in terms of lines were also computed, excluding headlines or pull-outs. Sources were coded along with their institution and profession or qualification if noted. Sources were those who were quoted directly, indirectly or by any other attribution or citation (See the Appendix). Source categories were, governmental, medical, scientific, military, industrial, institutional, periodical, layperson, author, publication, legal and other. When possible, industrial, institutional, governmental and military sources were also divided into more specific types such as governmental medical or military science.

The use of art was also coded. Art included charts, graphics, illustrations and photographs.

All articles for all publications were coded for positive, neutral and negative tone of nuclear content. Both newspapers' articles were also coded for the tone of their headline and lead. Because of the different story types and international style differences, lead was defined as the introductory paragraph for all pieces coded; likewise, headline was defined as all bold faced phrases above the story proper. The more scholarly style of <u>Science's</u> and <u>Nature's</u>

articles required that only the overall article tone be coded.

The following definitions were used:[4]

Tone -- The position and/or messages and images the segment of the article presented on the nuclear issue(s).

Positive -- Coded when the headline/lead/story suggested, implied or stated that the nuclear issue(s) was beneficial, helpful, good or useful to individuals and/or society. The topic of the article was presented in a benevolent and good light.

Neutral -- Coded when the headline/lead/story neither indicated, accused, implied or stated that the nuclear issue(s) was good, bad, helpful or harmful to society or individuals nor did it redeem, promote, or destroy them in any way. Articles that were well balanced in presenting alternating opinions are also included in this category.

Negative -- Coded when the headline/lead/story suggested, implied or stated that the nuclear issue(s) was harmful, fatal, or dangerous to living beings and or society. In these articles, the reader received a message of caution or disdain toward the nuclear issue(s) or a feeling that the technology or science should be approached with caution or dread.

Pattern -- Will be the term used to describe the range of the nuclear coverage in the periodicals in terms of the evolution of the number and categories of stories and sources indexed.

In the preliminary study[5], intercoder reliability was 100 percent for headline and lead tone and 84 percent for article tone. For the full study all original stories were re-coded along with all new pieces added to the sample. Intercoder reliability was 98 percent for headline and lead tone and 94 percent for article tone. The figures were calculated by using a per-item agreement method for a randomly selected article sample that consisted of over 10 percent of the total combined sample population (N=18 of T=175 for the preliminary study and N=50 of T=491 for the full study). The test coding was done by an experienced coder other than the original coder. Errors for story coding often related to borderline stories. Due to the subjective nature of the coding categories, 94 percent intercoder reliability indicates that the results achieved provide a fairly accurate portrait of the total population. The improvement in coding reliability from the pre-study to this study was attributed to the more detailed definitions of the second study, and accounts for the slightly different tonal ranges found between studies for the two original publications assessed.

A Chi square was run on all sets of nominal data to test if the measured relationships were applicable to the larger population. For example, a Chi square was run on the number and types of tones coded in The New York Times and The Times of London. A two-tailed t-test was run on all codings of interval data, such as the number and types of categories coded in any two of the periodicals analyzed, to see if they are applicable to the larger population.

In addition to this quantitative analysis, additional qualitative analysis was done in part by using the coding categories of article format, headline summary and size, art, line size and sources, and use of metaphors. (Definitions for each category are in the Appendix). Much of the qualitative analysis focused on comparing and contrasting the trends in language and emphases of content found in each of the periodicals as the time period of the study evolved.

The specific research questions were:

1. What was the pattern of coverage in The New York Times and The Times of London in regard to the atomic issue from 1896 to 1922?

2. What was the tone of this coverage?

3. What was the pattern of coverage in Science and Nature in regard to the atomic issue from 1896 to 1922?

4. What was the tone of this coverage?

5. How does the pattern and tone of the two newspapers' coverage compare to that of Science and Nature?

6. What trends in images and practices does the analysis point to that reflect on the relationship between science journalism and science and technology at the turn of the century?

Answering these questions can provide a clearer picture of how the media communicated modern research and technology to the masses during this transitional period in both science and journalism.

CHAPTER FOUR

NOTES

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CHAPTER FIVE

QUANTITATIVE RESULTS

The first research question sought to compare the pattern of The New York Times's early nuclear coverage versus that of The Times of London. As Figure 1 & Table 1 show the coverage was continuous and variable over time for both publications.

Comparing Figure 1 to Figure 2 indicates that most of the peaks in coverage followed closely after such major events as Roentgen's 1895 X-ray discovery and the Curies' 1898 discovery of radium, but not always the year of or even the year after such discoveries. In the case of radium it took further research and world-wide recognition before the papers' gave the story wide coverage.

Coverage of the radium story didn't peak until 1903, the year that the Curies and Becquerel split the Nobel Prize. The Times of London ran 27 nuclear issue stories that year while The New York Times ran 15. The New York Times followed with 21 pieces the following year, while The Times of London's coverage dropped to six.

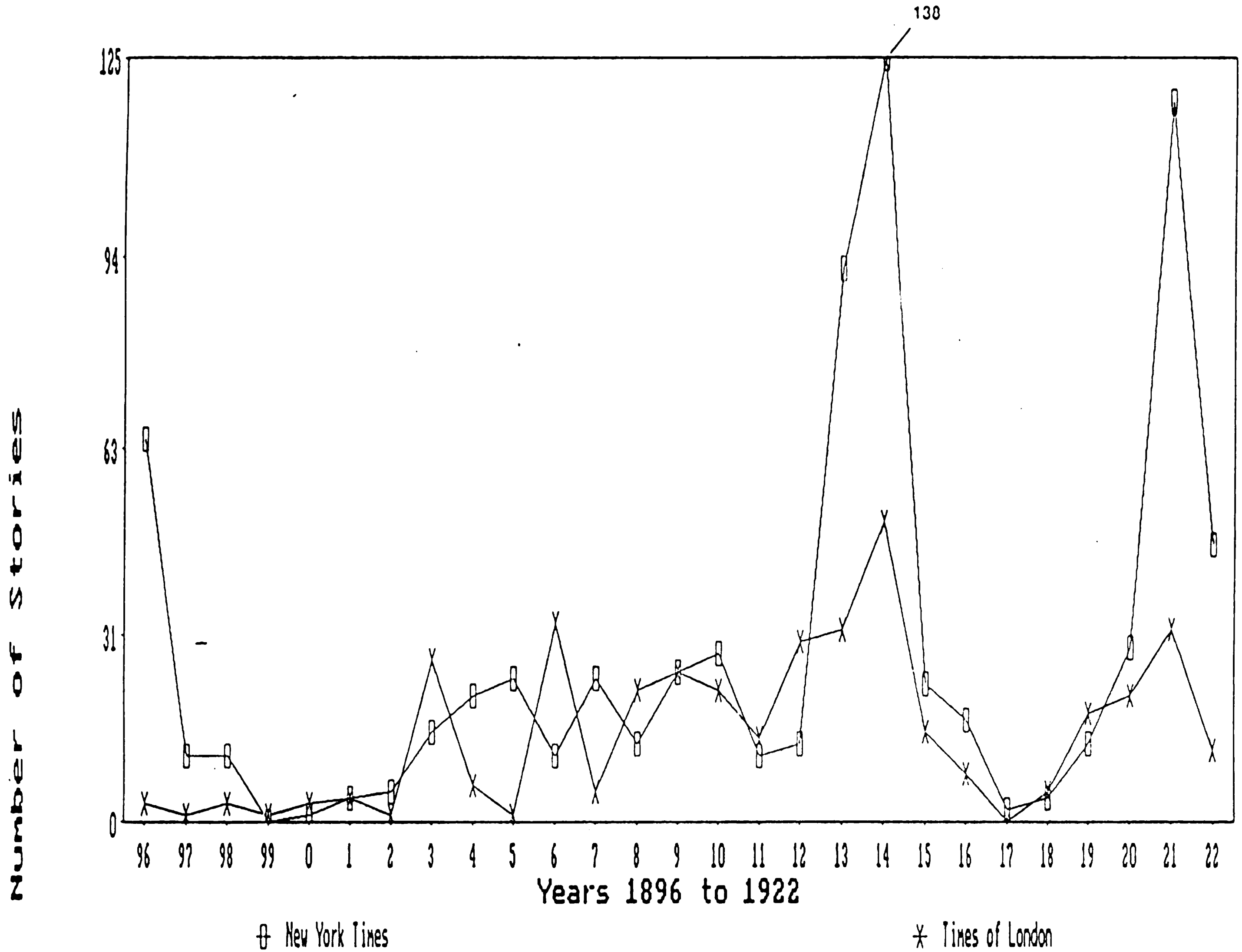

Figure 1: Total Number of Indexed Nuclear Stories in <u>The New York Times</u> and <u>The Times of London</u>: 1896-1922

Table 1: Sampled Story Tone of Early Nuclear Coverage for The New York Times and The Times of London by Year: 1896-1922

	The New York Times N=125			*The Times of London* N=130		
Tone	**Pos.**	**Neut.**	**Neg.**	**Pos.**	**Neut.**	**Neg.**
1896	5	4	0	1	1	0
1897	1	0	2	1	1	0
1898	0	2	0	1	1	0
1899	0	0	0	0	1	0
1900	1	0	0	2	0	0
1901	2	0	0	2	0	0
1902	0	2	0	1	0	0
1903	1	2	0	0	8	0
1904	2	1	1	0	2	0
1905	3	1	0	0	0	1
1906	1	0	1	2	8	1
1907	1	3	0	1	1	0
1908	1	2	0	0	2	2
1909	2	2	0	4	1	2
1910	1	3	0	2	3	1
1911	1	2	0	2	2	0
1912	0	2	1	3	6	0
1913	7	5	1	6	5	0
1914	7	9	2	7	10	0
1915	1	3	0	3	1	0
1916	2	0	1	1	2	0

Table 1 (cont'd)

1917	2	0	0	0	0	0
1918	1	1	0	0	3	0
1919	2	1	0	2	2	0
1920	3	0	2	4	0	1
1921	2	15	0	0	7	3
1922	1	4	0	1	3	0
TOTAL	50	64	11	46	70	11

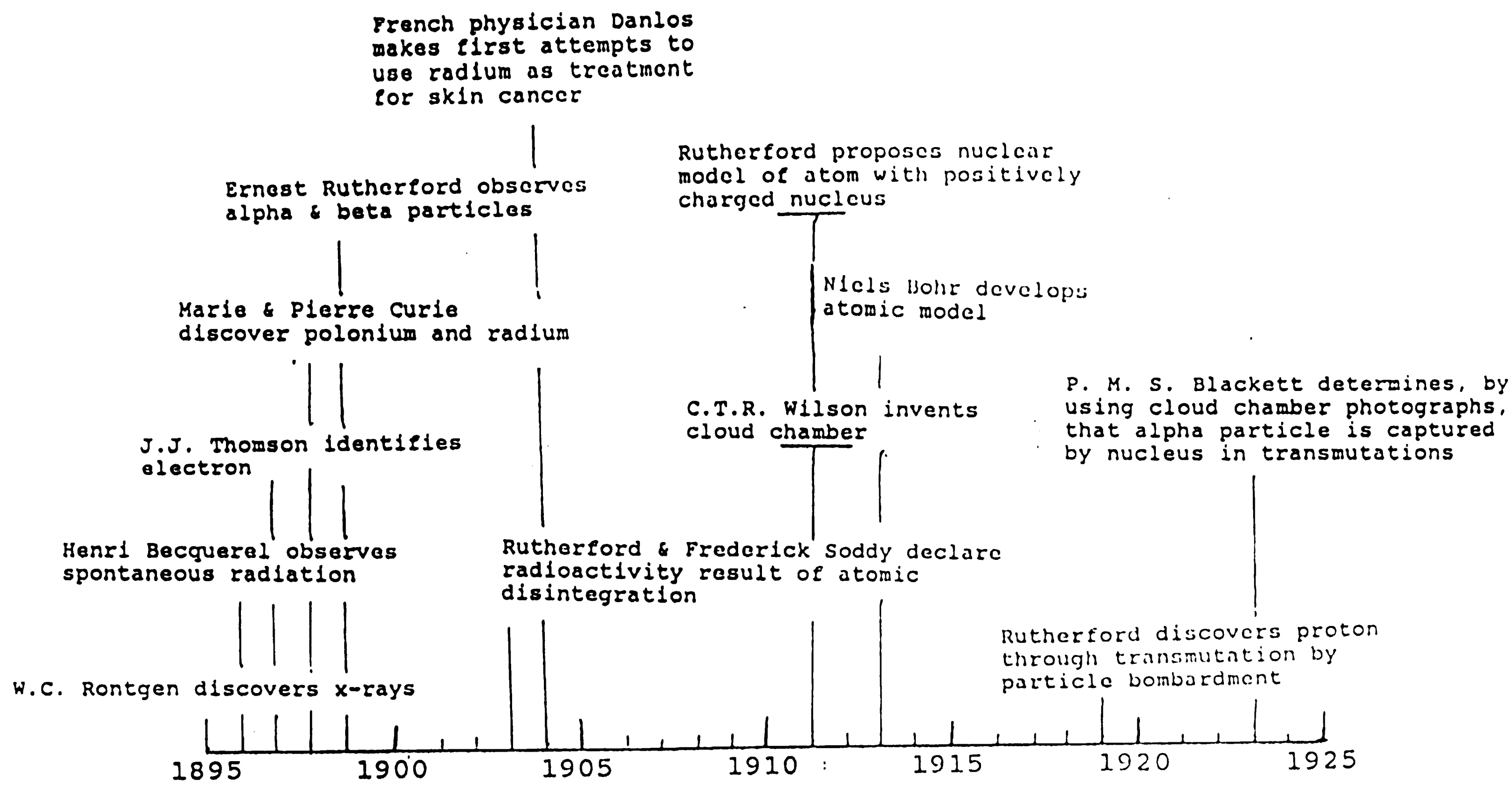

Figure 3: Timeline of Early Nuclear Coverage:

1895-1923

Yet, not all coverage peaks are a direct result of scientific discoveries or recognition of them. For example after 1904, The New York Times's coverage stayed around the 15-28 story level until it peaked again in 1913-14, when much discussion of the medical and industrial value of both radium and X-rays hit its pages along with talk about radium's high price and low supply (See Figure #1). No one major discovery contributed to this coverage peak: during this two year period, 20 of the 30 stories coded in the New York paper contained stories about medical topics and ten about supply--five of these stories mentioned both topics (See Table #1 for total coded).

Similarly, The Times of London's coverage peaked in 1913-14 with 34 and 63 stories respectively, of which the sample revealed that 16 stories spoke of medical topics, 11 of price and supply and five mentioned both categories. Both papers ran more stories in the two year period of 1913-14 than any other two year period in the sample (See Figure #1).

While there were a few major discoveries around this time, such as Rutherford's revelation of the positively charged nucleus and Niels Bohr's proposal for the orbital model of the atom, only nine discovery stories were coded in both papers compared to the large amount of price and supply and medical pieces.

Table 2 reveals that overall 36.0% of The New York Times's stories coded fell into the medical category, which was slightly more than the 31.5% coded in the same category for The Times of London. The Times of London carried more discovery pieces earlier in the period, but this trend evened out when looking at the total sample. Still, overall the London paper did carry a bit more discovery stories, at 12.8% and 18.5% for The New York Times and The Times of London respectively.

Table 2: Categories of Early Nuclear Coverage for The New York Times and The Times of London: 1896-1922

Category	Discovery	Power	Military	Medical	Price and Supply	Multiple	Other
The New York Times N=125	12.8%	.8%	.8%	36.0%	11.3%	26.4%	12.0%
The Times of London N=130	18.5%	*	*	31.5%	7.7%	29.2%	13.1%

X^2 = 4.83; d.f.= 6; Not Sig.; * = None Sampled

The final major peak in the newspapers' coverage occurred around 1921, when Marie Curie travelled to America, prompting renewed interest in the topic of radium. Of the 118 stories listed in the 1921 New York Times Index, 69 were primarily concerned with covering Marie Curie's American tour, with most mentioning radium in a secondary manner. The Times of London covered Curie's visit (10 of 32 indexed), but spread its coverage a bit more evenly among radium and X-ray topics that year.

Differences in the amount of coverage given atomic issues by the newspapers are most evident in the year following Roentgen's 1895 discovery of X-rays, when 64 articles were indexed in The New York Times but only three were listed in The Times of London. This lack of early coverage in the London paper may in part be due to the editorial turmoil it was undergoing during this time. This will be further explored in the Qualitative Results.

Another break in patterns occurred in 1906 when The Times of London gave a lot of coverage to the radium issue with 33 items listed in their index, while The New York Times's numbers dropped a bit to 11. The reason for this is unclear, but might be because of the in-depth coverage The Times of London gave to The British Association of Sciences meeting that summer, as well as the publishing of ongoing theoretical debates in the pages of the London paper.

Of the six nuclear categories coded there were no significant differences in the numbers coded for both newspapers (See Table #2). Table 3 reveals that when the stories coded as "multiple" were broken down and added back into the other percentages, The Times of London had more of its "multiple" coded pieces that contained both medical and price and supply issues. The London paper's price and supply totals went from 7.7% to 15.4% and medical stories increased from 31.5% to 37.9% with the "multiple" categories broken down, as opposed to a price and supply increase of 11.3% to 14.8% and a medical increase of 36% to 42.6% in The New York Times. This points to the greater practice of The Times of London to mention price and supply issues along with other categories such as discovery and or medical, while the New York paper more often devoted the whole story to the price and supply issues it covered.

Table 3: Categories of Nuclear Coverage With Multiple Category Types Broken Down and Added Back in for The New York Times and The Times of London: 1896-1922

	Discovery	Power	Military	Medical	Price and Supply	Other
The New York Times N=162	16.7%	4.3%	3.1%	42.6%	14.8%	18.5%
The Times of London N=182	25.8%	1.1%	3.8%	37.9%	15.4%	15.9%

X^2 = 7.83; d.f. = 5; Not Sig.

The New York Times sample contained seven articles discussing power uses of radium and/or X-rays while The Times of London sample contained only two. In terms of military usage, the numbers coded were not significantly different at five and seven articles for The New York Times and The Times of London respectively.

Table 4 reveals that no significant differences were found in sources used for the two newspapers, when looking at categories in which a particular source type was counted in both papers. The New York Times though did use more governmental sources than the London paper, which itself used a few more military sources. Science sources were the most popular type used in both papers with medical sources the second most popular.

Table 4: Mean Number of Source Types Per Story Used for Early Nuclear Coverage in The New York Times and The Times of London: 1896-1922

	The New York Times N=125	*The Times of London* N=130
Source-Type	**Mean Per Story**	**Mean Per Story**
Science	.776	.939
Medical	.608	.646
Industrial	.056	.054
Industrial-Med.	.008	.008
Industrial-Sci.	.008	*
Military	*	.008
Military-Medical	*	.008
Military-Science	.008	.008
Institutional	.016	.008
Inst.-Med.	.048	.077
Inst.-Sci.	.016	.015
Governmental	.088	.039

Table 4 (cont'd)

Gov't-Med.	.024	*
Gov't-Sci.	.032	*
Gov't-Legal	.016	.015
Layperson	.032	.023
Legal	*	.008
Author	.016	*
Publication	.040	.069
Other	.024	.023

t-test was not significantly different at $p < .05$; * = None Sampled

The newspapers' primary use of academic and non-aligned scientific and medical sources indicates that radium and X-rays were for the most part being researched and used outside of government and industrial locations--though sources from these areas were present in the coverage. The New York Times's greater use of government sources may point to greater activity by the U.S. government in new sciences and technologies than by the government in England.

In contrast, The Times of London's greater use of military sources may point to a greater pre-occupation of the English government with using the new technology in its military conflicts. The U.S. publications gave little coverage to the military significance in the new science and technology until World War I.

Table 5 reveals that no significant differences were found in the number of different source types used per story for the newspapers. It also reveals that 10% and 18% of the stories in The New York Times and The Times of London respectively cited no source, indicating a small inclination to run stories without direct expert collaboration. This calls to attention possible inaccuracies of these stories, but doesn't diminish the fact that the majority of stories coded were based to some extent on one or more experts' opinion.

Table 5: Percent of Stories With No Source Cited and Those with Multiple Source-Types Cited in The New York Times and The Times of London: 1896-1922

No. of Different Source Types Per Story	*The New York Times* N=125	*The Times of London* N=130
0	10%	18%
1	68%	65%
2	20%	15%
3	2%	2%

x^2 = 5.47; d.f. = 3; Not Sig.; * = None Sampled

There was a significant difference in the average length of articles coded for the two newspapers. The New York Times was found to have the longer average story length with 80.6 lines compared to 50.4 lines for The Times of London. Yet, longer length did not transfer over to an appreciable difference in the number of sources per story in The New York Times. In fact its numbers were slightly lower than those of The Times of London for both science and medical sources.

Table 6 reveals that the two newspapers differed in the number of story formats used. The Times of London relied much more on speeches and released reports, while The New York Times ran more editorials along with more hard news and feature articles. Yet, while the story formats so widely differed, the previous categories have demonstrated that the topics and types of sources used in the newspapers were very similar.

Table 6: Story Formats Coded for Early Nuclear Coverage in The New York Times and The Times of London: 1896-1922

	The New York Times N=125	*The Times of London* N=130
Article Format	**Percent**	**Percent**
Article/Story	**82%**	**62%**
Editorial	**8%**	**2%**
Letter to The Editor	**1%**	**13%**
Report/Speech	**8%**	**18%**
Abstract	**1%**	**5%**

$X^2 = 29.03$; d.f. = 5; $p < .001$

In terms of running art with their stories, The New York Times had six pieces coded with art compared to one in The Times of London. The New York Times also ran four pieces with more than one photo and/or line art, while no such combinations were coded for the London paper. This fits with the London paper's more conservative editorial approach to presenting news.

Comparison of Tone for The Two Newspapers

The second research question sought to compare the tone of the two papers' coverage. Tables 7, 8, and 9 indicate that the only significant difference in the coded percentages between the newspapers came under headline tone. The New York Times possessed more varied tone in their headlines with 26.4% positive, 16% negative and just 57.6% neutral compared to 83.8% neutral headlines found in The Times of London.

Table 7: Headline Tones of Early Nuclear Coverage in The New York Times and The Times of London: 1896-1922

	Positive Tone	Neutral Tone	Negative Tone
The New York Times N=125	26.4%	57.6%	16.0%
The Times of London N=130	9.3%	83.8%	6.9%

$X^2 = 21.45$; d.f. = 2; p.<.001

Table 8: Lead Tones of Early Nuclear Coverage in The New York Times and The Times of London: 1896-1922

	Positive Tone	Neutral Tone	Negative Tone
The New York Times N=125	32.8%	57.6%	9.6%
The Times of London N=130	23.8%	66.2%	10.0%

X^2 = 2.57; d.f. = 2; Not Sig.

Table 9: Story Tones of Early Nuclear Coverage in The New York Times and The Times of London: 1896-1922

	Positive Tone	Neutral Tone	Negative Tone
The New York Times N=125	40.0%	51.2%	8.8%
The Times of London N=130	37.7%	53.8%	8.5%

X^2 = .18; d.f. = 2; Not Sig.

Why the difference in the headline tones of the newspapers did not carry over into the lead and story tones is hard to answer, but part of the answer might relate to differing editorial practices of the papers. The Times of London was the more conservative of the two. It did not add photography until after 1908, with the first nuclear related photo not coded until 1921, as opposed to 1896 in The New York Times. This conservative nature fits with The Times of London's greater use of neutral headlines even though the leads and stories that followed contained a broader range of images.

In contrast, the more modern editorial practices of the New York paper might have focused on introducing their stories with a little more tonal variety to attract readers. Evidence for this practice is that the paper's 16% negative tone for headlines is greater than both its 9.6% negative lead tone and 8.8% negative story tone (See Tables #7, #8, & #9).

Still, the overall tone of both newspapers' articles was much more likely to be neutral or positive, with 91.2% and 91.5% of the stories in The New York Times and The Times of London respectively found in these two tonal ranges. These numbers are largely in line with Weart's findings in his analysis of headlines in the Readers' Guide to Periodical Literature. Yet, he found that the headlines from 1900 to 1940 were about 75% neutral, while this study found a wide range--from closer to 58% for The New York Times to 84% for The Times of London--during the first half of this period. This difference combined with the variance in lead and story tone from that of the headlines in the newspapers indicates that headlines are not an entirely accurate representation of the images presented in early nuclear coverage. Weart realized this, and thus also analyzed books and film from this period, but still the point remains that headlines do not accurately reflect the images presented in leads and stories.[1]

Weart also pointed out that he found very little negative coverage before the mid-20s, while this study largely concurs with that, negative coverage was found in the newspapers from the very beginning, and was present throughout this early period. The New York Times ran two negative pieces as early as 1897, along with only one positive. These negative stories talked of harm caused by X-rays. By contrast, negative pieces were absent from The Times of London until 1905. The Times of London ran another negative story in 1906 and peaked its negative coverage from 1908 to 1911, with 24% of its coverage being negative over this three year period (See Table #1).

The New York Times's peak period for covering the dangers of radium and X-rays came just after this period in the years 1912 to 1914, with 12% of its coverage being negative during this time. Along with these negatively coded stories The New York Times ran seven neutral stories that contained both good and bad aspects of atomic science and technology.

The negative coverage was for the most part due to deaths of X-ray workers by X-ray induced cancer. Why the coverage of this negative aspect of X-ray use peaked at different time periods in the newspapers is not readily answerable. The Times of London's coverage did increase again, however, from 1912 to 1914 along with the New York newspaper. During this time, 12 of the coded stories from the papers contained both good and bad aspects concerning radium and X-rays. It was by far the period with the most coverage given the debate over the use, nature and supply of X-rays and radium in the two newspapers for the time period sampled.

Comparison of Science and Nature

The third question concerned a comparison of the pattern of coverage for Nature and Science. Figure 3 and Table 10 show that both Nature's and Science's coverage of atomic issues were continuous through out the period studied. Nature carried by far the larger number of nuclear pieces with 1943 indexed pieces compared to 139 in Science. While the magnitude of coverage was much greater in Nature than in Science, both journals' coverage peaked in 1896, following Roentgen's late-1895 discovery. That year Nature ran 303 pieces on X-rays while Science ran 50. Table 10 shows that this was by far the most coverage given any nuclear discovery in one year by Science during the sample period, with 1914 being the next highest year with ten indexed articles. Nature's second most covered year for atomic issues was 1904, with 196 pieces counted in the index.

Coverage of the Curies' 1898 discovery of radium and polonium was low in Nature, with coverage dropping to 53 pieces (See Figure #3). The coverage of radium didn't really peak in the English journal until 1903-1904 with 124 and 196 indexed stories. Science covered the story with six indexed stories in 1900 and again peaked at six in 1903, then its coverage dropped to two in 1904. For Science the six stories in 1900 are a bit of a scoop on Nature, because of the fewer stories it normally ran.

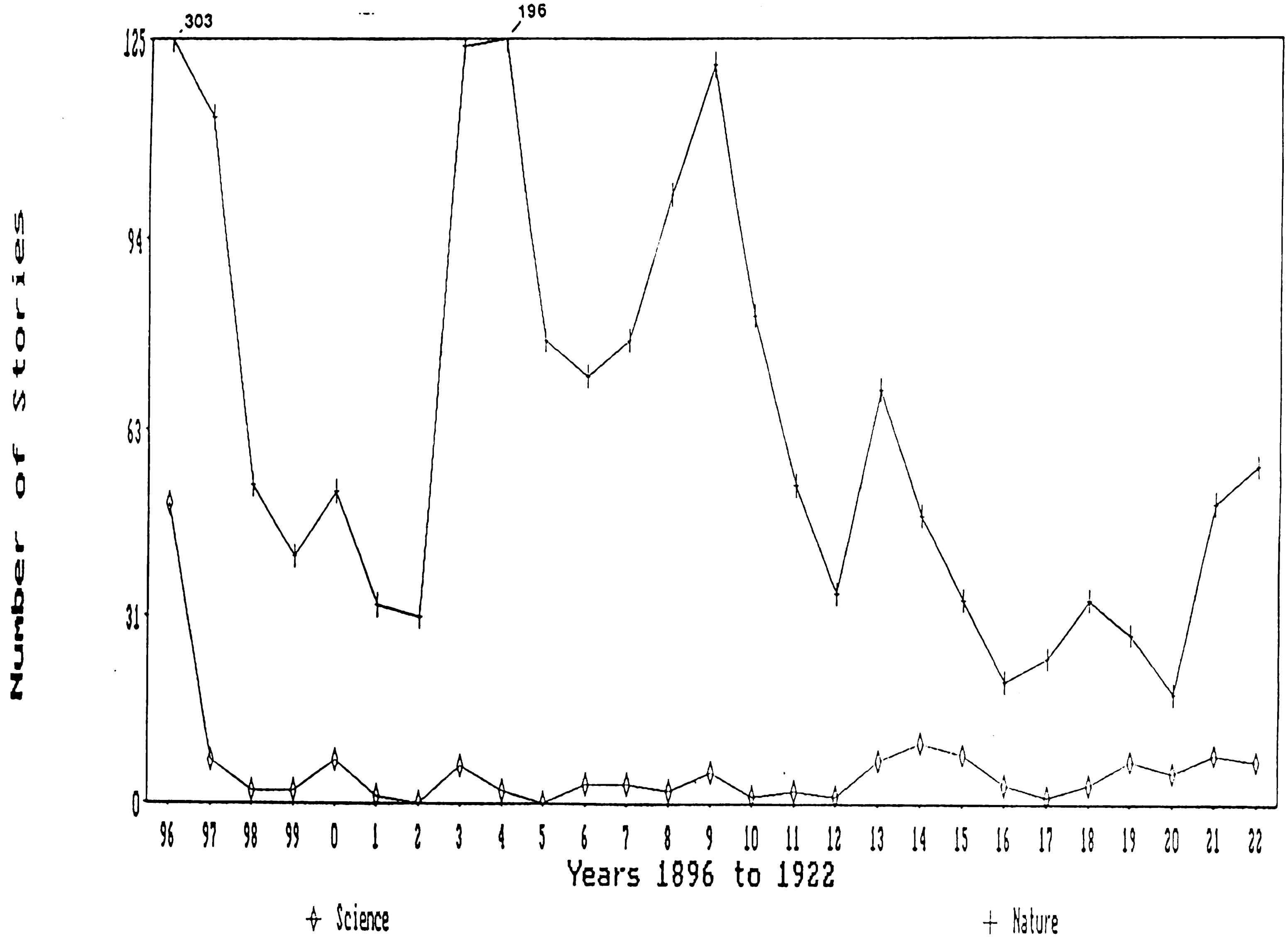

Figure 3: Total Number of Indexed Stories in

Science and Nature: 1896-1922

Table 10: Sampled Story Tone of Early Nuclear Coverage for Science and Nature: 1896-1922

	Science N=62			*Nature* N=174		
Tone	Pos.	Neut.	Neg.	Pos.	Neut.	Neg.
1896	2	10	0	4	23	0
1897	0	3	0	2	7	1
1898	1	0	0	2	3	0
1899	1	0	0	0	4	0
1900	1	2	0	0	4	0
1901	1	0	0	0	3	0
1902	0	0	0	0	3	0
1903	3	0	0	0	10	0
1904	1	1	0	1	16	0
1905	0	0	1	1	5	0
1906	0	1	0	3	4	0
1907	0	2	0	0	7	0
1908	0	2	0	0	9	0
1909	0	2	0	1	7	0
1910	0	1	0	0	7	0
1911	0	1	0	2	3	0
1912	0	2	0	1	4	0
1913	1	1	0	1	6	0
1914	1	3	0	0	5	0
1915	2	1	0	2	2	0
1916	0	2	0	1	1	0
1917	0	1	0	1	1	0
1918	0	2	0	2	2	0
1919	1	2	0	0	2	0
1920	2	0	0	2	0	0
1921	1	0	1	2	2	0

Table 10 (cont'd)

1922	1	1	1	1	4	0
Total	19	40	3	29	144	1

Coverage in both journals peaked again in 1909. Most of the stories coded for each periodical that year were found in the discovery category with 100% and 88% for Science and Nature respectively. Science increased its coverage again in the years 1913-1915, with four of its coded stories falling under discovery, two medical and three price and supply. Nature's coverage, though, actually fell during that three year period, and never again reached the 1909 peak of 121 indexed pieces. The decreasing amount of nuclear stories in Nature during this later period may be due in part to World War I, but another factor hinted at in some of the articles was the continuing increase in the amount of specialized science journals covering the nuclear topic in Europe. The presence of these other journals might have led Nature to decrease its coverage of nuclear issues over time, as it sought to redefine its market niche. The presence and effect of new journals will be more fully explored under Qualitative Results. Both journals had another major coverage peak in 1921-22--a period of major breakthroughs in atom smashing and when Marie Curie sailed the Atlantic to tour North America.

A significant difference was found in the types of nuclear categories covered in the two journals. Nature had 69.0% of its stories devoted solely to discovery, while Science's discovery articles made up 51.6% of its coverage.

Table 11 shows the contrast: Science contained more price and supply and "other" pieces with 6.5% and 11.3% of its coverage devoted to them as opposed to 2.9% and 6.3% in Nature.

Table 11: Categories of Early Nuclear Coverage for Science and Nature: 1896-1922

	Discovery	Power	Military	Medical	Price and Supply	Multiple	Other
Science N=62	51.6%	3.2%	*	6.5%	6.5%	21.0%	11.3%
Nature N=174	69.0%	*	*	7.5%	2.9%	14.4%	6.3%

$X^2 = 12.07$; d.f. = 6; p.<.035; * = None Sampled

The difference in story content resulted in part from Nature's tendency to run more laboratory reports and follow up experiments, while Science--published in the U.S., where large supplies of uranium ore were being found--ran more stories about supply issues. Science also covered a slightly broader range of topic categories than Nature, however, overall Nature presented many more nuclear stories. Table 12 reveals that the gap in price and supply stories closed when the multiple stories were broken down and added into the specific categories.

Table 12: Categories of Early Nuclear Coverage With Multiple Categories Broken Down and Added Back In for Science and Nature: 1896-1922

	Discovery	Power	Military	Medical	Price and Supply	Other
Science N=79	54.4%	5.1%	2.5%	8.9%	8.9%	20.2%
Nature N=205	67.8%	*	1.5%	12.2%	6.8%	11.7%

$X^2 = 16.34$; d.f. = 5; p.<.01; * = None Sampled

A further contrast is revealed in Table 13, with Science using significantly more science sources on average in its stories than Nature, with a mean of 3.951 as opposed to 2.373, even though Nature more frequently ran stories about discovery issues.

The differences in the number of scientific sources used is related to Nature's use of more abstracts as opposed to Science's use of more reports and articles. Science's use of longer story formats allowed for the inclusion of more sources per story. A significant difference was found in the length of the stories in the two journals, with 208 lines per story found in Science and 57 lines found in Nature.

Table 13: Mean Number of Source Types Per Story Used for Early Nuclear Coverage in Science and Nature: 1896-1922

	Science N=62	*Nature* N=174
Source-Type	Mean Per Story	Mean Per Story
Science	3.951[A]	2.373[A]
Medical	.194	.115
Industrial	.032	.012
Industrial-Med.	*	*
Industrial-Sci.	*	*
Military	*	.012
Military-Medical	*	*
Military-Science	*	*
Institutional	*	.012
Inst.-Med.	*	.006
Inst.-Sci.	*	*
Governmental	.016	.006
Gov't-Med.	*	*
Gov't-Sci.	.226	*
Gov't-Legal	*	*
Layperson	.048	.006

Table 13 (cont'd)

Legal	*	*
Author	*	*
Publication	.145	.046
Other	*	*

A = t-test revealed Sig. Diff at p. <.05; * = None Sampled

Most of the other source categories, including medical sources, were significantly different in the two journals. The length discrepancy used to help explain the difference found in science sources can also explain the similar numbers of medical sources--the majority of medical pieces coded in Science were shorter than its science pieces, thus providing further proof that the differences in the number of sources is due to the longer stories in Science.

Many of the source categories could not be individually compared because of lack of representation in one or more of the periodicals. One noteworthy difference, however, was the large use of governmental science sources in Science, with .226 sources per story as opposed to none found in Nature (See Table #13). This percentage is the second largest found in both publications after academic and non-aligned scientists. It is even greater than that found for medical sources. Additionally, under non-specific governmental sources a mean of .016 was found for Science as opposed to .006 for Nature. This also points to an increased use of governmental sources by Science over

Nature. This difference may be explained in part by the greater coverage in Science of the price and supply issues in the U.S.; much of this coverage cited governmental sources.

This different use of sources is also seen in Table 14 when looking at the percentages of stories with two or more source types. Science ran 31% of its stories with more than one source type as compared to Nature's 7%.

Table 14: Percent of Stories With No Source Cited and Those with Multiple Source-Types Cited in Science and Nature: 1896-1922

No. of Different Source Types Per Story	*Science* N=62	*Nature* N=174
0	*	1%
1	69%	92%
2	20%	6%
3	11%	1%

X^2 = 28.14; d.f. = 3; p. < .001; * = None Sampled

As mentioned previously, these coverage differences in part may be explained by the different styles of the two journals. Table 15 shows that 53% of the stories coded from Nature were abstracts of published pieces from other journals or sources, while only 15% of Science's pieces were in this format. Abstracts were usually less than 20 lines and often contained no more than three cited sources. Additionally, a larger percentage of Science's pieces were either articles or transcripts of speeches and lectures (which also tended to be lengthy) than were Nature's, with 25% to 6% respectively.

Table 15: Story Formats Coded for Early Nuclear Coverage in Science and Nature: 1896-1922

	Science N=62	*Nature* N=174
Story Format	**Percent**	**Percent**
Article/Story	**44%**	**16%**
Editorial	**0%**	**1%**
Letter to The Editor	16%	24%
Report/Speech	25%	6%
Abstract	15%	53%

$X^2 = 53.61$; d.f. = 4; $p. < .001$

Comparison of Tone of Coverage for The Two Journals

Table 16 shows that a significant difference was found in the tone of the nuclear stories in the two journals.

Table 16: Story Tones for Early Nuclear Coverage in Science and Nature: 1896-1922

	Positive Tone	Neutral Tone	Negative Tone
Science N=62	30.6%	64.6%	4.8%
Nature N=174	16.8%	82.6%	0.6%

$X^2 = 12.07$; d.f. = 2; p.<.004

Science was found to have a more diverse tone with 30.6% positive pieces, 64.6% neutral and 4.8% negative. Nature was much more neutral with 82.6% of its stories falling in that tonal area and 16.8% falling in the positive tonal range, just .6% were found to be negative. Some of this difference can again be explained by the different editorial styles of the two journals, with Nature running more short abstracts and Science more reprints of speeches--longer pieces with more room for personal opinion.

Science clearly presented a higher percentage of its pieces containing favorable images of atomic issues, while Nature remained closer to the scientific credo of objectivity in presentation of results and experimental progress. The flipside of this in terms of balance of coverage is that along with the more positive pieces Science also presented more negative articles than did Nature. Coverage balance within each journals' articles will be more fully analyzed in the Qualitative Results.

Comparison Among all Four Periodicals

The fifth question asked concerned the comparison of the pattern and tone of coverage for each of the four periodicals studied. Early coverage of the X-ray discovery and the subsequent experiments were heavy in three of the four periodicals. The New York Times ran 86 articles from 1896 to 1898 about the phenomena, Science ran 59, Nature ran 469, while The Times of London ran only seven articles. The year 1896 had by far the most articles listed in the journals for the nuclear issue, but the newspapers' coverage did not peak until 1914 (see Figures #1 & #3).

This later newspaper peak can be explained in part by the increased amount of medical stories found during this time, as opposed to the earlier focus on discovery issues--issues which continued to better fit the journals' focus (See Tables #2, #3, #11 and #12). Figures 1 and Table 1 reveal that the newspaper coverage of nuclear issues continuously evolved during the period studied, with 1913-1915 being the years when debate over its use was most varied and prevalent. Science too was found to have more coverage during this period than Nature. Finally, all four periodicals shared coverage peaks when Marie Curie travelled to North America in 1921.

In addition to having significantly different percentages of stories devoted solely to medical and science stories, the newspapers also carried more military, price and supply, "multiple" and "other" stories than the journals (See Tables #2, #3, #11 and #12). This points to a greater diversity of categories covered in the newspapers as opposed to the journals, with Science being the more diverse of the two journals.

A significantly greater number of scientific sources per story was found in the journals than in the newspapers, which contained more medical sources (See Table #4 & #13). The newspapers also used significantly more industrial and military sources than did the journals, another indicator of more diverse coverage.

These numbers also coincide with the numbers found concerning medical and science categories in the respective periodicals (See Tables #2, #3, #11, & #12). Nature's use of fewer medical sources follows along with its running of fewer medical stories as well as its citing of fewer different source types per article, with 93% of its pieces citing only one source type (See Table #5 & #14). The picture concerning governmental sources is more complicated.

While The New York Times used more governmental medical, governmental legal and non-aligned governmental sources than its home-country's journal, Science, it used fewer governmental science sources. In contrast, while The Times of London used more governmental legal sources, no significant difference was found between the number of non-aligned governmental sources it used as opposed to those cited in its home-country's journal, Nature. While the reasons for these observed differences are not readily apparent, it is obvious that the U.S. publications relied more on governmental experts than did the English publications.

Another difference between the publications was that while no significant difference was found between the length of stories in Nature and The Times of London, a difference was found between their length and that of both The New York Times and Science, which also differed among themselves. Length differences are attributed to editorial differences as opposed to differences in the perceived editorial importance of nuclear issues.

Nature's predominately neutral coverage caused its range of tone to be significantly smaller than The Times of London's, while no significant difference was found between the overall tone of atomic related stories in Science and The New York Times. This again highlights the more diverse tonal coverage found in Science's pieces during the period studied. The tone of its images were closer to that of two elite newspapers of its time than the science journal it was modeled after.

This is just one example of the differences found between journals. Some of these differences, such as reliance on certain source types and certain categories covered, can be seen to be influenced by location, but the tonal difference found between Nature and Science is attributed to the editorial style of the journals and in part indicates the tendency of Science to run stories that carried a broader range of tones concerning nuclear issues. The New York Times's coverage likewise was seen to be continuously more broad in the tone and categories covered than was that of The Times of London.

Coverage of nuclear issues during this period in all publications were mostly neutral and positive in tone, but voices of caution and images of danger were also continuously present in the media. The majority of the negative articles coded in the publications fell in the category of medical news. Of the 170 medical stories coded about 11% were found to be negative. The negative medical articles dealt mostly with radiation damage and cancers.

The subtleties of the patterns and tones used to present nuclear issues will be fleshed out in the Qualitative Results, through assessment of the metaphors and applications of early nuclear science.

Chapter Five

Notes

1. Weart, p. 53.

CHAPTER SIX

QUALITATIVE RESULTS

In discussing most scientific discoveries, the terms science and technology overlap. It is often hard to separate the two areas, though many have tried. In a broad sense, science can be said to be the continuous attempt to explain natural phenomena using methods of observation, experiment and hypothesis testing, replication of results and the continuous production of new ideas and experiments.[1] Technology can be thought of as the applied use of this knowledge through equipment, utensils, tools and devices (technics). These technics or technologies are often used to manipulate the environment to meet perceived human needs. But it is often not so easy to differentiate between the steps taken by science and technology. In an attempt to do so one technology historian came up with a definition of technology "as that research where the main product is not a paper, but instead a machine, a drug, a product, or a process of some sort."[2]

An interweaving of the continuous efforts of nuclear science and the production of resulting technics was found to be constant and almost simultaneous in this study. The first article coded from The New York Times was a front page article from February 7, 1896, discussing Roentgen's X-rays. The lead stated that after hurried attempts at Princeton to reproduce Roentgen's data, experiments have "yielded some very interesting results."[3]

It was clear from the article that the actual nature or effect of the rays was still a mystery, but it went on to quote a Princeton professor about "the practical application of this great discovery" in both the medical and industrial fields. Already the line between theoretical science on paper and applied technology in practice had been crossed with this article, of which almost 80 percent was direct quotations from the professor. Along with applications of the technology, the professor discussed such involved scientific topics as the differences of permeability of varied substances to the new rays, as well as discussing the debate over the wave nature of light.

The next coded New York Times article, from February 12, 1896, directly quoted the famous American inventor Thomas Edison concerning his experiences with the new rays. It too was a very technical piece that discussed the difficulties in getting the proper equipment to duplicate Roentgen's process. It was followed in the sample by two more articles in which Edison further explained his accomplishments in getting the rays to work, as well as his continued desire for better equipment.[4]

Yet, great inventors were not the only ones getting in on the new discovery at this early date. A New York Times piece, from March 21, 1896, told of how a Madison Square

Garden electrician had built an X-ray apparatus, which he used to take a picture of shotgun pellets in the hand of a man, who had accidentally shot himself. The possibilities and usefulness of the new technology were clearly being quickly explored by amateur and professional scientists alike. This wide spread, hands on exploration of the new and powerful technology can be seen as an early avenue of popularization.[5]

The lead from a New York Times Sunday magazine article on September 6, 1896, summarized the great interest and hope aroused by Roentgen's discovery:

> While some discoveries of a purely scientific character appeal only to a limited class, others broadly affect the life and happiness of the human race and thus become of universal importance. The discovery of Prof. Roentgen is unique in that it interests alike the scientific and non-scientific intelligent minds of all countries. To the world of science it suggests new problems as to the constitution of matter and the subtleties of electricity, while to the race at large it opens up a new means of diagnosis and relief of suffering and disease.[6]

Immediately, the new science and technology were perceived as interesting by both scientists and non-scientists and were being looked to as a way of reducing human suffering. The introductory article on Roentgen's discovery in The Times of London's sample, dated February 28, 1896, spoke of the use of Roentgen's rays in aiding medical diagnosis. Though just 26 lines long compared to the 160 lines of the first New York Times piece, it too showed that the discovery had already crossed from the laboratory to application in everyday life. The article, which originated in Montreal, Canada, told of how members of McGill University had used a cathode ray tube, following Roentgen's methods, to help in the extraction of a bullet from a man's leg. The article relayed that the university, "can boast of perhaps the first [surgical use] in America, and probably that in which the greatest thickness of tissue has been so far penetrated."[7]

X-ray technology and advancement of its use was quickly being presented in the language of competition and prize-winning. The race was on to reap the fame from controlling its power. At the same time though, scientists were also caught up in more mundane and less heralded debates such as those over proper nomenclature. A Times of London letter to the editor from March 10, 1896, focused on this topic of choosing the proper name for the new energy rays. The author talked of dropping the name "photography" from the X-ray process and instead calling it "scotography," to highlight the difference between rays of visible light and the rays that form X-ray images.[8]

Comparing the content of these early articles sampled in each newspaper reveals that the articles in The New York Times, in using many direct quotes from scientists, contained much more detailed scientific analysis of X-ray subjects than did the London paper's pieces. Yet the letter-to-the-editor carried in The Times of London did introduce a bit of the early scientific debate going on concerning the mystery rays. While the use of a large number of direct quotes from experts in The New York Times helped to better present the more technical aspects of the science and technology, it also limited the number of points of view presented. In the articles with a lot of direct quotes, much of it came from only one or two scientists.

This trend of using direct quotes from one or two scientists also points to the limited ability of these early journalists to synthesize and paraphrase the new scientific material. Yet, at the same time it allows them to somewhat escape the often heard charge that their stories about scientists' work were misleading and incorrect. Because of their practice of directly quoting the scientists, it is hard to say that the journalists did not accurately relay what was going on in the laboratory or medical office. Though the use of fewer sources did limit the number of scientific voices heard from.

Even with its early practice of using fewer sources, The New York Times's coverage was much more broad and comprehensive concerning the nuclear issues than London's elite paper right up until 1903, when the number of articles covering nuclear issues in The Times of London jumped to 27, up from one the year before.

A Times of London article from January 14, 1897, shows that the paper's limited coverage was not due to a lack of knowledge of the importance of Roentgen's discovery, but rather points to a more cautious approach to the topic--a more "wait and see" attitude than was present in its New York counterpart. The article headed, "Science in 1896," began with the statement, "The chief interests in pure as distinguished from applied electrical science during the year 1896 have centered round the important discovery which Professor W. K. Roentgen, of Wurzburg, announced at the beginning of the year."[9] The article went on to say, "Although a torrent of scientific literature has been poured out since the announcement of that discovery and having those rays for its subject, and although an army of investigators have attacked the subject, it can hardly be said that very much has been added to the original facts discovered by Roentgen...."[10] Continuing with this wait and see approach, the piece ended with, "It is not at all improbable that the so-called X radiation is a complex thing, and that much research will be necessary before we thoroughly understand the method of its propagation."[11] It is not clear why the London paper did not carry more of this early flood of X-ray stories, but it is clear that many continued to explore the complex mystery.

First Coverage of Roentgen's Mystery Rays in Science and Nature

The early, more cautious attitude found in The Times of London was somewhat similar to the coverage found in Science and Nature. The first pieces on Roentgen's discovery in the two science journals were printed two to three weeks before the papers picked up on the topic. The introductory Science article, from January 24, 1896, simply spoke of the ray's ability to penetrate certain substances and mentioned the trustworthy reputation of Roentgen, saying, "any experiments published by him would be accepted without hesitation." This peer trust of results based on an investigator's scientific reputation was also seen in the introductory pieces covering the Curies' revelations about radium and polonium. It was as if in each of these revolutionary discoveries, the journalists and scientists who wrote about them had satisfied their initial skepticism by looking to who in the scientific world had made such startling claims, thereby basing believable fact upon a researcher's reputation until time passed to allow his experiments and data to be reproduced.[12]

Another trend illustrated in this introductory Science article was that it opened by saying that the initial Roentgen story had first been reported in papers such as the Vienna Presse and the London Standard. This trend of using newspapers as initial sources was also seen in a piece dated June 26, 1896, as well as one from November 19, 1897. The 1896 piece began, "The daily papers contain several communications regarding reputed anticipations of the X-rays sufficiently curious to deserve repetition." It cited information from the Grand Rapids Herald, Mechanics Mirror, Scientific American and the Daily News.[13]

The Science article from November 1897 told of how the only two exhibitions mentioned by The Times of London, after a recent meeting of the British Roentgen Society in London, were both from America. One exhibit was a full-size, X-ray picture of a woman's skeleton, and the other was an X-ray apparatus that used a special Tesla-built tube, which could create an X-ray image from 50 feet away.[14] Science had quoted The Times of London's description--the bottom paragraph of a half page article--in full. Clearly, transfer of early atomic knowledge flowed among publications and across oceans.[15]

The initial Nature article concerning Roentgen's rays was printed on January 16, 1896, a week earlier than the brief Science piece--to which it was quite similar. The second articles coded from both journals were identical. They were reprints of Roentgen's initial article "On A New Kind of Rays." Nature had reprinted the article from the German journal, Sitzungsberichte der Wurzburger Physik-medic. Gesellschaft, which ran the piece in 1895.[16] Science reprinted the translated article from Nature on February 14, 1896.[17] This trail of publications gives further indication of how science news jumped from source to source at the turn of the century. It also points to the place on the academic chain in which American scientists and science journals fell in the field of atomic physics during this early period.

Roentgen's article related that the new rays were not observable to the eye, like those of visible light, nor hot like infrared rays, nor like the powerful ultraviolet rays from the sun. At the end of his article, Roentgen followed proper research etiquette and stated that more experiments were needed to better understand just how these rays traveled through the ether. The article also contained a picture of an X-rayed hand, in which the bones could be clearly seen along with a large wedding band. Roentgen himself had initiated the use of his discovery to explore the human body.

Deeper Analysis of the Early Coverage Concerning the Medical Use of X-rays

Articles in all four publications during this early period, from 1896 to 1902, increasingly dealt with both the medical and industrial benefits of the mysterious rays and the device that produced them. A New York Times article from June 27, 1897, talked of how the "invisible rays will in the future play an important part in the lighting of our houses and streets." The same article went on to state that when "the human body has been lighted up with them, it has been possible to find fragments of glass, needles, bullets inside it, and the surgeon seeing has been able to remove them."[18]

A positively coded New York Times front-page article from November 2, 1901, was headlined:

> X-rays USED AS A REMEDY FOR CANCER
> -Chicago Doctor Declares Roentgen
> Light is a germicide.
> -permanent cure said to have been effected
> in the case of Mrs. Orrin W. Potter.

Mrs. Potter had received X-ray dosages every other day for three months as treatment for breast cancer. The doctor treating her was adamant about the success of his treatment and said, "I believe this treatment is an absolute cure for all forms of cancer." He went on to explain his theory that X-rays kill the cancer-germ and then stimulate glandular action for new cell growth. True to the pattern already noted, only one source was cited for this story, 85 percent consisting of direct quotes from the treating doctor.[19]

The Times of London ran a X-ray medical story that originated in Vienna on April 19, 1898, which told of how a doctor had experimentally proven that X-rays could control lupus and remove superfluous hair.[20] Another piece, from February 8, 1901, echoed X-rays' medical importance, but this time they had been used to help save the wounded on the battlefield. The article relayed how Lt. F. Bruce, R.A.M.C. had set up his battery powered X-ray apparatus, while under fire during the "Siege of Ladysmith" in the Boer War in South Africa. In the course of the battle, Bruce X-rayed over 200 wounded, some who had been hit with exploding bullets. When the apparatus's batteries began to lose power, he ingeniously hooked up a recharging dynamo to the mill-shaft at the local flour mill. At the end of the article, Bruce suggested improving the appartatus's usefulness by building a better operating table, with which X-rays could be taken from beneath, and by including an oil motor with it to power the dynamo.[21]

During this early period, much of the atomic coverage was filled with similar amazing stories of the X-ray's usefulness, but at the same time a few stories were also being run that dealt with the adverse effects that the unknown rays could have upon the human body. The first negative story coded in any of the publications was a New York Times article from April 27, 1897. It relayed the story of a man who wanted to sue his doctor for negligence after his broken leg had healed shorter than the other. Wanting to use the new X-ray technology to prove his case, he had unsuccessfully tried four times to get an X-ray of the mended spot, and so, on the fifth time, had exposed his leg to the high energy rays for almost two hours. Shortly thereafter, the area that had received the radiation became gangrenous and doctors stated that the flesh, nerves and ligaments of the area had been totally destroyed.[22]

The New York Times followed this piece with an editorial on July 31, 1897, that stated, "After the courts have awarded heavy money damages in a few cases of injury and disfigurement by the X ray, the manipulators of that mysterious energy will probably employ the precautions which experience has already shown to be necessary." The article mentioned the "lamentable case of Miss Macdonald," and relayed Tesla's explanation that X-rays burn in much the same manner as a red hot stove, and thus operators who put the source of the rays too near their patients will severely burn them. While noting that Tesla's explanation may or may not hold for the mysterious rays, it ended by stating that, "The protection of patients against the dangerous emanations, whatever its nature may be, is the practical duty of the X ray operator."[23]

The editorial noting the danger of the mysterious rays was followed in The New York Times by a brief 12 line article on January 2, 1898, headed THE X RAY MADE INNOCUOUS,[24] and on November 1, 1902, by an article headed,

SUIT AGAINST DENTISTS FAILS.
They Contended That They Were Not
Responsible for X Ray Examination.[25]

The November article relayed the court case of Josephine McDonald, who presumably was the woman mentioned in the previous editorial, cautioning X-ray practitioners. McDonald was denied the $50,000 in damages she had sued her dentists for, because they had successfully argued that they had mearly watched the X-ray expert perform the procedure on her, to see if it would help her unhealthy jawbone. McDonald had sued because her face had been severely damaged during the treatment and her hair had subsequently fallen out.[26]

A month and a half later, The New York Times ran a related article that told of the establishment of the office of X-ray Expert and Electrical Diagnostician of the Law Department of Chicago. The office was set up to handle the "numerous attempts at fraud through the evidence of X-ray and electrical so-called 'experts' in claims against the city for personal injuries."[27]

An early cautionary article toward X-rays was also coded from The Times of London. The article was written on November 3, 1900, after a meeting of the Roentgen Society. It relayed a speaker's statement that "they had it on the authority of the editor of one of the leading medical journals that the result of the use of the rays in fractures had been over-estimated, and distinguished physicians had on more than one occasion of late given expression to regrets about their limited value in medicine." This statement seems to follow the same cautionary tone found in the "Science in 1896" piece previously discussed, but it does go on to say, that

> it was difficult to see what could give rise to extreme disappointment unless it were too high an estimate and expectation at the beginning of what was a very recent, but happily progressive, science. It should be remembered that when the microscope was first introduced into clinical work too much was expected of it.[28]

The tone of the piece is also similar to others found in this early grouping. It began cautionary, even negatively, but moved on to the positive and beneficial aspects of X-rays. This seems to exemplify the tone of The Times of London's articles from this early period. In contrast, The New York Times's coverage, true to its overall tonal pattern, presented both more outright positive and negative images right from the start. Admittedly, just the fact that The New York Times covered this early period with 96 stories to 16 stories for The Times of London (See Figure #1) may allow for this early similarity to its overall tonal pattern.

It is not totally clear why The Times of London didn't give more coverage to the early discoveries related to atomic issues. Much of it may have to do with the crisis in the head office that was occurring at that time--a period of decreasing circulation along with the introduction of competition from the penny press. Yet, at the same time the newspaper was spending a lot of money to maintain "the finest foreign news service in the world." Whatever the reasons for the limited early nuclear coverage, it is clear that many other publications, including the other three in this study, were interested in presenting atomic issues to their readers.[29]

Still, this hopeful Times of London article (November 3, 1900) did mention the great interest surrounding the use of the X-ray apparatus during wartime and is in many ways similar to other coded articles from the paper during this period. It originated from a Roentgen Society, of which many were established throughout the world shortly after the discovery. England's was among the first, and its purpose was to help advance the understanding and implementation of the mysterious rays. Many of the early stories in the London paper originated from lectures or demonstrations at the Roentgen Society. The increasing presence of specialized journals was noted in this piece. It commented about the creation of scientific and medical journals through out the world dedicated to reporting material on continuing investigations with X-rays. This publication trend was first noted by a Times of London piece from 1897, which stated that even at that early date "three journals had been established for the publications of observations and discoveries connected with Roentgen rays, and every month saw formidable additions made to the literature of the new science."[30]

Comparison of Early Coverage of X-rays: Journals vs. Newspapers

Most of the nuclear articles written in the journals focused on scientific and discovery issues, but Nature did run an article dedicated solely to the medical use of X-rays as early as February 6, 1896. The article exemplified two trends already mentioned: it quoted material from another journal of the time as well as a scientist from another country. The article cited the British Medical Journal as stating that "Medical science seems likely to benefit much by the application of Prof. Roentgen's discovery." It then added an Austrian scientist's account of taking a clear and precise X-ray of the damage caused by a revolver shot through a man's hand.[31]

On the same page as this positive, medical story was a short note by Nature's editor, William Lockyer, in which he described an X-ray photo of a hand, highlighting the visible differences in appearance of bone, gold and glass in the X-ray. This was the only piece coded where it was possible to identify one of the publications' editorial staff as a writer, and points both to Lockyer's close attention to the material in his journal and to the editorial importance given the new discovery.[32]

In regards to atomic related art, the two journals and The New York Times published more photos and line graphs of the early X-ray discoveries than did The Times of London. This in part is due to the more conservative publishing practices of the London paper that have already been noted. The paper did not modernize its presses or introduce the picture page until after Northcliffe purchased it in 1908.

Similar to Nature, the first solely medical related article in Science appeared early in 1896. The piece stated:

> The manifold uses to which Roentgen's discovery may be applied in medicine are so obvious that it is even now questionable whether a surgeon would be morally justified in performing a certain class of operation without having first seen pictured by these rays the field of his work, a map, as it were of the unknown country he is to explore.[33]

This article, in raising the question of ethical use of the X-ray technology, reads much like The New York Times's editorial that discussed the need for X-ray operators to protect their patients from any possible danger.[34] While ethical use is being offered here in opposing situations, it does indicate that some saw incorporation of the powerful new device as needing knowledgeable caution.

Three more generalizable points were also found in this Science medical article. The first is that it ran 189 lines, which fits with the finding that Science had the longest average story length of the publications analyzed. Secondly, it also contained eight medical, one newspaper and four scientific sources, true to the findings that on average the two journals used more science sources per article than the newspapers--the American journal containing more stories with three or more source types (See Tables #5 & #14). Finally, the article was written by a scientist as were 41% of the journals' articles, compared to just 5% for the newspapers.

While medical pieces were found early on in both journals, Nature contained more coded medical stories than Science, seven to three. One of these Nature pieces was an abstract of a story which detailed the ongoing debate over who was to get credit for being the first to use X-rays to determine if a patient's bone was fractured.[35] This article provides another case in which use of the technology was placed in a competitive framework by the scientists themselves. Another three line medical abstract, which originated in Paris, simply told of the discovery and extraction of a needle embedded in a patient's hand.[36] And another abstract from Paris told of how a coating of silver chromate allowed the X-rays not only to photograph muscles but also muscle bundles.[37]

The only other medically related article coded from Science during this early period was an abstract from Germany. The piece described the use of X-rays to determine the "calcification resulting from pulmonary consumption." It was followed on the same page by a non-coded piece from Paris that talked of the use of X-rays for treating tuberculosis.[38]

These articles point to the trend found in Nature, and to a smaller extent in Science, to use abstracted pieces from scientific societies and journals throughout the world--Canada, Paris and Germany being cited most often. Nature ran 53% abstracts, 6% reports and/or speeches and only 16% articles as compared to 15%, 25% and 44% for Science (See Table #15).

While no negative pieces were coded in Science during this early period to 1902, one was found in Nature. The article from April 8, 1897, referred to a previous Nature article about the harmful effects of X-rays on a scientist's hands. The piece then summarized an article from the British

Medical Bulletin:

> X-rays are even more powerful than have been generally thought, and that the deleterious effects may in some cases be quite serious; the cutaneous manifestations are not however, the most severe of the lesions, but they are surpassed in severity by those of the deeper tissues, and particularly of periosteum and bones.[39]

Another Nature medical article, from the Spring of 1897, acknowledged that X-ray workers are being injured by the apparatus, but suggested it was not the X-rays that were harmful but rather the strong currents surrounding the machines.[40]

While both negative and positive medical stories were found in the two journals, they were few in number. Most articles fell within the neutral tonal range and under the discovery category (See Tables #11, #12 & #16). Stories about discovery topics such as new instrumentation and changing theories were by far the most prevalent in the journals.

One such discovery abstract from Nature ran on April 21, 1898. It dealt with a method of increasing the intensity of X-rays by passing them through a glass or metal tube before reaching the photographic plate.[41] During this same time, across the Atlantic descriptions of new and improved apparatuses were also being printed. Sometimes the same description was run in both journals. Science ran Lord Kelvin's lecture ELECTRIFICATION OF AIR BY ROENTGEN RAYS, on January 22, 1897, which he had sent to them as it was printed on Nature's proof sheets. Much of it was a description of the apparatus built to test the scientist's hypothesis, as well as what was done to modify the apparatus as the experiment proceeded. A diagram of the apparatus was also included and the piece was signed by Kelvin and his two assistants.[42]

While discovery type stories consisting of instrumental and theoretical pieces made up most of the early coverage, "other" type stories were also presented. One "other" story subject that reoccurred in both journals concerned experiments with the effects of X-rays on plants. One of the two early Science plant-related articles was dated June 26, 1896. It began, "The marked attention which the Roentgen or X-rays are receiving from investigators of this and other countries, and the popular excitement felt in the investigations render all papers on this subject of particular interest." It went on to say that early research on the effects of X-rays on plants was inconclusive because the available apparatuses could not expose the plant to the rays for a long enough period of time.[43]

Nature also ran four early plant related abstracts. Two of them dealt with the use of X-rays to determine physiological aspects of plant life. The other two abstracts analyzed the effect of X-rays on germination and growth. Like the Science article cited above, neither found that X-rays had any major effect on plant growth. Unlike the longer Science article though, the two shorter abstracts did not mention the need for further experimentation or the deficiency of quality equipment.[44]

Another interesting "other" story found in Nature during this early period was an abstract of an article from the British Medical Journal. It dealt with the use of X-rays to help photograph bird, reptile and mammal fossils still embedded in rock.[45] In line with this innovative use of the new technology on June 4, 1896, Nature ran an abstract from the Royal Society of Edinburgh in which X-rays were used to photograph a mummy's foot.[46]

Experiments such as these which used the new power of X-rays to explore old questions continued throughout the study period, but were overshadowed somewhat in 1898 and more so around 1903, when it was learned that elements from the earth could similarly imprint the shapes of objects on photographic paper and could also produce their own heat.

Becquerel and the Curies Arrive on the Scene

Both Science's and Nature's largest peaks of coverage came in 1896 and were devoted entirely to the X-ray subject. After this peak, Science's coverage dropped to seven stories in 1897 and two in 1898. Whatever the reason for this drop, the journal gave much less coverage to Becquerel's 1896 uranium emanation discovery and to the Curies' 1898 revelations about radium and polonium (See Figure #3). Though Nature's coverage also dropped off during this period it still carried many smaller pieces on these early discoveries, with its first detailed Becquerel-ray piece running on April 23, 1896. In it J.J. Thomson briefly discussed the similarities between X-rays and uranium emanations before continuing on to describe his current X-ray work. This early trend to lump both radiating phenomena together was found in many scientists' work during this time. This also may partly explain why coverage of radium discoveries were more limited at first. The large amount of coverage that X-rays received may have taken away some of the early novelty from the new radiation phenomena.[47]

Nature's first coded mention of radium and polonium was in an abstract from the Paris Academy of Science on November 16, 1899. The piece talked off how substances placed over radioactive materials such as polonium or radium picked up their radioactive qualities.[48] Nature carried a few more such abstracts, but the first really detailed article wasn't coded until June 13, 1901. It was a 140 line piece by Ernest Rutherford, writing about his research from McGill University.[48]

Similarly, Science at first gave only brief mention to the new radioactive discoveries. It did run an article about J.J. Thomson's further research into the nature of the atom in its September 7, 1900, issue that quickly mentioned the effects that X-rays, uranium and radium have upon atoms. The article though was mostly concerned with relaying just how revolutionary his work was at the time. Thomson had begun to conceptualize matter and atoms not as solid balls but as porous. He came to this conclusion partly through the use of a cloud chamber, which allowed the calculation of air conductivity in a box saturated with water molecules.[49]

The article took on a very positive tone when discussing

Thomson's work: "'his theory must be classed among mere Utopias.' It would seem that a beginning has been made in attaining Utopia." This was not the last time that references to Utopias and the relieving of all illnesses and energy problems were to be associated with the communication of early atomic theory and its application.[50]

The discussion of the new discoveries continued and on July 12, 1901, one month after the Rutherford article had run in Nature, Science ran a more in depth, 672 lined piece on radioactive substances in which Becquerel's and the Curies' discoveries were more widely explored than before. Twelve different scientific sources were cited in the story. The article raised the possibility that the luminescent quality of radium salts were in fact "the longed for light without heat." It went on to say that a fortune might be made in investing in radium, but tempered itself by admitting that the fortunes would have to wait until the cost of extracting radium from pitchblende and its other ores decreased.[51]

These early articles on radium and uranium carried images both of wealth and the betterment of human life. The detailed pieces appeared in the journals' coding sample almost two-and-a-half years before the first comparable piece on radioactive elements was coded in The New York Times and two years before any mention was found in The Times of London.[52] Yet, two earlier, brief mentions of Becquerel's work were coded from The Times of London sample, one from its yearly wrap-up "Science in 1896" and another in "Science in 1897."[53]

Besides scooping both papers on presenting a detailed explanation of the theoretical aspects of radium, Science also scooped the papers and Nature in discussing radium's possible medical applications. On July 31, 1903, in a reprint of a letter from Alexander Graham Bell to a doctor in Washington, D. C., Science ran Bell's suggestion that if both radium and X-rays had been found to cure external cancers, "there is no reason why a tiny fragment of radium sealed up in a fine glass tube should not be inserted into the very heart of the cancer."[54]

Science's scoop is made more interesting when considering that medical stories made up only 6.5% of the stories from Science, while they accounted for 36.0% of the coverage from The New York Times and 31.5% from The Times of London. The letter scooped The New York Times by about five months in referring to radium as a cancer treatment, and beat Nature by about three years in reporting the use of radium in a medical setting.[55]

Science also scooped The Times of London by three years in the sample, though a brief mention of radium's power to burn flesh was included in the first radium story coded from the London paper. It stated that,

> Radium, if kept in contact with the skin for some hours, or even if carried in the waistcoat pocket, produces an open sore, by destroying the epidermis and the true skin beneath....Radium emanations act powerfully upon the nerve substances, and cause the death of living things whose nerve centers do not lie deep enough to be shielded from their influence.[56]

This story from The Times of London is an example of a story that was coded neutral because of its presentation of both the positive and negative aspects of radium. Along with the above quote the story also carried the message that "Radium has excited the keenest interest by its power of throwing off rays, vibrations, emanations,...It is obvious that M. Curie has introduced us to forces of a totally different order of magnitude." This debate over the positive and negative powers of the Curies' discovery was to continue throughout the decade.[57]

Nuclear Coverage from 1903 to 1911

Becquerel and the Curies split the Nobel Prize for Physics in December 1903 for their respective studies, marking the second peak of nuclear coverage found in the publications. Exploration of radium's mysteries and usefulness continued throughout the period from 1903 to 1911. As stated previously, the newspapers sampled didn't really pick up their radium coverage until 1903, which was a period in which Pierre Curie toured many nations with his vial of hard earned radium, lecturing and explaining that radium spontaneously emitted heat along with its already known qualities of luminescence and radioactivity.[58]

The New York Times ran an editorial concerning the great energy and heat released by radium on May 8, 1904. It opened with,

> There seems to be hardly any limit to the marvels of radium. A French person [Assumedly Pierre Curie] of science foresees its immense influence on mankind when it shall be procured at a less frantic cost. He affirms that its heat rays are capable of melting down stones and massive iron and steel structures and that its qualities must interdict all war.[59]

The writer thought it interesting that this very concept had been raised by H.G. Wells six years earlier, in his book The War of Worlds, and felt certain that the Martian death rays, from the classic space invasion story, were produced by radium.

This story was coded under both power and military and was the only power story that ran in The New York Times during this period, while none ran in The Times of London. In contrast, 11 and 26 pieces respectively ran in the two newspapers during this period dealing with the discovery aspects of radium and X-rays.

During this period the London paper carried a higher percentage of discovery stories than did the New York paper, which carried more stories on medical and price and supply issues along with its discovery pieces. The Times of London did switch to a wider variety of nuclear category coverage after 1911, when it too began to run more price and supply and medical pieces. This discrepancy in the amount of discovery pieces during this period is in part due to an ongoing debate that was being carried on the pages of London's elite newspaper. The debate took the shape of a series of letters-to-the-editor, mostly between a person who signed his letters, Ignoramus, and Sir William Crookes, one of the major discoverers of the cathode ray tube.

Over the course of many months these two scientists, as well as their supporters, argued over theoretical points of radium's nature on the pages of the London paper.

One such letter from March 28, 1903, stated,

> Sir,-According to the ingenious explanation offered by Sir William Crookes, the Radium effect depends upon the impact of rapidly moving molecules of gas. Ought not Radium in that case to cease to display its peculiar properties in a vacuum?...I ask merely to elicit information, being only an IGNORAMUS.[60]

Crookes replied one week later,

> Sir,-Perhaps I may be allowed to occupy a few lines in reply to the reasonable remarks of your correspondent "Ignoramus." According to the hypothesis I ventured to formulate, I have little doubt that radium would cease to show its peculiar properties in a perfect vacuum. But such experiments at present are impossible of performance....I have the honor to remain yours, &c., WILLIAM CROOKES.[61]

The debate continued with supporters of each man getting in on the dispute. The coverage of the debates between Crookes and Ignoramous and their supporters, indicates that both scientists and the media were interested in presenting scientific issues to the public. But more importantly it also reveals that the public were allowed to become involved in scientific debate over the proper interpretation of a new and powerful phenomena.

Such debates over scientific truth were not limited to London or to the letter-to-the-editor column. The New York Times presented another point of debate in an article discussing radium's possible transmutation of elements. The article appeared a couple of weeks after the awarding of the

1903 Nobel Prize. In this article, Sir William Ramsay, who had become famous for his 1895 discovery of the second smallest element, helium, wrote of the new discovery as if he were giving a lecture to a class. In it, he relayed that one product of radium radiation was the element with which he was very familiar, helium. This process of manufacturing one element from another he referred to as transformation. It invoked images of matter changes similar to those of the alchemists, who sought among other things the ability to turn lead into gold.[62]

Yet, among these references of new paths to wealth and power, Ramsay alluded to his doubt of obtaining the mythical transformation of elements:

> [C]an the process be reversed? No one knows. But as gold is an element of high atomic weight, it may be confidently stated that if it is changing, it is much more likely that it is being converted into silver and copper [smaller elements of lower atomic weight than gold] than that it is being formed from them.

A Nature article from August 13, 1903, contained many of the same facts as Ramsay's December New York Times piece, but presented them in a much more formal manner. In his newspaper piece Ramsay had given many more details concerning the history of the experimental process as well as the speculation about transmutation, quoted above. None of that was seen, in what was essentially a lab write up, in Nature.

Ramsay was not alone in his intrigue with the production of such a small atom as helium from the larger atom of radium. Ernest Rutherford discussed alchemy-like elemental transformations caused by radium's emanations in the June 10, 1904, issue of Science (which was a reprint of a lecture that first had been covered by The Times of London). He also spoke of how

> If we could collect a cubic inch of the emanation, the tube that contained it would probably melt, while a few pounds would supply enough energy to drive a ship across the Atlantic, though each of these pounds would require 70 tons of radium to supply it.[63]

But Everybody did not agree with Ramsay's and Rutherford's positive views on transmutation and radium emanations. In a long article written by Frederick Soddy, a blow by blow account was given of the debate between Lord Kelvin and practically everybody else in the arena of the physical sciences. Kelvin had dropped the gauntlet after one of Soddy's lectures, by writing to The Times of London that he did not believe Soddy's statement that "the production of helium from radium has established the fact of the gradual evolution of one element into others....[nor that] the heat of the sun was due to radium, and ascribed it to gravitation."[64]

The article continued with many examples of rivalry between scientific disciplines, such as Sir Oliver Lodge's belief "that whereas chemists have an instinct of their own for arriving at their results, reason is the monopoly of the physicist, whose results the chemists usually manages to absorb in the end." There was also Prof. Armstrong's "criticism of physicists in general," who he declared were, "strangely innocent workers under the all-potent influence of formula and fashion." Armstrong was a supporter of Kelvin's and one of his letters of support was also reprinted in Science.[65]

The reprinted letter quoted Armstrong as writing:

> Workers in the radium school appear to have cast caution to the winds and to have substituted pure imagination for it. Among ourselves, we should always be at liberty to postulate the most crack-brained of hypotheses, to dream the wildest of dreams, as a means of guiding inquiry; but we should not court popularity on such a basis. By so doing we lose all claim to guide public opinion.[66]

In the course of his article over this particular debate that spanned the Atlantic, Soddy stated:

> Whether anything more is known about transmutation now than formerly, whether lead could change into gold or gold into silver with an emission of energy similar to that evolved from radium, whether this or similar energy plays the large share that has been attributed to it in cosmical processes, are questions which may be legitimately discussed and left open....It would be a pity if the public were misled into supposing that those who have not worked with radio-active bodies are as entitled to as weighty an opinion as those who have. The latter are talking of the facts they know, the former frequently of the terms they have read of....The sooner this is understood the better, for in radio-activity we have but a foretaste of a fountain of new knowledge, destined to overflow the boundaries of science and to impregnate with teeming thought many a high and arid plateau of philosophy.[67]

Both Armstrong and Soddy mentioned the public's perception of science as well as the scientist's ability to guide this opinion. Soddy also expressed his belief that only the experimenter can ultimately know the truth of any one phenomena. His statement presents an image of the scientist as closer to truth, especially when dealing with radium phenomena, which he called "a fountain of new knowledge."

Ramsay, Rutherford, Kelvin and others continued to debate and research radium's powerful potentials and the media continued to cover their findings. On July 28, 1907, Ramsay was back in the press. On this date, The New York Times ran a page-one story about Ramsay relating how "The great scientist" had confidence in his research into the transformation of elements, which he now called transmutation. He had carried out experiments in which he felt sure that radium radiation had degraded copper into the lower atomic-massed element, lithium.

In the article, the journalist attempted to explain the scientific controversy surrounding Ramsay's claims. He listed both those who agreed with Ramsay's findings and those, like Lord Kelvin, who were holding out for more replicable data and for greater amounts of the rare radium to be made available for larger experiments. The article also contained the only reference to a science writer coded from the study period. The science journalist sided with Lord Kelvin. He apparently thought Ramsay was just trying to prove what alchemists had failed to prove for centuries. The writer communicated his negative views about such an attempt as well as his view on the status of American science with this comment:

> Those who have studied the literature which has recently dealt with the subject will have noticed that if we except those actively working on radium, the belief in transmutation is for, the most part, confined to American textbooks, while writers such as Arrhenius, whose book was issued only a few months since, agree with Lord Kelvin in preferring to wait for further experiment...[68]

On August 2, 1907, Science ran a short article by Ramsay himself, in which he further discussed his transmutation findings. At the bottom of the article it was noted that the reprinted letter was from Nature and "apparently the basis of the alleged interview with Sir William Ramsay, cabled to a prominent New York newspaper on July 28 and widely quoted." The letter was short and much less committed to the absoluteness of transmutation than were the quotes used in the New York Times piece. Ramsay's December lecture covered by The Times of London was similarity cautious. (December 12, 1907).[69] Again the trail of scientific coverage is seen to have travelled from one publication to another. This time The New York Times was a bit more sensational with the facts than were the other publications.[70]

A letter-to-the-editor in The Times of London, one year later on September 19, 1908, took a much more blunt view toward the whole transmutation debate being presented to the public. The author wrote,

> As the public have been entertained of late almost ad nauseam with descriptions of the magic power of radium in transmuting copper into lithium and various other elements, it is desirable to make the opinion of chemists known....Although previously whispered from America, the assertion that elements could be transmuted by radium was first made at last year's meeting of the Association at Leicester....It may be said, without fear of contradiction, that the powers of radium have been vastly overrated. Itself a most mysterious substance, we have yet to learn the exact nature of the changes which it undergoes....It is hoped, in the interests of science, and therefore of truth, that in future guesses may not be made public until they have been transmuted into facts.[71]

Science capped the transmutation debate for awhile on December 4, 1908, with a lengthy article of 399 lines by an independent researcher who stated, "we must say that we have not succeeded in confirming the experiments of Messrs. Ramsay and Cameron."[72] The reason given was that the researchers could not obtain a sample of copper that was free of all traces of lithium before irradiating it, and even when irradiated they never could produce the amount of lithium that Ramsay had claimed.

While scientists' commitment to popularizing science are historically reported to have been low during this time, the coverage of the transmutation debate gives evidence that some in the scientific world were very aware of the public--a public which was interested in reading about what was going on in the laboratory. The debate also gives further evidence of the permeable editorial boundaries among the four publications. Many stories were seen to cross from one publication to another without editorial resistance.

The potential of radium was clearly being communicated with language and images that invoked works of magic and great power similar to that which had been used with X-rays. At the same time though, as was seen with X-rays, voices of caution and admonishment of poor science were being carried in the publications. This range of images was presented in both scientific mediums such as Science and Nature as well as in popular press publications such as The Times of London and The New York Times.

While messages of caution were present, some very positive stories also appeared through out the study, some of which ran with little or no scientific backing and without the presence of supporting sources. One such front-page piece, from the June 20, 1905, issue of The New York Times, was headlined:

> GENERATION BY RADIUM
> Cambridge Professor Reported to have Produced Artificial Life

The headline referred to an experiment in which radium and sterilized bullion, after being placed in a test tube, had generated cultures that seemed alive, and thus "almost certainly demonstrated the possibility of spontaneous generation."[73] No evidence of reproducibility nor any other source was included in the two-inch article.

Another New York Times article, from February 6, 1904, related the manner in which some scientists actually paid homage to the power of radium. At one point, during a technology club's annual dinner, each member drank a toast with liquid that had been irradiated with radium capsules. The lights were then turned off and the scientists were treated to dancing skeletons and pasteboard chickens, which had been painted with luminescent paint. One scientist appeared in the dark and began to lecture with a luminous cigar in his mouth. The coverage of the ceremony portrayed it as a celebration of the wonders of the new discoveries, highlighted by the drinking of the radium toast, which presents an image of a eucharist to the god of scientific knowledge.[74]

The Times of London also carried an article with magical and alchemical images on August 2, 1906. In mentioning the Curies' work with radium during a scientific convention, the author talked of the long arduous process needed to extract a few particles of the mysterious element and retold a story of the absent-minded Pierre: "On his return to Paris he was one day demonstrating in his lecture room with this precious tube the properties of radium when it slipped from his hands, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance." The piece had been written ~~three~~ four months after Pierre's fatal accident in Paris on April 19, 1906.[75]

The Death of Pierre Curie

The Times of London reported Pierre Curie's sudden death by stating that he had slipped while getting out of the way of a taxi on a busy thoroughfare in Paris. As he tried to rise from the street where he had fallen, the wheel of a horse-drawn dray ran over his head, killing him immediately. The article then reviewed the famous scientist's accomplishments--his work with piezo-electricity and his and Marie Curie's discovery of radium and polonium.[76]

Contrary to the normal difference found between the language of London's elite paper and England's leading science journal, The Times of London's piece was much more reserved in its discussion of Pierre Curie and his work than Nature's article, written by Frederick Soddy. Soddy wrote:

> Cut off in the midst of a career of active scientific investigation, in the flower of life and at the height of a unique reputation, brilliantly won and universally acknowledged, his death will be mourned by the whole civilized world. In this country, where the importance of his work and discoveries was early and fully recognized, and where the fame attaching to his name has spread widely, deep sympathy will be felt for Mde. Curie in her tragic bereavement, coupled with a sense of loss that a partnership in science so illustrious and fruitful has been brought to so untimely a close....It has been said by a recent writer that there will come a time when men will date the coming of their kingdom to the day when Curie and Laborde discovered the spontaneous evolution of heat from radium. Certainly no limit can be set to the consequences in the near or distant future which may be expected to flow from the discoveries with which the name of Curie is associated. Like Roentgen shortly before, Curie emerged at one step from comparative obscurity to universal fame, and what they achieved is still within the horizon of the humblest investigator.[77]

Soddy in his words of condolence, clearly reveals his opinion that the Curies, like Roentgen, have reached the summit of human endeavour through their scientific discoveries. The illustrious partner, who shared Pierre's humble discovery of this element of limitless possibilities, grieved terribly for him. In her biography of her mother, Marie's daughter, Eve, told of how, "From the moment when those three words, "Pierre is dead," reached her [mother's] consciousness, a cape of solitude and secrecy fell upon her shoulders forever. Marie Curie, on that day in April, became not only a widow, but at the same time a pitiful and incurably lonely woman." Days later, Mme. Curie finally burned the blood soaked clothes of her husband, kissing the fragments of his brain left upon them as she did so. She then quietly took up the responsibilities of the household and eventually took over Pierre's chair in physics at the University of Paris, becoming the first woman to hold such a position in French higher education.[78]

Marie Curie's naming to this post was not without resistance, and it was not the only time she found herself in the center of debates over her accomplishments and merits. A letter-to-the-editor in The Times of London from November 10, 1906, spoke out against the recurrent description of Marie Curie as "the widow of the discoverer of radium." The writer proceeded to recite lines from Marie's 1903 doctoral thesis, in which she stated that working alone she found that certain minerals possessed more radioactivity than uranium or thorium. It was after these early discoveries that she and Pierre began to work together to isolate the "radioactive element," as Marie was to call it.[79] Eve Curie backed up the disgruntled letter writer's facts in her book, but tried to silence the debate about who did what when, with the statement that "We cannot and must not attempt to find out what should be credited to Marie and what to Pierre during these eight years. It would be exactly what the husband and wife did not want."[80]

The mourning expressed for Pierre Curie, as well as debate over credit for the discovery of radium, point to the importance that was placed upon such discoveries and the notoriety given to those credited with making them. It also indicates just how revolutionary a place Marie Curie holds in the honor roll of women scientists. She and her discoveries were at the center of women scientist's early efforts to break into a male dominated world, where fame and respect were reserved for the explorers of the scientific unknown. Exploration of this remarkable woman's discovery was to proceed in the realms of heaven and earth.

Radium in the Earth and the Stars

While coverage of advances in new equipment and technologies and ongoing theoretical debates continued to be present in all four publications during this period, other topics of scientific interest also emerged. Two were the nature of radium and uranium in the Earth and the search for radium in the stars. In a letter-to-the-editor in Nature, Charles Darwin's son, George, speculated that the source of radium's great power might be the same that powers the sun, thus modifying the theory of the time concerning the sun's age.[81]

Science ran an article on May 28, 1909, that also dealt with radium and the stars. The author stated that it was possible to track cosmic evolution using radium spectrum lines. During the course of the article he noted limitations, but pointed to the vast amount of work currently being done on understanding the effects of radium on the Earth's surface and noted that knowledge of its effect on the stars would likewise continue to grow.[82]

Two years earlier, another article in Science had dealt with radium and fluctuations in the Earth's temperature. The article was written by J. Joly, whose work from Trinity College in Ireland was also often found in Nature.[83] All four publications carried stories from scientists world-wide, such as Joly. This gives some indication as to how important certain editors felt nuclear coverage was, and it reflects the use of new technologies such as telegraph cables to transmit these foreign pieces long distances.

Stories transmitted by telegraph began to more frequently appear in the sample. They revealed that Joly was not the only one working with the nature of radium in the Earth. The geological issue was complicated by radium's ability to generate its own heat as well as its quick degeneration. Scientists could not explain why all of the uranium in the Earth hadn't already degenerated into other elements, or why this degeneration didn't show up in an increase in the temperature of the Earth. They were later to learn that it had to do with the isotopic nature of the element. The isotopes of radium and uranium produced in the laboratory were often much more radioactive than those that naturally existed.

The debate over the presence of radium and uranium in the Earth and the stars was still raging in September of 1910, when the International Congress of Radiology and Electricity was held in Brussels. The proceedings of the Congress clearly indicated that Ernest Rutherford and Marie Curie were looked to as the leaders in the field of atomic science. Rutherford stated that a standard of pure radium was needed as a reference for future research, and Curie agreed to produce 20 milligrams of the purest radium salt sample she could. At the meeting, the esteemed scientist was honored by having her name given as the unit of radium emanation. Radioactive disintegrations would be measured from then on in "curies."[84]

Medical Coverage from 1903 to 1911

Debates over the nature of radium weren't the only ones going on during the period from 1903 to 1911. Coverage of medical issues also remained strong, with The New York Times carrying more such stories during this period, followed by The Times of London and Nature.

Most of The New York Times's headlines dealing with medical news during the period had a positive tone similar to that which topped a three column spread in The New York Times Sunday supplement of July 24, 1904:

> War on Skin Cancer
> Waged with Radium
> Berlin specialist tells of his epoch-making cures, methods and results.

The article, based on one source, talked of cures for tongue, lip and skin cancer as well as psoriasis and swollen hands. The form of treatment was a daily half-hour application of a small amount of encapsulated radium salt plastered to the skin.[85]

On May 21, 1909, The Times of London discussed a lecture in which radium was claimed to have cured eczema, acne, angioma, epithelioma and to have helped with breast cancer. The lecturer did note at the end though that "too much must not be expected, and its use was limited to cases which were not too extensive and which were sufficiently localized."[86] Another Times of London piece, from August 2, 1911, heralded, without such caution, the opening of the new egalitarian Radium Institute, developed by King Edward. It was

> arranged that although poor and rich patients enter the building by separate doors, yet the actual rooms in which their several cases are diagnosed, and in which they may receive subsequent treatment, are identical in the matter of professional fittings and upholstery. There is nothing grim or sinister about the building or the internal decoration. It has been designed as a "Temple of Hope"[87]

The article also mentioned that the institute had the largest supply of radium of any institution of its kind, with L50,000 (pounds) worth of the element locked away in a specially built safe.

Much of the coverage over the next few months expressed this same awe toward the healing power of the mysterious element. Yet, while many stories praising radium and related scientific advances continued to be written, more articles also began to appear discussing the dangers of excessive exposure to radium's precursor--Roentgen's X-rays.

A New York Times article from June 1, 1906, talked of the tragic end met by a doctor who had long explored the healing power of X-rays. In the course of two years the doctor had to have both of his hands removed because of cancerous tumors as well as part of his shoulder and chest. Finally, the doctor realized that he could not stop the cancer from killing him and so "calmly and philosophically waited for the end, with the only consolation of knowing that he had done something for the advance of medical science."[88]

The Times of London also carried many pieces on X-ray workers stricken with X-ray dermatitis, who were also forced to undergo amputations similar to the New York doctor. One piece from a correspondent spoke of how people were wary of getting X-ray treatments because of the number of workers getting cancer: "It is advisable, therefore to point out that it is the pioneers in the field who have paid the penalty of their boldness and that their sufferings have secured immunity for subsequent operators." It went on to speak of the evolution in equipment that had occurred as well as new precautionary measures such as using lead shields. Many of these early workers were seen as martyrs to their science.[89]

One such martyr was Harry Cox, who also suffered from X-ray dermatitis. Cox, however, was treated for his X-ray radiation induced cancers by radium emanations. Here the new technology was used to try to cure the damaging aspects of the earlier one. Radium treatments relieved the pain and removed tumors just has X-rays were seen earlier to have done for other ailments. Without the benefit of longitudinal studies the doctors applied the radium treatments to the X-ray dermatitis, their faith in the new technology unwavering in their attempt to use it to treat another technology's damage.[90]

Two other articles from The Times of London dealt with the dangers of X-rays, calling for better regulated treatments. In one the president of the Radiology and Medical

Electricity Society "alluded to the importance of X-ray examinations and treatment being conducted by medical men properly equipped for the task, incidentally observing that the day would come when medical men who now employed laymen to do that work would regret the precedent they had established."[91]

The second article backed up the president's statement. It told of a clerk who, on a doctor's advice, received ten or 11 X-ray treatments to cure the early stages of locomotor ataxy. The doctor was never present during these treatments and often the X-ray operator would leave the patient and his wife in the room, with a machine that emitted great sparks. The patient did not complain, and "eventually the soles of his feet sloughed off, and he has never since been able to put his feet to the ground and walk." Contrary to the early X-ray damage cases, the defendant won his subsequent legal case, in part because of the expert testimony of an outside X-ray doctor.[92]

Evidence that such negligent use of the technology was worldwide came in an article from <u>The New York Times</u> on April 7, 1907. It contained a warning from the German Roentgen Society, which had passed a resolution to prevent unlicensed persons from using X-rays to diagnose and treat illnesses.[93]

A few negative pieces were also written about radium treatments during this time. For example, an early editorial attacked the claims of doctors who had used radium salts to cure cancer:

> Meanwhile it is obvious that the evidence thus far produced will be no more satisfactory to physicians than are the canes and crutches which decorate certain shrines as evidence of the curative power of relics....There is plenty of opportunity to prove the efficacy of radium in the cure of cancer, and when this is accomplished we shall hear of it under conditions leaving no more room for speculations...[94]

Science, however, kept away from the negative aspects of radium in its few medical articles. The three negative stories coded for Science were all coded in the discovery category. One already discussed was Lord Kelvin's letter to the editor, which itself referred to a letter that had been reprinted from The Times of London. Kelvin had chastised the scientific community for seemingly accepting transmutation and the alchemy of elements without solid evidence. The other two negative stories came late in the period, one in 1921 and one in 1922, both were written by the same scientist and described negative aspects of the genetically mutating power of X-rays on the development of fruit flies.[95]

Nature also carried limited negative medical coverage during this time. One example of the stories it did carry, wa a very thorough book review of THE RADIUM TREATMENT OF DISEASE (May 11, 1911). The piece walked the fence between the pro's and con's of radium as a medical treatment. It was a convoluted piece, both critical of the book author's methods for administrating radium emanations, but at the same time suggesting better ways of using the treatment. The reviewer stated that

> A cure is occasionally obtained, but every case of malignant tumour that can be dealt with by the surgeon should be extirpated. Subsequent treatment

> with radium may be of the greatest value in destroying any cancerous cells that have escaped removal by the surgeon, and so the recurrence of the disease may be prevented.[96]

The author then compared radium to X-rays as a treatment. He noted that radium's treatment values were that it penetrated tissue much further, was more constant in quality and quantity, could be left in tissue to give off constant radiation, left little scaring, and was portable. X-ray's major benefit was that it was cheaper and thus could be used over larger areas. The article ended:

> In reviewing the present state of our knowledge of the therapeutic effects of radium, the feeling reached is that we are making our applications empirically in the hope of lighting, almost by accident, on some property of value in the cure of diseases which have hitherto baffled the physician's skill.[97]

While doctors waited for experimental serendipity, a Times of London article on February 27, 1907, pointed to how during this same time X-rays continued to be viewed as a precious technology. The short nine line piece relayed a question asked of the Secretary of State for War, concerning what "steps he proposed to take so that the United Kingdom might not be dependant on foreign countries for a supply in the event of war with a Continental Power." The debate over nuclear issues was yet to reach its peak.[98]

Nuclear Coverage from 1912 to 1920

The period from 1912 to 1914 had more coverage of nuclear issues than any other three year period in the study. The pros and cons of radium and X-rays were broadly discussed in all four publications studied. Much of the debate was carried in the medical stories from the period. Medical stories from 1913 were for the most part neutral, like one from The New York Times which spoke of advances in treating cancer since countries began to set up radium institutes. Although its lead stated there was, "proof positive this week of the curative value of radium in cases of cancerous vascular tumors, classed as deep angiomas," the story ended by saying that the full effect of radium cancer treatment was still unknown:

> [T]he investigators make no extravagant claims regarding radium's effect on cancer. The best method of proceeding, they assert, is to combine the therapeutic effects of radium with surgical operations.[99]

A negatively toned article in The Times of London from this same period exemplifies how radium and X-rays were continuing to be more and more discussed together in the media. The piece was a synopsis of a speech by Sir James Mackenzie Davidson. In his lecture, Davidson discussed the burning effect that X-rays caused as well as the fact that "The physiological effect of radium was very similar to that of the X-rays, and depended upon the penetrability of the gamma rays....While it was important in cancer it could not be said to be a cure, and while it could inhibit the growth of tumors it would not destroy them altogether."[100]

These and other articles about the limitations and injuries caused by the mystery rays of both X-rays and radium began to appear more frequently both in The New York Times and

The Times of London, with 1914 being the year in which the most stories were written with such a cautionary and negative tone toward both X-rays and radium.

A large number of The New York Times's medical articles from 1914 took a position similar to a large piece that ran in the Sunday magazine section of the January 4th issue. The writer was Van Buren Thorne, M. D. A large seven-column headline proclaimed:

THE PLAIN TRUTH ABOUT THE RADIUM CANCER CURE

The article started out with the statement that historians will write of 1914 as the year when "the civilized world, as well as the men of science, were engrossed in the discussion of this subject: 'Will radium cure cancer?'" Through the course of his article, Thorne relayed that scientists were "trying to curb an unjustified over-enthusiasm...[for they had] reached the ear of the world-audience attuned nowadays in a remarkable degree to catch the faintest whisperings of progress from the laboratory and the clinic." This story came before the era of greater popularization of science that was to come after WW-I.[101]

But not all of the stories getting out were cautious or related negative consequences of radium therapy. A Times of London piece dated April 2, 1913, from Berlin gave the details of a doctor's discussion about the possible healing value of water treated with radium emanations. The story stated that, "On the Continent remarkable results had been attained by this treatment in the whole range of diseases of metabolism, including gout, rheumatoid arthritis, nephritis, and arteriosclerosis."[102]

Another story talked of how one man had continued with his research even after losing an arm to X-ray dermatitis. Dr. Hall-Edwards discussed his ongoing work with very soft X-rays (less penetrating power) in regards to imaging insects, flowers and even metal-based, ink written letters on a piece of paper within an envelope.[103]

Nature got into the medical debate with a short article on October 9, 1913, which lectured the public media for their treatment of the topic. It discussed an article from a daily paper that stated that a "complete revolution in the future of radium" had occurred at the Radium Institute in the form of collecting radium emanations in glass vials, so that they might be delivered to other hospitals, (this was part of the October, 3, 1913, Times of London story coded). The author of the Nature article stated, "It was assumed by the literary young men who write the leaders and notes in the daily papers that radium emanation had just been discovered instead of being known and named for ten years or more, so they let their enthusiasm overstep the bounds of their knowledge."[104]

The author then noted that the remedy described by the newspapers was not new, and had been written about fours years earlier in a scientific journal and followed up two years after that in the same journal. The author closed his cautionary piece by saying that, "Even in this dreaded disease [cancer] many favorable result have been reported both with radium and with the Roentgen rays, but unfortunately disappointments are far more frequent than cures." This is by far the strongest piece coded in which a scientist admonished the content of science stories. Most earlier comments about the media were in regards to how the scientists were presenting themselves. In fairness, The Times of London article mentioned did cite and quote the administrators of the Radium Institute through out. It is more likely that they were misleading than that the journalist misrepresented what they had said. This issue, in addition to being an example of a scientist's active involvement in critiquing science reporting, is also another example of the increasing concern with popularizing science even before the war.[105]

In contrast, the war also probably influenced a subsequent decrease in nuclear coverage. While The New York Times's and The Times of London's coverage of medical issues were at its highest in 1914--it fell in 1915. In England the probable cause for this fall was the escalation of World War I. Still, a Times of London article from January 19, 1915, contained an important first for the sample. It was written by what was called a Medical Correspondent.

The byline of Medical Correspondent was coded eight times for The Times of London, and was not found in any other publication studied, not even the science writing, flag-carrier, New York Times. The London paper's medical correspondent wrote mostly about X-ray technologies, and it is supposed that this was his area of expertise, because of the limited amount of sources he used per piece and the great amount of detail given.

This first piece opened with a discussion of how valuable X-rays were in treating the war wounded. Later in the article he wrote that "Wherever modern science could be called to the help of surgeons or patients that assistance has been secured, and no detail has been regarded as beneath notice." He continued the article with a description of new protective measures being taken to protect the X-ray operator.[106]

A later piece, in 1919, by the medical correspondent followed up on the use of X-rays during the Great War. "The enormous value of X-rays during the war in locating bullets and pieces of shrapnel has convinced the world that this branch of medicine deserves to be cultivated and studied." He went on to describe the need for expert use of the rays so that they would not become "dangerous."[107]

Nature too gave page space to the use of nuclear science and technology for the war effort. A brief mention of it came in a 1915 abstract that compared radiological methods of localizing projectiles and treating wounded.[108] A much more thorough 387 lined lecture, reprinted on January 31, 1918, was entitled X-RAYS AND THE WAR. The piece relayed how in addition to imaging bullet fragments, X-rays were also used to depilate hair and make flaps of skin more pliant for the plastic surgeons. It noted the unpreparedness of England's X-ray manufacturers, especially the glass makers, who had to make up the loss of those units normally supplied by Germany.

They were helped in their effort to produce enough high quality glass by both France and America. The author then discussed in great detail the current advances in X-ray technology. He closed his lecture by saying that,

> It is the shameful truth that the man of science, with few exceptions, has received little or no recognition by the mass of people....But the country, in its hour of need, has turned to its scientific sons for help in its war problems, and has not turned in vain. The war is bringing home to the nation the dependence of its very existence on science, and a little good may come out of very great evil if public opinion can be brought to realize that the statement is as true in peace as in war, and that a nation's administrators should always include among them suitable men of the highest technical and scientific standing, not merely to advise, but also to initiate and direct.[109]

One year later, Nature ran a four page article by the same author, G.W.C. Kaye, in which he discussed both medical and industrial advances and uses of X-rays. Among the eight photos included in the article were a 20 minute X-ray of a hand from 1896 and the higher quality image made of a hand in 1/100 second in 1919. X-ray images were also included of internal organs, airplane wings, golf balls, steel welds and ancient paintings. In discussing the future of X-ray technology Kaye stated,

> Simultaneously comes the awakening of the medical faculty generally to the importance and promise of physical methods and physical agencies as a means of progress in medical research. There is little doubt that within a short time every large and progressive hospital will have a physicist of standing on its staff; and in this connection we would congratulate the Middlesex Hospital on the good fortune which enables it to establish what we believe is the first medical chair of physics in this country.[110]

This phenomena of science popularity addressed by Kaye has been historically recognized. The use of technologies such as X-rays and airplanes during the war put the products of scientific and technological advancement on the front page, in life and nation saving dramas. In articles such as Kaye's, it can be seen that some scientists were in the front lines popularizing science.

X-rays were not the only atomic energies seen as valuable during the war. Two articles ran in The New York Times in which radium was used for military purposes. In one, the rays were to be emitted from airplanes to help locate submarines beneath the water.[111] In the other, the rays were to be used by police to analyze unexploded bombs. Specific mention was made of detecting the high explosives that soldiers may have brought back from World War I.[112] The Times of London on August 14, 1918, reported an order by the Ministries of Munitions prohibiting the use or sale of luminous materials without a permit, thus pointing to the need for the rare element in the war effort.[113]

Throughout this period articles about the rarity of radium were more frequently carried in all of the publications. Often stories of price and supply were coupled with medical topics. A 1913 piece about the Radium institute in England discussed how the four grams of radium in possession had a value of L80,000. Statistics of patients treated in the last year were also given, with 3,000 "well-to-do" and 4,300 "afflicted poor" patients being treated. It also discussed how it had been necessary to close the institute for the month of August, "in order that the staff, who are working at high pressure during the other 11 months of the year, and all of whom have upon their hands burns caused by radium, may have a holiday and the rest which is the only know cure for those burns." This was one of many mentions of using the benefits of nuclear technology to treat both the poor and wealthy. It also shows that radium was beginning to harm its handlers just as X-rays had previously done to those who worked with it. Still, the benefits were seen to outweigh the negatives and the patients continued to seek out its healing power.[114]

This powerful element was discussed in a New York Times article from October 6, 1913, which presented Austria's plans to corner the world's radium market by purchasing mines and patents.[115] The Times of London had covered this story almost a year earlier, giving the details of the Austrian government's L100,000 purchase of an estate that would "give the State a practical monopoly of the radium production in Austria, if not the world." These stories are an example of how the publications often followed the same story across time.[116]

Another New York Times piece, from October 24, 1913, discussed the reaction of two philanthropists who reportedly wanted to counter any such moves to monopolize the world's radium. In this pursuit they had purchased what was touted as the world's largest deposit of radium, located in Paradox Valley, Colorado. The men were quoted as saying, "not one cent's worth of the radium would be for sale...every particle of the precious metal would be used in the cause of humanity."[117] Just how large a gift these men were donating to humanity is realized by considering that one gram of radium was worth $120,000 in 1913. Another article contained a discussion about a bill, which would allow the federal government to take control of all radium ore held on public lands "for the benefit of the whole Nation, so that the government would see that the radium was distributed where it would do the most good." Here again the positive aspects of the technology were seen as the right of all humanity--rich and poor.[118]

A Science article written by a governmental geologist on October 31, 1913, talked about the radium-carrying carnotite deposits in Colorado as being "the largest source of radium at the present time." In discussing how to best use this rare resource, the author talked about the need for a steady supply of radium of high quality. As evidence for such a need he stated:

> The "wonders of radium" have been so extensively exploited in the public press that already the naive is being employed as a psychological agent in advertisements of all kinds of materials, many of which contain no radium at all.[119]

The use of governmental sources on price and supply issues was more common in the U.S. publications and reflects more governmental regulation of the precious commodity, but as noted earlier the price and supply topic was not totally disregarded in England. A Nature piece from January 30, 1919, discussed an article reported in The Times of London, about the discovery of a "fine lode containing pitchblende" in Devon, England. It then went on to discuss the various qualities of ore from other countries and ended with, "Further developments at Kingswood will therefore be awaited with interest, especially in view of the statements made as to the abnormal richness of the ore in uranium oxides."[120]

As articles about radium's price and supply continued, its potential for solving problems that arose out of the war was also being discussed. From 1913 to 1922, more articles appeared that dealt with the use of radium specifically for energy purposes. This was a direct result of the adversity encountered from coal and oil shortages during the war.

On July 1, 1915, early in the war, Nature ran a speech given by Ernest Rutherford discussing his work with atomic particles. In discussing the differences between alpha and gamma particles he stated, "The transformation of each atom results from an atomic explosion of an exceedingly violent character, and in general results in a liberation of energy many million times greater than from an equal mass of matter in the most vigorous chemical reaction."[121]

Likewise, The New York Times wrote about Sir Oliver Lodge's speech, in which he noted that molecular fuels such as coal were running out and therefore humanity must look to the atom, where there is "enough energy to raise the German fleet from the bottom of the sea to the top of the Scottish mountains." Lodge added that he hoped

> the human race would not discover how to use this energy until it had brains and morality enough to use it properly. If the discovery were made before its time, and by the wrong people, this very planet would be unsafe.[122]

Science did not include this paraphrase in its story on Lodge's speech. It instead highlighted that

> Possibly there might occasionally be explosions due to the liberation of power more quickly than it was wanted, but in general he presumed that the conditions of utilization would be good.[123]

The coverage of Lodge's speech in the two publications were essentially both positive in tone and content except for The New York Times's inclusion of Lodge's tempering philosophical visions.

Discovery and power issues such as those presented by Lodge were not common in the newspapers' coverage during this time; most of their stories dealt with price and supply issues as well as medical stories. The journals though continued to present discovery and power issues. Science ran a six-page piece on July 24, 1914, discussing the great advances in atomic theory. One of these advances being Niels Bohr's revelation that atoms have a positively charged nucleus around which the negatively charged electrons revolve. Bohr stated that the revolving negative electrons create an electric current which helps to hold the atom together.[124]

On April 22, 1915, Nature ran a book review of the Braggs' new book on X-ray crystallography. The article relayed how the Braggs had used X-rays to measure the structures of atoms and crystals. "It reveals crystallography more than ever as the handmaid of chemistry, and enhances a hundredfold the necessity for a much more universal study of crystals than has hitherto been recognized."[125]

This period also saw further research into transmutation phenomena, with much work also underway in identifying isotopes. A letter-to-the-editor in Nature by J. Joly and J.R. Cotter discussed how the Geiger-Nuttall curve (a measurement of radioactivity) indicates that thorium might be made of both stable and radioactive isotopic elements.[126] In following the unlocking of the atom's secrets, Science on November 21, 1919, ran a seven-page article by Rutherford discussing the possibility of using the enormous energy of gamma rays to smash the atomic nucleus to investigate its inner workings. He explained that gamma particles travel at about 20,000 times the speed of a rifle bullet, and that if an ounce of helium moved at the speed of a gamma particle which had been emitted from radium, it would be equivalent to 10,000 tons of solid shot traveling at 1 kilometer per second.[127]

From 1913 until Marie Curie's American visit, in the spring of 1921, several more articles ran which dealt further with the exploration of the atom as well as its use in new technologies.

Madam Curie's visit to America and Particle Bombardment

Rutherford's articles highlight the fact that scientists were slowly learning more and more of the secrets within the atom through the use of Marie Curie's radium and other radioactive materials. Curie's American visit in 1921 was a milestone for the country and its relationship with her and her discovery. Women across the country donated money to buy a gram of radium for Curie to take back to France for her research.

A New York Times article from May 18, 1921, was headlined:

> MME. CURIE CALLED
> GREATEST SCIENTIST

The article relayed how she was the first woman to be named an Honorary Fellow of the American Museum of Natural History. References were made about her continued advances in the treatment of cancer. One chemist said, "I bring to Mme. Cure, the mother of radium, the love, admiration and affection of the chemists of America."[128] In an article on May 20, 1921, Curie was acclaimed the "high priestess of science." The titles of "mother of radium" and "high priestess" presents an image of Curie as one who knows the secrets of wielding the powerful element for renewal and nurturing.[129]

This image is reinforced in The Times of London's reprint of President Harding's speech in honor of Curie, given during the ceremony where he presented her with the vial of radium. He praised the famous scientist and made an analogy between the spiritual and physical world:

> I have been very sure that that which I may call the radioactive soul, or spirit, or intellect-call it what you choose-must first gather to itself, from its surroundings, the power that it afterwards

> radiates in beneficence to those near it. I believe it is the sum of many inspirations, born in on great souls, which enables them to warm, to scintillate, to radiate, to illumine and serve those about them.[130]

In this analogy, Harding took words from the world of science to help describe what he believed only by faith. In particular, his use of "radioactive soul" was a direct reference to Curie's term for the mysterious emanations of radium. The power of the element is made analogous to that which powers human good.

Science celebrated the significance of Curie's discovery and visit in an eight-page article by R.A. Millikan on July 1, 1921. The American physicist was to later win the 1923 Nobel Prize for, among other things, his oil drop experiment, which provided a measure of electronic charge. He wrote:

> Madame Curie has always remained simple, modest and unaffected in the face of the world's applause. That is the highest compliment which a fellow scientist can pay her, and the surest sign that she is not an ordinary person.

Millikan in praising Curie's humility again reveals the notoriety to be gained through scientific discovery, but also implies that humility is to be praised in the face of such notoriety and in doing so raises the discoverer even higher in the eyes of the public.

He then went on to explain how her discovery of radium had helped to change the conception of the atom from a hard ball to that of something more like a miniature solar system, in which nuclei were like planets, electrons were like moons and gamma rays were like shooting stars. He ended his essay with the comment that

> The most important thing in the world is a belief in the reality of moral and spiritual values. It was because we lost that belief that the world war came....[Yet] no efforts toward social readjustments or toward the redistribution of wealth have one thousandth as large a chance of contributing to human well-being as have the efforts of the physicist, the chemist, and the biologist toward the better understanding and the better control of nature.[131]

Millikan, like Harding, brings morality and spirituality together with science, raising science above all other social practices in controlling nature and improving life. After this high praise of her efforts to better control nature, Curie toured such American natural wonders as the Grand Canyon and Niagara Falls. She then returned home with her radium gift, and was only mentioned a few times in 1922. Two small pieces in The Times of London that year discussed the resistance in France to her taking up one of the vacant seats in the Academy of Medicine. One article stated, "Mme. Curie's friends are determined to secure her election in the teeth of the opposition of the last of the die-hards, unrepentant and irreducible, to whom the idea of a woman's admission to the Academy is absolutely repugnant."[132] The piece was followed up one month later with the announcement that she had been accepted into the academy. The speech in her honor stated,

> All those discoveries which result from yours are as nothing compared with the fundamental fact which you found--I mean the formidable energy contained in the atomic system. If we are to succeed in being able to release it methodically it would relieve the world from the dread of seeing disappear, at short notion, reckoning time in relation to the age of the world, the fuel accumulated in former centuries which is at present our principal source of energy.[133]

This comment among others shows how prominent was the fear of an energy crisis even at this early time, and how right from the start the atom has been seen by a few to be the source to overcome such a shortage. Many stories from 1922 also discussed other uses of radium's energy in industry, on items like watch dials and hard-to-see machine parts. X-rays also came back into favor as new technologies improved their reliability. More articles about their use in curing cancer appeared because of their relative affordability, as opposed to the high price and low supply of quality radium. But negative stories also continued, with <u>The Times of London</u> running three during this period and <u>The New York Times</u> running 15 neutral stories, many of which contained both the positive and negative aspects of nuclear energy's use.

One negative article, which had one of the few stacked heads coded for <u>The Times of London</u>, read:

X-RAY MARTYR
DR. IRONSIDE BRUCE DEAD.
DANGERS OF NEW TUBES.

The article, written by the medical correspondent, told of how the young doctor had begun to use of the most powerful tubes available, while using protective measures developed for the less-powerful older tubes. "In his zeal to help others, this brilliant young physician has sacrificed his own life....his researches were of the most brilliant kind. His martyrdom holds a quality of inspiration."[134]

In spite of these words of loss, the overall tone of medical coverage was that of balanced optimism, as was observed in one of the few editorials coded in The Times of London. The author wrote,

> Attention is being called at present by many competent observers to the increase which, year by year, has been taking place in the incidence of cancer. This is not a new warning, as those who have followed the history of the disease are aware....Both radium and the X-rays have strong advocates [as treatments], and both have certainly succeeded in particular instances and as certainly failed in others.[135]

This cautious optimism gave way to positive research in the last article coded from The Times of London. In this article, the medical correspondent did not cover the usual X-ray beat, but instead concentrated on a recently issued scientific monograph about radium treatment of cancer. The monograph experiment ran for 20 months and used radium in "the largest quantity hitherto made use of." This large amount of the expensive element was acquired in 1919 "from innumerable gunsights, watch dials, and other instruments of war." The article was based on the data from the monograph, and because of this it was very detailed and even gave a chart of the success rates of the treatment. "These results, as can be seen, are chiefly important as showing that something can be done." Even after the war, radium's use in it was generating positive stories.[136]

Nature's last piece was also a medical story, but concerned the use of X-rays as opposed to radium. The article discussed the opening of a new X-ray department at the Manchester Royal Infirmary. "The new department is on the ground-floor, is well lighted and ventilated, possesses generous head room, and is cheerfully decorated, all features which are stressed in the recommendations of the X-ray and Radium Protection Committee."[137]

X-rays were also the topic of Science's last piece in the sample. It discussed the use of quantum theory to calculate the wave length and number of quanta used to create an energy releasing chemical reaction. "On account of the large effect produced by relatively small amounts of energy, it seems that the use of X rays may acquire great importance in the production of organic compounds, especially if substances are produced in this manner which can not be obtained by other means."[138]

The last New York Times article coded, from December 28, 1922, also fell into a discovery category. It dealt with a practical use of radium, relaying how scientists were able to photograph the smashing of atoms with alpha particles. The alpha particles were emitted from radium into an enclosure full of air supersaturated with water. All the dust had been pumped from the box so that, as the high-speed particles traveled through the mist, they left a water vapor trail which was then photographed.[139]

In just 26 years the sources of Roentgen's and the Curies' mysterious rays had been tracked down and photographed. Much of this journey had been covered on the pages of elite newspapers and science journals from around the world.[140]

CHAPTER SIX

NOTES

1. James B. Conant, Science and Common Sense (New Haven, Conn.: Yale University Press, 1951), p. 27.

2. Derek J. de S. Price, "The parallel structures of science and technology," in Science In Context, eds. Barry Barnes and David Edge (Cambridge, Mass.: The MIT Press, 1982), p. 170.

3. The New York Times, 7 February 1896, p. 9.

4. The New York Times, 12 February 1896, p. 9.

5. The New York Times, 21 March 1896, p. 5.

6. The New York Times, 6 September 1896, pp. 12-13.

7. The Times of London, 28 February 1896, p. 13.

8. The Times of London, 10 March 1896, p. 12.

9. The Times of London, 14 January 1897, p. 14.

10. Ibid.

11. Ibid.

12. Science, 24 January 1896, p. 131.

13. Science, 26 June 1896, p. 926.

14. Science, 19 November 1897, p. 766.

15. The Times of London, 6 November 1897, p. 12.

16. Nature, 23 January 1896, p. 274.

17. Science, 14 February 1896, p. 227.

18. The New York Times, 27 June 1897, p. 17.

19. The New York Times, 2 November 1901, p. 1.

20. The Times of London, 19 April 1898, p. 4.

21. The Times of London, 8 February 1901, p. 11.

22. The New York Times, 27 April 1897, p. 5.

23. The New York Times, 31 July 1897, p. 6.

24. The New York Times, 2 January 1898, p. 12.

25. The New York Times, 1 November 1902, p. 16.

26. Ibid.

27. The New York Times, 18 December 1902, p. 9.

28. The Times of London, 3 November 1900, p. 4.

29. The Story of The Times, p. 185.

30. The Times of London, 6 November 1897, p. 12.

31. Nature, 6 February 1896, p. 324.

32. Ibid.

33. Science, 6 March 1896, pp. 344-346.

34. The New York Times, 31 July 1897, p. 6.

35. Nature, 9 December 1897, p. 135.

36. Nature, 12 March 1896, p. 455.

37. Nature, 11 February 1897, p. 359.

38. Science, 24 July 1896, p. 114.

39. Nature, 8 April 1897, p. 541.

40. Nature, 22 April 1897, p. 590.

41. Nature, 21 April 1898, p. 600.

42. Science, 22 January 1897, p. 139.

43. Science, 26 June 1896, pp. 919-920.

44. Nature, 23 April 1896, p. 600; Nature, 4 June 1896, p. 111; Nature, 21 October 1897, p. 600; Nature, 24 February 1898, p. 408.

45. Nature, 26 November 1896, p. 81.

46. Nature, 4 June 1896, p. 118.

47. Nature, 23 April 1896, p. 581.

48. _Nature_, 16 November 1899, p. 71.

48. _Nature_, 13 June 1901, p. 157.

49. _Science_, 7 September 1900, p. 369.

50. Ibid., p. 368.

51. _Science_, 12 July 1901, p. 53.

52. _The New York Times_, 11 December 1903, p. 1; _The Times of London_, 25 March 1903, p. 10.

53. _The Times of London_, 14 January 1897, p. 14; _The Times of London_, 26 January 1898, p. 12.

54. _Science_, 31 July 1903, p. 155.

55. _The New York Times_, 11 December 1903, p. 1; _Nature_, 1 November 1906, p. 15.

56. _The Times of London_, 25 March 1903, p. 10.

57. Ibid.

58. _The Times of London_, 13 August 1903, p. 6.

59. _The New York Times_, 8 May 1904, p. 6.

60. _The Times of London_, 28 March 1903, p. 14.

61. _The Times of London_, 2 April 1903, p. 8.

62. _The New York Times_, 23 December 1903, p. 10.

63. _Science_, 10 June 1904, p. 899.

64. _Nature_, 20 September 1906, p. 516.

65. Ibid.

66. _Science_, 14 September 1906, p. 347.

67. _Nature_, 20 September 1906, p. 516.

68. _The New York Times_, 28 July 1907, p. 17.

69. _The Times of London_, 12 December 1907, p. 6.

70. _Science_, 2 August 1907, p. 158.

71. _The Times of London_, 19 September 1908, p. 11.

72. _Science_, 4 December 1908, p. 805.

73. The New York Times, 20 June 1905, p. 1.

74. The New York Times, 6 February 1904, p. 6.

75. The Times of London, 2 August 1906, p. 14.

76. The Times of London, 20 April 1906, p. 7.

77. Nature, 26 April 1906, p. 612.

78. Eve Curie, Madame Curie, (Doubleday, Doran & Co., Inc.: Garden City, N.Y., 1937), pp. 247, 256 & 253.

79. The Times of London, 10 November 1906, p. 10.

80. Curie, p. 159.

81. Nature, 24 September 1903, p. 496.

82. Science, 28 May 1909, p. 866.

83. Science, 18 October 1907, p. 528.

84. Science, 2 December 1910, p. 805.

85. The New York Times, 24 July 1904, p. 21.

86. The Times of London, 21 May 1909, p. 12.

87. The Times of London, 2 August 1911, p. 5.

88. The New York Times, 1 June 1906, p. 1.

89. The Times of London, 16 April 1909, p. 4.

90. The Times of London, 5 May 1909, p. 13.

91. The Times of London, 28 July 1901, p. 14.

92. The Times of London, 14 July 1906, p. 4.

93. The New York Times, 7 April 1907, p. 17.

94. The New York Times, 31 December 1903, p. 8.

95. Science, 23 September 1921, p. 277; Science, 17 March 1922, p. 295.

96. Nature, 11 May 1911, p. 340.

97. Ibid.

98. The Times of London, 27 February 1907, p. 6.

99. The New York Times, 9 February 1913, p. 4.

100. The Times of London, 5 February 1912, p. 3.

101. The New York Times, 4 January 1914, sec. 5, p. 1.

102. The Times of London, 2 April 1913, p. 8.

103. The Times of London, 6 December 1913, p. 5.

104. Nature, 9 October 1913, p. 172.

105. The Times of London, 3 October 1913, p. 6.

106. The Times of London, 19 January 1915, p. 11.

107. The Times of London, 10 March 1919, p. 7.

108. Nature, 11 February 1915, p. 663.

109. Nature, 31 January 1918, p. 438.

110. Nature, 26 February 1920, p. 696.

111. The New York Times, 20 July 1919, p. 9.

112. The New York Times, 18 September 1919, p. 13.

113. The Times of London, 14 August 1918, p. 3.

114. The Times of London, 3 October 1913, p. 6.

115. The New York Times, 6 October 1913, p. 3.

116. The Times of London, 5 February 1912, p. 8.

117. The New York Times, 24 October 1913, p. 1.

118. The New York Times, 15 January 1914, p. 2.

119. Science, 31 October 1913, p. 612.

120. Nature, 30 January 1919, p. 427.

121. Nature, 1 July 1915, p. 494.

122. The New York Times, 18 September 1919, p. 13.

123. Science, 24 October 1919, p. 388.

124. Science, 24 July 1914, p. 115.

125. Nature, 22 April 1915, p. 199.

126. Nature, 5 February 1914, p. 632.

127. Science, 21 November 1919, p. 467.

128. The New York Times, 18 May 1921, p. 17.

129. The New York Times, 20 May 1921, p. 3.

130. The Times of London, 25 May 1921, p. 9.

131. Science, 1 July 1921, p. 1.

132. The Times of London, 5 January 1922, p. 9.

133. The Times of London, 16 February 1922, p. 10.

134. The Times of London, 23 March 1921, p. 10.

135. The Times of London, 20 August 1921, p. 9.

136. The Times of London, 6 March 1922, p. 9.

137. Nature, 2 December 1922, pp. 753-754.

138. Science, 25 August 1922, p. 231.

139. The New York Times, 28 December 1922, p. 4.

140. Eventually Ramsay's transmutation was further explored by Marie Curie's daughter Irene, who generated knowledge that eventually led to the practical utilization of nuclear energy (Taton, p. 218.). The ether, though still discussed, fell from favor as it was realized that the energy rays could travel independently through space without any supporting force such as an ether.

CHAPTER SEVEN

CONCLUSION

The data reveal that The New York Times's and The Times of London's coverage of the early exploration of modern atomic theory evolved along with the new discoveries. A definite pattern of increased coverage of the differing sides of complex issues developed over time.

Science and Nature took a more neutral stance toward the early discoveries and technologies than did the newspapers, Nature being the most neutral with a figure of about 83% as opposed to 65% for Science and around 53% for each of the newspapers.

The more detailed coding definitions and analysis allowed this study to produce more accurate and thus slightly different percentages of tones than were found in the pre-study. Still, as in the first study, the pattern of coverage was similar between journal and newspaper, as Caudill had found in his previous study concerning Darwin.

The time lapse between certain discoveries and their coverage in the publications, such as the delay in peak radium coverage from 1898 to 1903, gives evidence of the existence of complex factors needed to make the pages of the media. Even the science journals were slow to publish material on radium until more startling characteristics of the phenomena were discovered, such as the ability to generate its own heat. Thus, even though great things were expected of the new element from early in its discovery, these expectations were not entirely believed or rewarded until the scientific world had time to work and test them. Ultimate approval was granted with the awarding of the 1903 Nobel Prize.

Some of this lack of coverage may have occurred as a backlash to the great amount of coverage that X-rays had elicited when they hit the scene. It's almost as if the revelations about X-rays had taken away the initial novelty from radium, discovered just two years later. This points to a window where being first is heralded--X-rays being initially defined as the more important radiation phenomena because of its status as fore-runner. This changed as the new discovery was found to possess different and more powerful characteristics.

While nuclear coverage lagged a bit behind most of the newsworthy events both in the journals and in the newspapers, the journals did scoop the papers often. This is to be expected for such specialized periodicals; but while they gave earlier coverage to nuclear issues, the journals' overall coverage was less broad both in terms of tone and categories--Science having the broader coverage of the two journals.

The large number of reprinted articles found in all the publications indicates that science news travelled regularly from publication to publication, country to country and continent to continent. Many of these reprinted stories were seen to originate with Nature, which fits with its practice of carrying the proceedings and contents of many different science societies and journals as well as early reports on new methods and subsequent follow up studies. But newspapers also generated early coverage of nuclear science and technology, as did other journals.

Sensational pieces were found in both newspapers, but the journals also carried the hopeful and overzealous words of excited researchers. Suggestions and images of radium and X-rays as remedies for social ills, as well as magical in power, were common in all publications. Early nuclear science and technology were seen as a way out of an impending energy crisis, and also were quickly put onto the battlefield to help treat the wounded. Those who controlled these mysterious powers were referred to as high priestesses and great scientists. Among these power wielding, magic-like references, a few images of radium's destructive powers also appeared.

In Nuclear Fear, Weart brushed off the early negative press coverage given the nuclear issue, in part, because the harm happened mostly to doctors and technicians and also because larger and more gruesome disasters were prevalent in the newspapers of the time.[1] While the data generally support Weart's headline analysis that there was little negative coverage during this period, headlines in this study were seen to be only a marginally accurate representation of the tone of the coverage in the newspapers. The New York Times's headlines were found to be more varied in tone than the stories that followed, whereas The Times of London's headlines were found to be more neutral than the subsequent stories.

While most of the early stories presented neutral and positive representations of the issues, harmful aspects of the technology were written about early. In addition, more and more newspaper stories began to present better balanced articles about radium and X-rays across time, with 1914 and 1921 being the years in which the most such balanced stories were coded.

While Weart noted that the lack of early public concern over radiation danger was because the people who were most often hurt by these new technologies were those workers and doctors who used them, a few stories of patient lawsuits were present throughout the study, as well as mentions of the proper and ethical application of this new technology. Just as Weart noted the presence of a sub-conscious cultural fear after the 1920s about the potential danger of human meddling with natural forces, this study reveals that stories with similar cautious whispers and warnings were present from the beginning of the second scientific revolution. Through a balanced optimism that called for replication of results and sound scientific method, these voices formed a counterpoint to the heralded sounds of success favoring nuclear technologies as methods of relieving all human suffering. Stories of cure-alls and the regeneration of life were found along with scientific debates and lawsuits by patients who had been burned by sparking X-ray machines.

For stories such as these it is not possible in this study to test how accurately they represented what their expert sources had said. Still, many stories contained a high percentage of direct quotes from experts, leaving little room for mis-representation. Often the experts themselves wrote the articles on nuclear issues, with more such stories occurring in the journals. The journals also contained more sources per story, as is to be expected because of their use of laboratory reports and scientific speeches--forms which follow the practice of reporting all relevant previous research.

Science writers' habit of reporting experts' words verbatim may have arisen because of the novelty of the difficult and technical topics covered, but also can be seen as limiting the media's interpretation of these same technologies. The science experts were surely presenting their own agendas in their speeches and interviews, yet these views were hardly ever revealed or interpreted in the coverage of the period. Yet a few corrective stories by scientists and editors alike were found. In addition, scientific debates were covered by the media, indicating an investment of space on their part and thus a sign of significance.

Scientists too indicated that they were very aware of the public and its perception of the new science and its facts. They sometimes raised questions about the accuracy and completeness of the coverage found in the newspapers, but most often this inaccuracy appeared to be related to the airing of differing scientific views as opposed to inaccurate reporting.

It is not possible within the scope of this study to determine the agenda-setting effect of early coverage of nuclear issues, but it is clear that the issues were often placed before the public, mostly in stories with neutral tone, with both positive and negative aspects sometimes included. Evidence of how important the public perceived nuclear issues to be comes from the numerous mentions made of them by scientists and journalists alike--both groups were concerned with how the nuclear stories were being perceived by the reading public. This occurred even before WW-I, in what is historically thought of as a low point in the popularizing of science.

Further study in this area might compare science and technology coverage with that of business and/or national government during the same period. Additionally, more publications could be added to better study the effects of media competition on science coverage. Research into the context and images of current press coverage of new science and technologies would also help to understand the role of science in our society.

This study has pointed to how potent new scientific discoveries can be. The resulting technologies were seen to have both positively and negatively affected lives, while those who possessed the technologies and their secrets attained both wealth and fame. The coverage came at a time when science and industry were more and more looked to as tools of hope and betterment of life for both rich and poor. Egalitarian applications of the new and powerful technologies were spread throughout the coverage.

In addition to images of power, destruction and wealth, the coverage of the nuclear issue also carried explanations and language that suggested the mystery and complexity of the issues. Due to this complexity, much of the media's coverage was verbatim reports from one expert, without any interpretation or inclusion of contradictory sources. This raises a question regarding the current state of science writing.

Recall that many researchers agree that large numbers of the population get their science news from the print media, and that the current trend is for mostly verbatim reporting from media aware experts. The question then becomes: If the trend of reporting science news verbatim continues with little interpretation, how will this affect the culture when dealing with the powerful effects of future science and technology?

In this era of AIDS and recurrence of drug-resistant strains of diseases such as tuberculosis, people look to the scientists and the medical practioners for answers. Powerful diseases such these are frightening--invoking a fear of death and of loss of control over one's life. As new technologies come out of the laboratories claiming to aid or cure today's feared diseases, it is important to look back to how such technologies were received in the past.

This study showed that initially nuclear technologies were well received, and were looked to as a technological fix for all areas of life--energy, health and defense. Nevertheless, these technologies were not cure-alls; they possessed their own dangers and hazards. Yet the voices which asserted such cautions were muffled by the louder voices of hope and need. In a time when society was benefiting from the machines of the industrial revolution many felt sure, at least at first, that the scientists had discovered a technological savior. Many scientists, patients, doctors and people on the street wanted the cure-all; they wanted a device that would take the fear of death out of cancer; they wanted a source that would solve all energy crises.

But this study showed that the true nature and safe use of the technologies took time to evolve. We know now, after almost a century, that nuclear devices only help in certain cancers, and that nuclear energies have yet to solve all energy needs. It is important for the media to remember the lessons of the past as they look toward covering the scientific breakthroughs of today and tomorrow.

CHAPTER SEVEN

NOTES

1. Weart, p. 52.

APPENDIX

APPENDIX

CODING DEFINITIONS

Periodical: Publication in which selected article was published.

Headline: Bolded or large font size story caption above text.

Byline: To include author of article and titles as well as affiliation such as a scientist, doctor, industry worker, governmental.

Dateline: Date of and location from which story was written.

Article length will be measured in lines by counting the lines in the first three inches of each story, measured from the first ascender to the last full line, then calculating the average lines per inch. ALI is then multiplied by the length of story in inches. Caution is to be taken to notice any change in print or column size in any given article, and a new ALI is to be calculated where applicable.

Pieces Coded: Includes articles or stories, speeches and lectures, abstracts of other stories, editorials and letters to the editor.

A: Articles are defined as any indexed communication of facts in any form and any size, blurb or full length story, and can be both feature and news related.

B: Speeches and Lectures are defined as pieces which originated from public forums. Some are paraphrased while other are direct reprints. For the reprints, the author was coded as such under byline.

C: Abstracts are defined are brief mentions of other stories, studies, often including the title, author, subject studied and main finding.

D: Editorials are defined as opinion pieces written by staff of the publication.

E: Letters to the Editor are defined as communications submitted to the publication by people other than staff. Usually include the name and occupation or qualification of the author.

Tone: Defined as the position and/or messages and images the segment of the article presents on the nuclear issue(s).

A: Positive is coded when the headline/lead/story suggested, implied or stated that the nuclear issue(s) was beneficial, helpful, good or useful to individuals and/or society. The topic of the article was presented in a benevolent and good light.

B: Neutral is coded when the headline/lead/story neither indicated, accused, implied or stated that the nuclear issue(s) was good, bad, helpful or harmful to society or individuals nor did it redeem, promote, or destroy them in any way. Articles that were well balanced in presenting alternating opinions are also included in this category.

C: Negative is coded when the headline/lead/story suggested, implied or stated that the nuclear issue(s) was harmful, fatal, or dangerous to living beings and or society. In these articles, the reader received a message of caution or disdain toward the nuclear issue(s) or a feeling that the technology or science should be approached with caution or dread.

Article Categories: Categories of articles are broken into discovery, power, military, medicine, price & supply, multiple and other.

A: Discovery articles deal with the advancement of scientific, medical technological and theoretical knowledge of nuclear related materials including X-rays.

B: Power articles deal with the use of nuclear related materials including X-rays to generate energy for human use.

C: Military articles deal with the use of nuclear related materials including X-rays in terms of war time destruction, protection or deterrent.

D: Medical articles deal with the use of nuclear related materials including X-rays being used or studied for use in treating illness or other life threatening ailments or health threats.

E: Price and supply stories deal with the cost of nuclear related materials and technology including X-rays as well as the availability and methods use to acquire and produce nuclear related material.

F: Multiple stories are defined as stories in which more than one of the above categories appear. Each story type should be recorded.

G: Other stories are defined as stories that do not fit in any of the above categories.

Art: Art being photographs, charts and line drawings used to illustrate the coded story.

Sources: Sources are defined as the expert or witness cited in regards to the story. The institution of the source is important i.e. medical, governmental, educational, non-profit, layperson or any other included affiliation of source with an larger institution.

Medical sources are coded when referred to as working with health care or when such a title is given. They can be either academic or non-aligned private health care workers.

Science sources are coded when referred to as an expert in an area of science or when such a title is given. They can be either academic or non-aligned private science workers.

Industrial sources are coded when referred to as being affiliated with a corporate/industrial or other private money making enterprise.

Industrial-Medical sources are medical workers or experts affiliated with corporate/industrial enterprise.

Industrial-Scientific sources are science workers or experts affiliated with corporate/industrial enterprise.

Military sources are coded when referred to as working for some defense institution or project if no other affiliation is given.

Military-Medical sources are medical workers or experts affiliated with defense institutions or projects.

Military-Scientific sources are science workers or experts affiliated with defense institutions or projects.

Institutional sources are coded when referred to as working for a non-profit, a charity or a independent regulatory body.

Institutional-Medical sources are medical workers or experts affiliated with an institutional enterprise.

Institutional-Scientific sources are science workers or experts affiliated with an institutional enterprise.

Governmental sources are coded when referred to as working for a regulatory agency or unit affiliated with a public governing body.

Governmental-Medical sources are medical workers or experts affiliated with a public governing body.

Governmental-Scientific sources are science workers or experts affiliated with a public governing body.

Governmental-Legal sources are legal workers or experts affiliated with a public governing body.

Layperson sources are coded when no other affiliation is mentioned and no references to any particular expertise or skill is given.

Legal sources are coded when referred to as a non-aligned worker or expert in practicing and interpreting public law.

Author sources are coded when referred to as the writer of a book, both fictional and non-fictional, and if no other professional qualifications are given.

Publication sources are coded when any magazine, newspaper, journal or any other periodic printed work is cited or referred to.

Other sources are coded when the person or item referred to does not fit any of the above source categories.

Sample sentence: To be used for any particularly interesting part of article that helps relay the point of view of the article or metaphors used in communicating nuclear issue covered.

Coding Sheet

Coder #__________

Date____________

Periodical______________________________

Article #________

Date of Article__________________________

Page, Column & Position_______________________

Headline Summary_____________________________

____

Byline______________________________________

Dateline____________________________________

SPACE MEASUREMENT & TONE:

Head Lines, Size & Columns_____________________________________

Article Lines____

Article Format____
0=Article, 1=Editorial, 2=Letter To Editor

Headline Tone:____

Lead Tone for Article:_______________________________________

Story Tone:____
0=Positive, 1=Neutral, 2=Negative

Article Category:____
0=Discovery, 1=Power, 2=Military, 3=Medicine, 4=Price &Supply, 5=Multiple, 6=Other.

Art____

Sources (Cited/Number)______________________________________

____

____

____

Sample Sentence and Metaphors:_______________________________________

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