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The Electric Light and The Future: American Perceptions and Expectations, 1879-1890

M.A. Thesis
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University of Ottawa

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Abstract

Perceptions and Expectations: The Electric Light and The American Future, 1879-1890

This thesis explores the manner in which electric lighting was applied during the first decade after Edison's Menlo Park demonstration, and how these applications influenced American public perceptions of the technology, particularly in relation to imagined future uses and social meanings. Specifically, the thesis focuses on expectations and perceptions of electric lighting as applied or related to three important aspects of late nineteenth century American society: crime, warfare, and aesthetics and health. Using these three themes, this thesis illustrates how electric lighting was viewed during the 1880's and what hopes and images were attached to it.

Scribner's (October 1879)

THE ELECTRIC LIGHT.

Harper's New Monthly Magazine (October 1870)

"We shall walk and live in the light,
and this will disclose to us
how much we have done that was unworthy,
and suffered that was unnecessary,
because of darkness,
which may perhaps have seemed light to us,
not having before known light."

The Operator and Electrical World
Feb. 3, 1883

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Introduction

Shortly after developing a practical incandescent light Thomas Edison suggested that electric lighting could one day obliterate darkness as the world knew it, and possibly even erase the necessity of sleep.[1] While today the statement may stand out as a farfetched exaggeration, to the late nineteenth century American public there was little unique or overly fantastic in the expressed sentiment. The practice of imagining the future or predicting the impact of a new technology was not uncommon to the time.[2] Visions and expectations about new or anticipated technological inventions were frequently published in newspapers, journals, and fictional literature.[3] Science and innovation, exalted by the nineteenth century belief in "progress", raced

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[1]David Nye, Electrifying America: Social Meanings of a New Technology, 1880-1940 (Cambridge: The MIT Press, 1990), p. 147.

[2]The history of the future began nearly four hundred years earlier. I.F. Clarke writes that "throughout many centuries the evidence of the past seemed to show that the unchanging destiny of the human race was to repeat the eternal round of an agrarian civilization," but with the explorations of Columbus and Magellan and the scientific discoveries of Vesalius, Harvey, Galileo and Kepler new worlds, possibilities, and expectations emerged. By the middle of the 17th century each scientific advance produced new expectations and future visions. One of the greatest fascinations of society was that of human flight, and news of the Montgolfier balloons in 1783 in France opened up the skies to the imaginations of most people, and led many to believe that one day travel to the moon would be possible. This fascination with space travel, particularly with the moon as the ultimate destination would continue to interest society for generations. I.F. Clarke, The Pattern of Expectations, 1644-2001 (London: Jonathan Cape, 1979), p. 3.

[3]An in-depth analysis of the history of utopian and visions literature is out of the scope of this thesis, but the international acclaim and readership drawn by the works of Jules Verne, Chesney, Edgar Allan Poe, and even Mark Twain in A Connecticut Yankee in King Arthur's Court, and later H.G. Wells shed light, particularly on the industrial future cities, utopian states warfare, space, and travel aspects of future visions. Fictional works glorifying Edison, such as Garrett P. Serviss' Edison's Conquest of Mars will be later discussed. See: Brian Ash, Faces of

forward at such a pace that the public could barely keep their imaginations up to speed with the work of the engineers, scientists, and inventors. There was an unparalled belief that technological progress would alter the world in ways unimaginable only decades earlier. According to I.F. Clarke, by the 1860's "the various progressive and evolutionary theories of the nineteenth century had coalesced to form a pattern of general expectations. This was the idea of progress, and at its most simple it was no more than the universal agreement that things had changed for the better and would go on changing."[4] By the 1870's inventions such as the locomotive, steamboat, telephone, telegraph, trans-Atlantic cable, and phonograph served to justify this belief.

Electric lighting, in particular Edison's incandescent lamp, is one of the quintessential examples of how a new technology led people to speculate on the manner in which new inventions would affect and shape life in the future. In the eyes of many, Edison's incandescent light was a seemingly perfect alternative to the sun, and as a result, for the first time in history there was reason to believe that in the near future the concept and consequences of darkness would be forever altered. In maintaining the balance between light and darkness, nature controlled one of the most basic aspects of life. The social implications of disrupting this domination appeared monumental. Joseph Corn explains the enormity of the invention: " For thousands of years it was thought that only God could have invented light and rescued humanity

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the Future - The Lesson of Science Fiction (London: Elek/Pemberton, 1975). Paul K. Alkon, Science Fiction Before 1900: Imagination Discovers Technology (New York: Twayne Publishers, 1994). I.F. Clarke, The Pattern of Expectation, 1644-2001 (London: Jonathan Cape, 1979).

[4]I.F. Clarke, p. 90.

from the dread and evil of darkness, but with the incandescent bulb mere mortals could flick a switch and, in effect say 'Let there be light.'"[5] The magnitude of this realization was not lost to nineteenth century observers, as from such grand considerations speculation on the social impact and would-be meaning of electric lighting emerged. During the decade that followed Edison's Menlo Park demonstration of December 31, 1879, the idea of an electrically-lit future was the subject of extraordinary and insightful speculation on the imagined social impact of the electric light in the future.

Joseph Corn refers to the study and interpretation of future visions and expectations as the history of the "future that used to be." He explains that the study is "first and foremost" concerned with "ideas, expectations, and projections."[6] Methodologically, the task of interpreting and analyzing the impact and importance of future visions involves three preliminary questions that need to be addressed. One must first determine who put forward these impressions of the future. Herb Brody warns that "rosy predictions often originate with people who have a financial stake in a new technology."[7] At a quick glance this interpretation appears to apply to the electric lighting visions literature of the late nineteenth century. Both sides of the lighting industry, gas and electric, used all available venues to publish conflicting reports on the superiority and glorification of their light over all others. Trade journals such as Electrical World and Electrical Review, and electrical literature written by engineers and inventors with vested

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[5]Joseph Corn, Imagining Tomorrow (Cambridge: MIT Press, 1985) p. 221.

[6]Joseph Corn, p. 2.

[7]Herb Brody, "Great Expectations: Why Technology Predictions Go Awry" in Albert H. Teich (ed) Technology and the Future. (New York: St. Martin's Press, 1993).

interests in the industry forecasted extravagant and revolutionary changes to be brought about electric lighting.[8] Yet one must take into consideration that a great many articles on electric lighting were verbatim republications from mainstream city newspapers, and not necessarily a product of the electrical journals in which they appeared. Articles featured in electrical journals often originated in newspapers such as the New York World or Chicago Tribune.

In the case of the incandescent light there existed a genuine wave of enthusiasm and speculation on the impact of electric lighting in the future as reflected in mainstream American journals.[9] Popular science magazines, such Scientific American, Popular Science Monthly, American Journal of Science, Boston Journal of Chemistry and Scientific American Supplement also published a number of articles on the significance and future of electric lighting. As such, the argument that predictions of the social impact of a technology derive from supporters of the artifact is a legitimate one and relevant to the electric light, but rather than hinder, it leads the historian to be cautious and selective of his sources and the sentiments expressed therein.[10]

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[8]For a brief discussion on electrical content in late nineteenth century magazines see, Frank Luther Mott, A History of American Magazines (Cambridge: Harvard University Press, 1967), pp. 118-122.

[9]By "mainstream" I mean a popular journal without a definite readership, trade, or profession in mind, such as: Scribner's, The Atlantic, Harper's New Monthly Magazine, Appleton, Century, etc. The term "popular" was based on relative circulations numbers. See Mott, pp. 6-9.

[10]Source examination played a critical role in writing this thesis. Many historians on the subject have failed to ask and examine where a given source came from, who wrote it, why it was written, and what audience it could have had. Carolyn Marvin in When Old Technologies Were New (New York: Oxford University Press, 1988) makes the mistake of reading too much into the sensationalist reports of electrical trade journals. While Bernard Finn, in "The Incandescent Electric Light," Annals of the New York Academy of Sciences vol. 424 (1984) pp. 247-263 used the wrong source in N.H. Schilling's The Present Condition of Electric Lighting (1886) to the determine, that gas lighting was not severely damaged by electric lighting in the

A second problem concerns who read and believed such speculation. This question is almost impossible to answer. It can be safely maintained that accounts of the impact electric lighting were read by the upper middle and upper classes of society, but there is also reason to believe that the middle and lower classes interested themselves in the literature. In an age and country where scientific progress was exalted, literacy was relatively high, and self education saw such men as Henry Ford and Thomas Edison emerge from humble beginnings, it can be suggested that an interest in science, invention, and the future reached multiple levels of society. While the cost, education, and leisure time required meant that only few could subscribe to a journal like Scientific American or The North American Review, this does not imply that a literate laborer could not pick up a copy of the New York Graphic or The NY Times and find mention of the electric lighting discussion.[11] Nor was he restricted from wandering into districts where electric lights appeared on streets or in department stores. These possibilities aside, historical impressions of the unprivileged classes, as is the case with many other topics, remains limited.

After determining relevant social groups, the third question to be asked is how important these future visions are in the process of technological development and diffusion. Expectations may have both economic and social consequences. In an economic analysis, Nathan Rosenberg argues that "expectations concerning the future course of technological innovation are significant

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nineteenth century. Schilling's pamphlet was written with Munich gas interests in mind (later translated into English) and cannot be taken as a valid, unbiased reflection of conditions and opinion in the United States at the time.

[11]Joseph Corn cautions that "our understanding of how blue-collar workers, farmers, blacks, and immigrants historically conceived relationship between technology and the future is not likely to be furthered by the study of mainstream literary evidence." Corn, p. 225.

and neglected."[12] He writes that "most inventions are relatively crude and inefficient at the date when they are first recognized as being a new invention."[13] This was true of both forms of electric lighting in the nineteenth century, in that both arc and incandescent lighting, for reasons to be discussed, were impractical and flawed technologies. In Rosenberg's opinion, because of the unformed shape of new technologies, they "are of necessity badly adapted to many of the ultimate uses to which they will eventually be put, therefore, they may offer only very small advantages or perhaps none at all over previously existing technologies."[14] The essence of Rosenberg's argument is that the period that follows the introduction of a technology is a period of innovation during which improvements on the flawed artifact are made. According to Rosenberg, "The pace at which subsequent improvements are made will be a major determinant of the rate of diffusion."[15] He explains that the expectations that surround these improvements "may lead to a surprising result of making rational a delay in the widespread diffusion of the innovation."[16]

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[12]Nathan Rosenberg, Inside the Black Box: Technology and Economics (Cambridge: Cambridge University Press, 1982) p. 104.

[13]Nathan Rosenberg, Perspectives on Technology (London: Cambridge University Press, 1976) p. 195. This was certainly the case with the electric light. The lamp demonstrated by Edison in 1879 was marred by flaws and weaknesses, and improvements were not completed until the introduction of the metallic filaments in the early twentieth century. Arthur A. Bright, Jr., The Electric-Lamp Industry (New York: MacMillan, 1949) p. 93.

[14]Rosenberg, Perspectives p. 195.

[15]Rosenberg, Perspectives p. 195.

[16]Rosenberg, Inside The Black Box, p. 105. Rosenberg also writes that "Diffusion...will necessarily be slow because the clear superiority of the new technique over the old has not yet been established." Perspectives p. 195.

Harold Passer who earlier examined the industrial and economic aspect of the electrical industry in The Electrical Manufactures noted a similar trend: "The manufacturer has to convince the prospective buyer that no major improvements are in the offing. At the same time the manufacturer must continue to improve his product to maintain his competitive position and to force existing products into obsolescence."[17] According to this economic analysis, expectations of improvements slow diffusion. The owner of a large factory, pondering electrification, would be hesitant to invest in electric lighting if he happened to come across an article in Scientific American or Electrical World predicting that in less than five years the cost of electric lighting would be greatly reduced.

In contrast to Rosenberg and Passer, Joseph Corn adopts a social perspective in addressing the importance of future visions and expectations of a new technology. He sees the relationship between technological futurism and nineteenth/twentieth century American culture as similar to Karl Marx's view of religion as the opiate of the masses earlier in European history.[18] Corn argues that society's ability to deal with social and political dimensions of a problems has been "dulled by the euphoric solutions proffered by technological utopians."[19] Technological change came to be widely seen as the most direct route to happiness and social progress. Thus, while earlier, deprived generations saw salvation and solace in the hope of an eventual ascent to heaven, by the nineteenth century many had turned their ambitions and dreams to the notion of an

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[17]Harold Passer, The Electrical Manufactures, 1875-1900 (Cambridge: Harvard University Press, 1953) p. 45.

[18]This analogy was earlier raised by John McDermott, "Technology: The Opiate of the Intellectuals." Teich, p.100.

[19]Corn, p. 227.

equally glorious technological future. In this manner, late nineteenth century society saw electrically-lit streets as a means of salvation from the criminal activity that thrived on darkness, and the opulence of a well-lit home as an answer to the poverty, filth, and unhappiness so commonly attached to darkness.

Corn also argues that future visions and expectations play a role in bringing about "workable innovations."[20] Even the most inaccurate visions and expectations often lead to practical technologies. Invention is based on ideas, dreams, and personal ambition. Generations were required to wonder and dream about human flight before it was actually accomplished. In this sense a successful idea or achievement is rarely the result of spontaneity, but rather the practical application of a dreamer's scheme. Future visions from the past help to create a social history of a technology by revealing the ideas and expectations of specific social groups. In Corn's opinion "even the most flawed or utopian dream offers insights into how people thought about their world, about social change, about themselves, and about their technology." How significant or telling was the fact that warships were equipped with electric light years before a majority of homes? How does the adoption of a technology as a status symbol influence the way the technology is perceived and accepted?

Accepting both economic and social interpretations of the role of future visions, this thesis explores the introduction of electric lighting in late nineteenth century America, and the perceptions and expectations associated with this development. The study will focus particularly on early uses, public perceptions, and future visions of electric lighting in America. In Rosenberg's opinion, any given technology goes through a "period of improvement" after its

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[20]Corn, p. 229.

initial introduction.[21] Rather than describing the work of industrialists, inventors, and scientists, this study concentrates on the development and social impact of the imperfect technology during this period of innovation. In the case of nineteenth century electric lighting, with its expensive cost, technological imperfections, relative inefficiency, and perceived dangers, it must be asked how the image of electric lighting was influenced during the decade that followed its introduction. To answer this, the thesis will explore the manner in which electric lighting was applied during the first decade after Edison's Menlo Park demonstration, and how these applications influenced American public perceptions of the technology, particularly in relation to imagined future uses and social meanings.

While a discussion of incandescent lighting will be the predominant theme, the subject of electric lighting is approached from a nineteenth century perspective that makes little distinction between arc and incandescent lighting. The arc light is not treated here merely as an independent rival of the incandescent light, but as an essential component of the nineteenth century definition of "electric lighting." To place the subject in its proper historical context, a discussion of the evolution of both technologies as well as the role of the gas industry they hoped to replace is presented in the opening chapter. By analyzing the process of invention and the conditions of lighting before the latter half of the nineteenth century, the impact and social meaning of electric lighting can be better understood.

The time period studied is the first decade following Edison's development of the practical incandescent light, 1879-1890. During these years electric lighting, particularly by incandescence, was still very much in its infancy, and therefore remained a mystery and novelty

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[21]Rosenberg, Perspectives p. 195.

to most of society. As a part of the social absorption of new technologies, the nineteenth century public frequently expressed their opinions in literature, newspapers, and journals on the probable influence of electric lighting on society. This thesis examines perceived social meanings and future visions from these sources, as illustrated in the chart on page sixteen.

The corpus was selected on the basis of trying to provide the broadest possible reflection of the discussion on electric lighting that occurred between 1879-1890. To achieve this, works on nineteenth century American literature, such as Frank Luther Mott's A History of American Magazines were consulted to determine relative circulation numbers, readership, and subject material. Also a number of indexes, such as Poole's Index to Periodical Literature, were used to determine in what journals references to electric lighting frequently occurred.

When the research was completed the sources were divided into five categories: mainstream journals, newspapers, scientific journals, electric trade journals, and books on electricity and the electric light. Each type of source was consulted with specific guidelines and goals. Electric trade journals, such as Electrical World and Electrical Review were read issue by issue to obtain a comprehensive understanding of the abundance of articles and references to electric lighting which appeared between 1879-1890. Scientific Journals were consulted to reflect three levels of readership. Scientific American and Popular Science Monthly reflect a mainstream audience and the Journal of the Franklin Institute, an engineering audience, while the American Journal of Science and the Boston Journal of Chemistry are examples of what was being read by the professional classes. All these journals were indexed, and articles under the headings of electric light, electricity, warfare, crime, and health were consulted.

The objective of the third type of source, books on electricity and the electric light was to consult a comprehensive selection of electrical literature published between 1872-1892 as found from various bibliographies and sources.[22] A total of twenty-one books on electricity or the electric light were consulted. The final two categories, newspapers and mainstream journals illustrate opinions expressed in high circulation, general readership publications. The New York Times was the primary newspapers consulted, alongside occasional references from the Chicago Tribune, The New York Daily Graphic, or articles from other newspapers cited in other sources such as Electrical World or Electrical Review. The New York Times is indexed for these years, and articles were found under the headings: the electric light, arc light, incandescent light, and electricity. Articles from a number of indexed mainstream journals, such as North American Review, Scribner's, Lippincott's Monthly, Harper's New Monthly Magazine, and Arthur's Home Magazine, were also used in the analysis of the subject.

The examples selected to discuss the expectations and perceptions of electric lighting are the electric light as applied or related to crime, warfare, and aesthetics & health. These categories were by far the most commonly discussed topics related to the perceived impact of electric lighting in America between 1879-1890. For this reason they were selected as focal points in this study and provide a thorough reflection of the varied aspects of life which many believed would be influenced and altered by the introduction of electric lighting.[23]

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[22] Examples of the sources that were of assistance in this pursuit, include: Bernard Finn's The History of Electrical Technology: An Annotated Bibliography. Also Electrical World and Electrical Review frequently printed lists of newly published books on the subject. An article in Literary World on September 4, 1887, "A List of Books on Electricity" was also very helpful.

[23] In determining the focus and framework of this thesis it was continually suggested that including a section on the late nineteenth century discussion of the perceived impact of the electric light in the workplace, its use in factories, or the issue of

Under crime and public safety this thesis discusses early applications of electric lighting in city streets, the attached imagery, and to what extent lighting was seen as a possible crime deterrent or social savior. The application of the electric light in warfare will illustrate how a new technology can be used by the military complex of a nation and be deemed essential years before it is used to serve the populace of the country which it protects. The discussion also includes late nineteenth century opinion on the military use of electric lighting and its perceived importance in the future of national defense and warfare. The subject of aesthetics and health illustrates the role the electric light played as a status symbol, how it was depicted as a necessary improvement in health and hygiene, and how it was used for spectacle and grandeur. From this information the image and future visions of the electric light are discussed.

Using these three themes, this thesis illustrates how the electric light was viewed during the 1880's and what hopes and images were attached to it. It examines the process by which it was developed and introduced to the late nineteenth century public, and how this affected the way the technology was perceived. This thesis will show that, although Edison intended the electric light to be a populist technology, a number of factors insured that, during the 1880's, it would remain an elitist technology affordable by the wealthy and powerful classes of society. The impact this had on public perception of the electric light during this decade and its role in the future is addressed.

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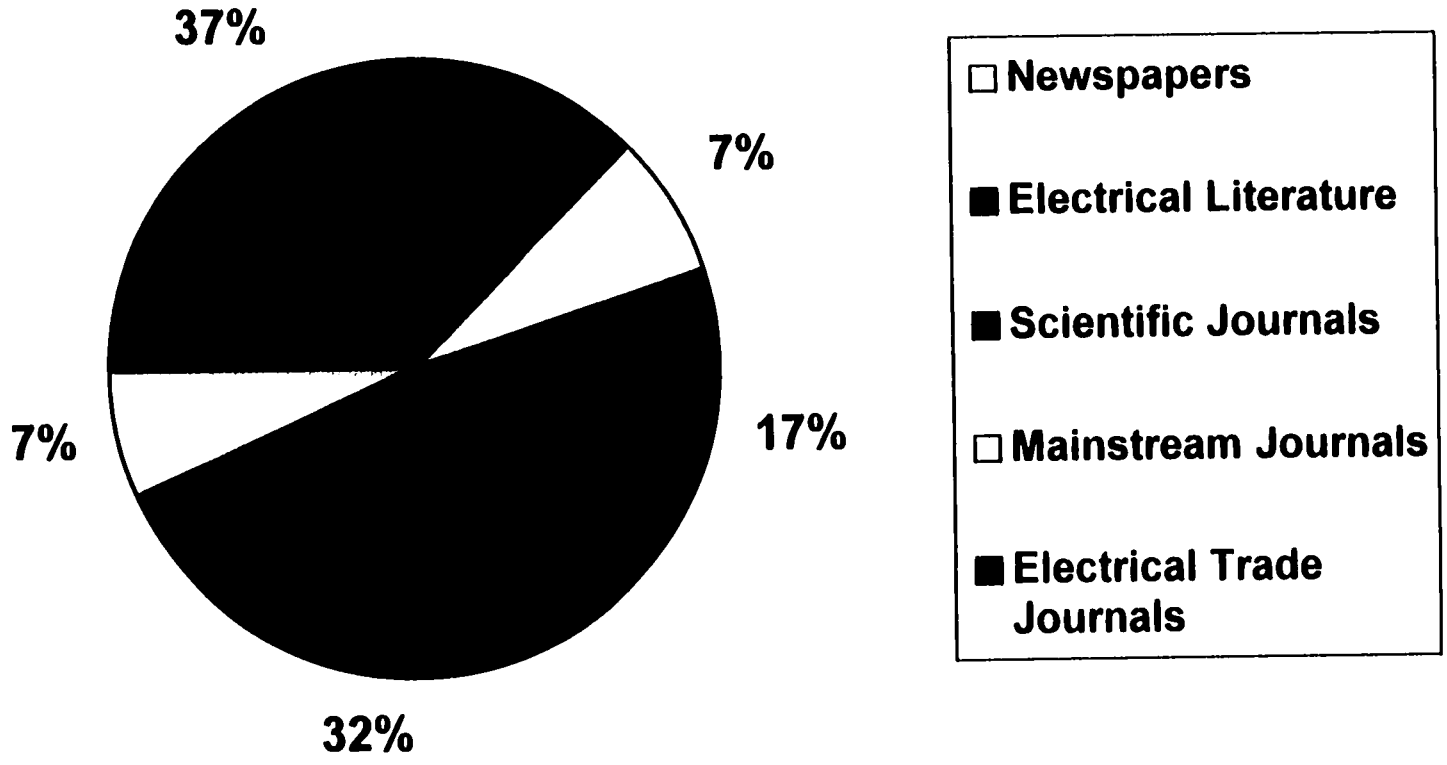
gender, would serve to complete the study. Yet close examination of published literature on the subject between 1879-1890 shows a very limited discussion of the relationship between the electric light and these subjects. As the goal of this thesis was to provide an accurate reflection of the nineteenth century American discourse on the meaning of the introduction of electric lighting, these subjects were not included in the study.

DATABASE: Cited Sources,* 1879 - 1890



* Percentages represent actual number of articles cited from each source category.

The Historiographical Context

David Nye correctly states in his conclusion to Electrifying America that of all the studies done on electrification in America none had focused on "electricity's meaning and uses for ordinary people." He argues that most people were not "inventors, engineers, or utility employees," and yet most accounts have chosen to focus exclusively on such individuals.[24] Until recently nearly every history of electric lighting has focused either on biographical sketches, the process of invention, industrial and corporate engineering, or what Nye refers to as "insider" history of technology.[25] What Nye sought to achieve with electrification, and what this thesis hopes to supplement with a concentration on electric lighting, is to present a social angle to an important part of electrical history. David Nye explains, "The electrification of America is...far more than the story of inventions and corporations; it involves a popular absorption in the potentialities for personal and social transformation."[26]

The traditional emphasis on "insider" history in studies of electrification also occurs in specialized studies of electric lighting.[27] The most popular approach, stemming from 19th century

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[24]Nye writes that "earlier studies of electrification have been plotted as the biographies of inventors; as a sequence of inventions; as the effects of the inventions; as the story of power generation and transmission; as the concentration of power in monopolies; and as the profiteering of giant utilities." Nye, 381.

[25]Nye, p. 381.

[26]Nye, p. 382.

[27]A great many studies of electric lighting are often included in general works on electrification, as is the case with David Nye's Electrifying America (1989) and Harold Platt's The Electric City (1991). In fact, the only significant work devoted exclusively to the social impact of electric lighting remains Matthew Luckiesh's, Artificial Light: Its Influence Upon Civilization (1920).

beginnings, is to provide a biographical sketch of the inventors and engineers and the sequence of events involved in the introduction of a technology. This approach relies heavily on the narrative to describe the technical process of invention. The sources consulted are commonly contemporary accounts and records of the technology's development. Franklin L. Pope, in Evolution of the Electric Incandescent Lamp (1889) wrote one of the earliest and most popular accounts of the development of the incandescent light. This was followed by a number of similar narrative studies on electric lighting. Henry Schroeder & John W. Howell's, History of the Incandescent Light (1927) provides a meticulous history of the progressions of inventions in the fields of dynamos, vacuum-pumps, lamp design, and biographical sketches of the lives of inventors. Arthur A. Bright's The Electric Light Lamp Industry: Technological Change and Economic Development from 1800-1947 (1947), written from an economic perspective, is likely the best history of the scientific and technical development of the incandescent light. Harold Sharlin's The Making of the Electrical Age (1963) frequently cited by historians of electricity, is an excellent source for the development of technological factors related to electric lighting. The most comprehensive study of the process by which Edison's incandescent light was developed was published by Robert Friedel & Paul Israel, Edison's Electric Light: A Biography of an Invention (1985). Friedel and Israel, with material drawn from the laboratory notes and drawings from Menlo Park, Edison Electric Light Company bulletins, newspapers and journal clippings, and other secondary sources seek to describe the "inventive act" of the electric light rather than the "institutional, economic, and social basis for technological change."[28] They attempt to

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[28]Robert Friedel and Paul Israel, Edison's Electric Light: A Biography of an Invention (New York: Russell Sage Foundation, 1985) p. 6.

delineate the personalities behind the inventive act, emphasizing "innate talent, technical experience, laboratory facilities, and self-confidence"[29] as the major factors behind the success of Edison.

A related approach focuses on the life and deeds of Thomas Alva Edison because of the essential role he played in the development and commercialization of the incandescent light. Edison has been the subject of a stream of biographies and studies which began during his lifetime and continue to this day.[30] In these studies, two interpretations emerge which either defend or attempt to debunk the phenomenon commonly referred to as the "Edison myth" or the "Glorification of Edison."[31]

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[29]Bernard Finn, p. 219.

[30]While Edison will appear to a great extent in any work listed here, he has also been the subject of several biographies. Matthew Josephson's Edison (1959) remains the most complete and authoritative study of life and times of the inventor. Robert Silverberg's Light for the World: Edison and the Power Industry (1967) is little more than a summary of Josephson. Others worthy of note include: Ronald W. Clark, Edison: The Man who Made the Future (1977); Robert Conot, A Streak of Luck (1977); Andre Millard, Edison and the Business of Innovation (1990) Neil Balwin, Edison: Inventing the Century; (1995).

[31]Literature "glorifying" Edison began to appear shortly after he was dubbed the "Wizard of Menlo Park" after his invention of the phonograph in 1878. The origin of such glorification can be found in various newspaper and journals articles during the late nineteenth century and early twentieth. It also quickly surfaced in nineteenth century science fiction literature. Auguste de Villiers in Tomorrow's Eve (1886) uses Thomas Alva Edison as the genius scientist in the fictional work. For a discussion see Alkon, pp. 84-86. Later in 1898 Edison's Conquest of Mars by Garrett P. Serviss described Edison inventing "antigravity spaceships and disintegrator weapons" and then organizing "an expedition to defeat the Martians on their planet." Alkon, p. 108. On the basis of such glorification the inventor has become a subject of controversy, being described in words that range from genius to charlatan. William Adams Simonds described the debate in the introduction to his 1940 work, Edison: His Life, His Work, and His Genius: "There were his inventions, but there seemed to be also some question of the sincerity of his work. There was a belief that he had enjoyed exceptional luck, stumbling upon some of his results and borrowing or even stealing others. There was no wide-spread acceptance of his personality or the unique quality of his character." William Adams Simonds, Edison: His Life, His Work, His

Another approach to electrification in America has been to focus on the construction of systems of electrical distribution and on an industrial/corporate analysis on the subject.[32] Harold Passer in The Electrical Manufactures, 1875-1900, based on an in-depth analysis of company records, presents a comprehensive history of early electric utility companies in the United States. John W. Hammond's Men and Volts: The Story of General Electric (1941) and later James A. Cox's, A Century of Light (1979) examine the growth of General Electric. The monumental work in the area remains Thomas Hughes's Networks of Power: Electrification in Western Society, 1880-1930. Hughes describes Edison's greatest accomplishment as the development of his system of electrical distribution. He attributes Edison's success to his understanding of the importance of electrical systems and discusses the role of systems in the successes or failures of electrification in Chicago[33], London, and Berlin. Hughes describes an evolutionary, four-staged

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Genius (New York: Blue Ribbon Books, Inc., 1940. Preface, xiii.) The best analysis of the Edison persona and myth is found in Wyn Wachorst's An American Myth. (Cambridge: MIT Press, 1981) Wachorst studies the creation and development of the Edison myth from its inception in 1878 to the present, maintaining that few men in American history have been proposed as symbols for so many cultural themes: "the gospel of technological progress, the rural Protestant virtues, the success mythology of the self-made man, individualism, optimism, practicality, anti-intellectualism, the American Adam and the New World Eden, democracy, egalitarianism, and the idealization of youth." p. 3. Wachorst, basing his themes and analysis on literature and opinions polls of each period, follows the development of Edison in the public eyes over the years, and cites cases such as The New York Times opinion poll that listed Edison as the greatest living American in 1922 or later the National Opinion research poll which listed the inventor as more popular than Jesus, FDR, Lincoln, or Washington. pp. 5-6. The study is the most complete and interpretative work on the historiography of Edison.

[32]This approach sees the electric light as part of a system, and in this manner fits into a broader discussion of electrification.

[33]For a more complete study of the electrification of Chicago see Harold Platt's The Electric City: Energy and the Growth of the Chicago Area, 1880-1930 (Chicago: University of Chicago Press, 1991).

process in the electrification of a city: invention and development, technology transfer, system growth, and system momentum, in the creation of electrical system in these cities.[34]

A number of other works have focused on factors other than scientists and engineers to describe the growth of electric systems in North America. Christopher Armstrong and H.V. Nelles in Monopoly's Moment: The Organization and Regulation of Canadian Utilities, 1830-1930 (1986) describe their research as stemming from the "city hall basement" and focus on the role of city and provincial politics in the dissemination of gas and electric systems.[35] Harold Platt in The Electric City: Energy and the Growth of the Chicago Area, 1880-1930 (1991) argues that the "rapid diffusion of electric light and power systems across the urban landscape of America was neither inevitable nor driven by some inherent technological imperative," but rather "contemporary social values and cultural orientations determined the pace and direction of technological change."[36] Platt uses Chicago as the ideal test-case city because of the rapid rate of population growth and entrepreneurial opportunity. He examines the growth of electricity from the introduction of Edison's incandescent lamp in 1880 to 1930 and discusses the critical role of political culture.[37]

Mark H. Rose in Cities of Light and Heat: Domesticating Gas and Electricity in Urban America agrees with Armstrong & Nelles and Platt in the important role of social and political

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[34]Thomas P. Hughes, Networks of Power: Electrification in Western Society, 1880-1930 (Baltimore: John Hopkins University Press, 1983) pp. 1-18.

[35]Christopher Armstrong & H.V. Nelles, Monopoly's Moment: The Organization and Regulation of Canadian Utilities, 1830-1930 (Toronto: University of Toronto, 1986) pp. 4-7.

[36]Platt, Preface, xvi.

[37]Platt, Preface, xvii.

influences on the rate at which at new technologies were adopted in North America, but additionally argues that "context is one of the core ideas of contemporary historical scholarship." In Rose's opinion historians have overlooked a number of contexts, for example, "dynamic city politics, rapid population increases, and fast-growing suburban districts," as well as the "educators, home builders, architects, and executives and salespersons who worked for the great gas and electric corporations."[38] Like Platt, Rose chooses two Mid-western cities, Denver and Kansas City to describe the social and political forces behind the introduction of gas and electric power.[39] He studies city and company records, newspapers, and concludes that "the first gas and electric firms were extensions of the idea that it was possible to secure wealth and the prestige of science by linking urban growth, public policy, and new technologies in the form of gas and electric service."[40]

All of these studies are valuable in understanding the variety of factors involved in the introduction of electric power and lighting. They illustrate important factors in the development and diffusion of electrical power and its technologies, such as the role of inventors, geography, economics, and systems. This thesis, however, aims to add to a relatively new focus in the

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[38]Mark H. Rose, Cities of Light and Heat: Domesticating Gas and Electricity in Urban America (University Park, Penn.: Penn State University Press, 1995) p. 4.

[39]Rose emphasizes the role of geography in that "executives of gas and electric firms made choices not only as part of large organizations informed by a political culture, but also in terms of the social and political geography of cities." p. 206. Denver and Kansas City were ideal cities to study because, in Rose's opinion, both experienced "nearly identical efforts of leaders to boost property values, boast urban greatness, and secure railroad connections." but at the same time geography made them unique. Denver was surrounded by an abundance of clean-burning lignite and Kansas by natural gas. p. 11.

[40]Rose, p. 12.

history of electric lighting by analyzing what Mark H. Rose refers to as "the enthusiastic reception they (gas and electric service) received among ordinary citizens and the meaning of that enthusiasm for shaping patterns of technological and cultural change."[41]

A study of the social reactions to the electric light begins with nineteenth century accounts and perceptions of its role and future in society.[42] The intent of analyzing and studying these

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[41]Rose, p. 207.

[42]The best source for nineteenth century electrical news is found in the trade journals, Electrical World, Electrical Review, and to a lesser extent Western Electrician. These are excellent sources for tracing the views of both advocates of electric lighting and eccentric visionaries, but they are at times extremely sensationalist and impartial. For a conflicting opinion, equally dramatic in its opposition to electric lighting, see the Journal of Gas Lighting. Other mainstream scientific journals with excellent electric content worthy of serious consultation are Scientific American, Boston Journal of Chemistry, Van Nostrand Eclectic Magazine. Scientific American Supplement and The American Journal of Science are useful, but perhaps too theoretical and scientific. Other mainstream journals in which the electric light is occasionally addressed include the North American Review, The Atlantic, Scribner's, and to a lesser extent Harper's New Monthly Magazine. Newspapers such as the New York Times and Chicago Tribune also contain a number of excellent articles on the subject. A second valuable primary source information is found in the literature on electricity of the period. The notion of electricity was one of the greatest wonders of the age, and numerous books were written attempting to explain it workings and possible uses in the future. Some of the following at times are too scientific for the subject of social history and others suffer from being written by a impartial advocate of either gas or electric lighting, yet within each are interpretations and information pertaining to the social meaning and future visions of electric lighting: J.T. Sprague, Electricity: Its Theory, Sources, and Applications (1875); H. Fontaine, Electric Lighting (1878); Paget Higgs, The Electric Light in its Practical Application (1879); George Prescott, The Speaking Telephone, Electric Light, and other Electrical Inventions (1879) William E. Sawyer, Electric Lighting by Incandescence (1881); K. Hedges, Useful Information on Electric Lighting (1882) E. Hospitalier, The Modern Applications of Electricity (1883); J.E.H. Gordon, A Practical Treatise on Electric Lighting (1884); T. DuMorcel & William H. Preece, Incandescent Electric Lights (1882) L.H. Latimer, Incandescent Electric Lighting (1890); Cyrus Fogg Brackett & Franklin Leonard Pope, Electricity in Daily Life (1891) For a negative account of the early electric light industry see A. Hickenlooper, Edison's Incandescent Light for Street Illumination (1886) and N.H. Schelling, The Present Condition of Electric Lighting (1886) The best source for application of the electric light the homes is Robert Hammond, The Electric Light in Our Homes (1884) and to a lesser extent J.E.H. Gordon, Decorative Electricity (1891) and William Sawyer, Electric Lighting by Incandescent and its Application to Interior Illumination (1881).

social meanings and changes brought about by the electric light was earliest and most aptly discussed by Matthew Luckiesh in his book Artificial Light: Its Influence Upon Civilization (1920) This work serves as a valuable secondary source because of the insightfulness of the author's discussion of the many ways in which lives had been altered by electric lighting. Relying heavily on the Social Darwinism theology popular in the electric age of progress and advanced civilization, Luckiesh attempted to prove that "As an influence upon civilization no achievement surpasses the production and application of artificial light."[43] His focus was broad, in that he addressed the influence of artificial light on nearly every aspect of life, including work, safety, education, and the home. Luckiesh's greatest attributes were his imagination, skillful composition, and original ideas, but the work is essentially a philosophical discourse on the impact of artificial light. The author provided no citations or adequate bibliography, and this marked lack of evidence inevitably diminishes the arguments presented. Nonetheless, Luckiesh remains one of the earliest authors to address the social influences and impacts of artificial lighting, and the ideas he raised, supplemented with further research, are essential to comprehending the topic of the electric light and society.

A work of less originality, though more historical professionalism was offered by William O'Dea in his publication of a very broad history of lighting since the beginning of time in the Social History of Lighting (1967). It remains the most comprehensive social history of lighting. However, because of the extended time span covered, it only briefly addresses the social impact

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[43]Matthew Luckiesh, Artificial Light: Its Influence on Civilization (New York: Century Company, 1920) p. 6.

of electric lighting.[44] The strength of the work lies in O'Dea's ability to summarize, in a fairly condensed book, a history of light since the dawn of civilization, but because of the broad scope of the book, it offers little critical analysis or insight, particularly in regard to the electric age. Like Luckiesh, the work also suffers from a weak bibliography and few citations, which leaves reader in doubt as to the truth of many statements and assertions.

More recently, the topic of social influences of the electric light has entered the realm of more professional historical research and study. Carolyn Marvin in When Old Technologies Were New: Thinking About Electric Communication in the Late 19th Century addresses the social impacts of two mass media technologies introduced in the late nineteenth century: the telephone and the incandescent lamp. Marvin avoids the traditional artifact-based approach, and argues along a social constructivist line that "the early history of electric media is less the evolution of technical efficiencies in communication than a series of arenas for negotiating issues crucial to the conduct of social life."[45] She attempts to show the social meanings, effects, and changes (both real and perceived) brought about by the two new technologies, and their relation to issues such as gender, class, race, families, and professional communities.

Marvin has been criticized for drawing conclusions that are not warranted by her evidence. Andre Millard in a review of the book argues that this paucity of evidence "sometimes leads Marvin to build great edifices on small foundations, reading volumes of meaning into minor

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[44]William O'Dea The Social History of Lighting (London: Routledge & Paul, 1958). mentions a number of themes relating to the social meanings of electric lighting, many to be addressed here, but does so only in passing. For comments on electric lighting and crime see, pp. 93-94, 100 and for the electric light and warfare see, pp. 126-127.

[45]Marvin, p. 4.

actions."[46] An example of this can be found in her assumptions on the functions of the Electric Girl Lighting Company, which this thesis will show never actually existed.[47] In another case, Marvin attempts to illustrate, in her chapter "Dazzling the Multiple,"[48] how the electric light was used in public display, exhibition, and ostentatious show, basing her analysis almost exclusively on electric trade journals, without indicating an awareness of the motives and focus of these sources. The work also lacks structure, because Marvin addresses each point as an independent issue rather than as part of a broader line of argument. Finally the book is damaged by complex and vague descriptions of simple events, leaving the reader wondering whether she is hiding behind the complexity of her language as a diversion from her apparent lack of evidence. Nonetheless, When Old Technologies Were New is an insightful study of nineteenth century media communications. Marvin introduces a social angle to a subject that had for many years been reduced to the actions of the technicians, industry, or the momentum of the introduced artifacts. The book's abundance of suggestions and ideas provides an excellent starting point for further research.

David Nye, like Marvin, attempts to address the "social meanings" of electrification in the United States from 1880-1940. Using a social constructivist approach, which sees the electrification of the country as a social process, he systematically discusses the impact of electrification on society, and unlike Marvin, presents a cohesive, focused account of the subject. The source material consulted by Nye is also more complete than Marvin's in that he

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[46]Andre Millard, American Historical Review vol. 94 (June 1989) pp. 714-715.

[47]Marvin, p. 138.

[48]Marvin, pp. 152-190.

borrows from a number of mainstream and technical publications, as well as a wide range of secondary sources.[49]

Nye's work, in addressing the many applications of electricity - in radio, communication, travel, as well as lighting - argues against the notion of technology as "a system of machines with certain functions." Nye opposes those who see electrification in the United States as a "thing" and suggests that "electrification is not an implacable force moving through history, but a social process that varies from one time to another and from one culture to another."[50]

David Nye's analysis of electric lighting in the late nineteenth century is concentrated on its use in spectacle, exhibition, and other instances of public electric grandeur. He describes the causes for its slow dissemination, but suggests that despite this, "a fully electrified world emerged at world's fairs and expositions."[51] The book's greatest asset lies in its treatment of domestic lighting, and the related themes of class[52] and wealth. In describing the nineteenth century incandescent light as an item of "conspicuous consumption" he outlines the reasons for emergence of ostentatious electric displays.[53]

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[49]Out of fairness, it must be said that Carolyn Marvin wrote exclusively on the nineteenth century, whereas Nye's study continues well into the twentieth. The sources available to Nye were broader because of the development of electricity during the twentieth century, and many of his citations and evidence are irrelevant to a nineteenth century social history of electric lighting.

[50]Nye, Preface, ix.

[51]Nye, p. 33.

[52]See also, David Nye, "Social Class and the Electrical Sublime" in Rob Kroes (ed.) High Brow Meets Low Brow (Amsterdam: Free University Press, 1988).

[53]Nye, Electrifying America pp. 242, 389.

David Nye's work, however, is predominantly a discussion of the social meanings of twentieth century electrification in the United States. On the one hand, the electric light is addressed as a subsidiary theme alongside other electrical technologies, and on the other, Nye is more concerned with impacts of actual wide-spread application, most of which occurred after the nineteenth century, than with public perception of what social impacts and changes the electric light would deliver to the future. As a result, the attention he offers to the early history of electrification, particularly the electric light, is marginal. Nonetheless, Electrifying America provides excellent insight into the social meanings and impact of electrification.

The following thesis supplements these works and adds insight into the early social history of electric lighting in the United States. It begins with a comprehensive account of the history of lighting, which shows how the new lighting technologies were shaped by the context of the past. Once this historical understanding is established, the social impact of electric lighting is more easily understood.

Unlike the works of David Nye, Harold Platt, Mark Rose, Thomas Hughes, and William O'Dea, the primary focus of this thesis is on nineteenth century perceptions of electric lighting. This is evident in the broader range of nineteenth century literature consulted here. The three themes selected (the relationship of the electric light to public safety, warfare, and aesthetics & health) moreover, have been overlooked by most historians and only briefly mentioned by Carolyn Marvin in When Old Technologies Were New. Using these themes this thesis illustrates the impact of electric lighting on late nineteenth century America, and addresses the importance of future visions and social expectations in the early history of the technology.

II

Light and History

Sunlight and fire were the earliest sources of illumination and for centuries people associated the very idea of light with their manner of action. These natural sources were inconsistent in the quality, intensity, and duration of their light. Aside from the fact that the sun would set every evening, the quality of its light was often affected by changing seasons or weather patterns. In wintery northern regions the sun sometimes shone for a mere six or seven hours, and on other days, clouds and inclement weather would bring darkness at times when light was meant to reign. Nature was fickle and untrustworthy. Fire was inadequate because of the heat it produced, the quality of its light, in its flickering and poor illumination, and in the fact that it could in one instance be easily or accidently extinguished and in another instance dangerously uncontrollable. In time human endeavor would begin to utilize and adapt what nature had given to improve illumination. Candles, oil lamps, torches, and eventually gas offered, if not ideal, at least adequate and practical forms of lighting in times of darkness.

The notion of an artificial light that was not based on principals of fire and heat is little over a century old, and yet today it is difficult to understand what darkness meant to the pre-electric world. Our age is one of immeasurable light, and as such we are incapable of comprehending what people felt at the sight of the brilliant radiance produced by a 4000 candle-power arc lamp or the intense, steady, fireless, incandescent light. David Nye equates the impact of electric illumination during the nineteenth century society to the supernatural simply because,

for the first time in the history of mankind, an artificial light "violated the natural order."[54]

Gas Lighting

Gas lighting has been described as the first 'modern' light source.[55] Unlike tallow candles or lamps derived from various animal fats such as whale oil, lighting by gas was the first centrally controlled system. In areas fortunate enough to be in the vicinity of a serving gas company, the home, factory, or commercial establishment could be provided with gas for lighting at a predetermined price.[56]

The gas industry experienced remarkable growth during the nineteenth century.[57] It was first introduced in Baltimore in 1816, followed by Boston (1820), New York (1823) New Orleans (1835) and Cincinnati in 1841.[58] Yet as the case would be with the electric light nearly fifty years later, the commercialization of gas was by no means free of public resistance. Municipal debates over the practicality and safety of the new lighting method were common in most U.S. cities

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[54]Nye, p. 3.

[55]Bright, p. 11.

[56]The price differed from city to city, but on average gas sold for $2.50 per thousand cubic feet in 1865, declined to $2.00 between 1875-1885, and further declined to $1.50 between 1885-1895. Luckiesh, p. 215. The reason for the steady decline in the once fixed gas price was naturally competition from electric lighting.

[57]The number of establishments grew from 30 in 1850 to 390 in 1870. The much publicized invested capital in the industry grew from $6,674,000 in 1850 to $71,773, 694. (Data from the U.S. Census 1900) Harold Sharlin, p. 152. The annual revenue of the gas industry in the United States at the time of Edison's invention was $150 million. Josephson, p. 180.

[58]Stanley Wells, Period Lighting (London: Pelham Books, 1975). p. 146. For the list of the dates other major U.S. cities adopted gas lighting see: Sarah Pressey Noreen, Public Illumination in Washington, D.C. (Washington, D.C.: George Washington University, 1975) p. 9.

during the early nineteenth century.[59] In 1833, Philadelphia citizens submitted a strong protest against a plan to install gas lighting in the city[60], and though losing the cause, the example illustrates that nineteenth century society was not apt to change something as critical as lighting on a whim.

Late nineteenth century discussions of the gas lighting industry are ridden with disparaging and unflattering descriptions. Gas lighting was subject to such criticism primarily because of its monopolistic tendencies and devotion to the maintenance of inflated prices[61] and high profit margins, rather than to the improvement of its product and service. In fact, gas companies rarely established service outside highly populated, affluent urban areas. Harold Platt in The Electric City remarks that in many Chicago districts gas light was not affordable to most residents, and in others not available at any price.[62] The gas industry was centered in urban areas during a time when three-fourths of the American population lived in rural districts. This meant that gas was by no means the only form of illumination used before electricity; in most areas old forms of lighting such as oil lamps and candles remained dominant because of the cost or unavailability of gas. As a result, electric lighting was eventually introduced in many areas which

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[59]Noreen, p. 8.

[60]Luckiesh, p. 98. The author also asks the reader to take note of the fact of what he feels was a rapid development of artificial light. To some degree society was in no way more prepared for the advent of gas lights in the early nineteenth century, as late nineteenth century society was prepared was for the introduction of the electric light. The industry that preceded gas lighting, (candles and oil lamps) was in use when the pyramids were built. p. 97.

[61]In Chicago, as was the practice in most major US cities, the gas monopoly did not let the per thousand cubic feet price fall below $3.00 over the twenty-five year period that preceded the introduction of electric lighting. Platt, p. 15.

[62]Platt, p. 15.

had been bypassed by the gas age altogether.

While gas light was an improvement on all previously known sources of lighting, it was by no means the ideal illuminate. To begin with it was dirty. The soot it produced necessitated the incessant cleaning of walls and fixtures, and often ruined books, paintings, and furniture. It was also expensive. Gas monopolies across the country refused to lower prices so that its availability was reduced to those who could pay for it at high, fixed prices. The open flame of gas lighting caused fear, and indeed led to numerous instances of fire. The oxygen it consumed also brought with it fears of asphyxiation. The quality of light was poor and its range of illumination small; gas lights flickered and yielded between 12 and 16 candle power.[63] Nor did the gas industry attempt to make improvements on their product, but rather concerned themselves with its distribution.[64] It was only after the introduction of the arc and incandescent light that the gas companies seriously began to attempt to improve the quality and distribution of their product. Their most important innovation was the gas mantle. As a result of both this critical improvement and the slow dissemination of electric lighting, the gas industry survived well into the twentieth century.[65]

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[63]A discussion of the short-comings of gas lighting is common to all sources and periodicals on the subject. See for example: Bright, p. 21; Wells, p. 146; Nye, pp. 3, 6, 243; Platt, pp. 11-12, 15; Noreen, p. 28.

[64]Bright, p. 21. Bright writes that the gas industry was not "research minded", and most historians on the subject seem to agree. Historians have referred to the industry as stagnant, corpulent, greedy, slothful, and so on. The only exception to this is Stanley Wells, in an admittedly less academic book, who points out that in 1870 gas companies did introduce an improved coal gas enriched with naphtha, which improved the gas flame to about twenty candle power. Wells, p. 146.

[65]Luckiesh, p. 99.

Early Developments in Electric Illumination

In 1808 Humphry Davy demonstrated before the Royal Institution in England the basic principals behind the use of electricity to produce an artificial light. Davy had discovered two means by which a strong electric current, generated by a chemical battery (invented only a few years earlier by Alessandro Volta) could produce artificial illumination.[66] By connecting wires of a battery to two pieces of charcoal and separating them, Davy illustrated that the interrupted connectors would create a bright glare in the intervening space.[67] This was the earliest form of the electric arc light. He also presented the basic principals behind the incandescent light. Using a voltaic cell, he produced a brief incandescent glow by passing a current though a platinum wire or a carbon rod.[68] This rod glowed until consumed by oxidation.

While these demonstrations proved the possibility of electrical illumination, scientific advance was far from offering a practical electric light. Inventors who sought to apply Davy's principals soon discovered that the amount of energy required to produce even the slightest glimmer was too great or expensive for primitive contemporary power sources.[69] These

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[66]Bright, p. 22.

[67]Ronald W. Clark, Edison: The Man Who Made the Future (London: Macdonald and Jane's, 1977) p. 89 & Bright, p. 22.

[68]Sharlin, p. 151.

[69]Robert Freidel & Paul Israel, p. 22. Although both inchoate technologies suffered from flaws unique to their own design, little improvement could be made on either the arc and incandescent light until progress had been made in the field of dynamos. For this reason the early histories of the two technologies run a parallel course. The independent discoveries of electromagnetic induction in 1831 by Michael Faraday (England) and Joseph Henry (United States) proved significant in solving the energy problem for both technologies. In the following year, a French inventor, Hippolyte Pixii applied these principals in creating an electric machine. This was followed by improvements in dynamo design. Use of an electromagnetic field in

inadequacies led to a stagnation in the field of electric light research which lasted for nearly forty years.[70]

The Arc Light

Arc lighting was an imperfect though much simpler alternative to the incandescent light. The scientific principals it applied were fairly elementary, and as such, the difficulties it faced more easily overcome. Decades after Davy's demonstration, scientists and inventors labored on, building on the successes and failures of those who preceded them, to solve two major problems: finding electrodes that would not burn up too fast and regulating the distance between the two charcoal rods.[71] These problems were partially solved mid-way though the nineteenth century. In 1843, Foucault in an attempt to slow the speed at which charcoal electrodes would burn up, replaced them with carbon. Carbon proved to be more durable, but the charcoal arc produced a longer and larger flame. Later in 1846 W.E. Staite developed a method by which the distance

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Charles Wheatstone's dynamo in 1845 eventually led to the a third advance in design with Z.T. Gramme's dynamo in 1870. Gramme's dynamo played a critical role in revitalizing development in both fields of electric illumination. John W. Howell & Henry Schroeder, History of the Incandescent Lamp (New York: The Maqua Company, 1927) pp. 15.16; Bright, p. 28; Josephson, p. 177

[70]This is not to suggest that scientists and inventors ceased working on the notion of electric lighting or that no new improvements were made on either the arc or incandescent light. Quite to the contrary, inventors such as De La Rue, Grove, Moleyns, and Starr all contributed to the advancement of electric lighting, and patents were applied for on both sides of the Atlantic. Still it was not until the second half of the century that considerable progress was made on the design of the light itself, and the most troublesome problems associated with power and vacuum were seriously challenged. For an overview of the early development of the incandescent and arc light see: Table IX: Historical Evolution of the Incandescent Lamp, 1809-1878 in Bright, pp. 39-40.

[71]Freidel and Israel, p. 7.

between the carbon rods (or other suitable substitutes) could be regulated. These improvements resulted in an imperfect, but functional arc light, which as early as 1850, enjoyed successful, though limited use.[72] However, it was not until use of "coned" carbon, beginning in 1877, which utilized both the advantages of charcoal and carbon, that the arc was practical for commercial introduction.[73]

Commercialization of the arc lamp began in Europe with the introduction of the "Electric Candle" by Russian inventor Paul Jablochkoff in 1877. Despite defects in the lamp, the most notable being the brevity of it light-life (a mere two hours)[74], by the end of the year use of Jablochkoff's arc for outdoor lighting and street illumination was widespread through-out Europe.[75] In the United States public application of the arc light, which had been ignored only a year earlier at the Philadelphia Centennial Exposition[76], slowly began to spread.

The most important American contributor to the field was Charles F. Brush. After making a great number of technical improvements on Jablochkoff's defective arc light,[77] the young

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[72]Clark, p. 89 & Robert Silverberg, Light for the World: Edison and the Power Industry (Princeton: D. Van Nostrand, 1967) p. 74.

[73]Luckiesh, p. 115.

[74]Clark, p. 89.

[75]These defects included the waste of a great deal of light upward, the inability for it to be re-lighted once extinguished, its noisy discharge, the fact that it required alternating current, and its fluctuating light output. Bright, p. 29.

[76]Cox, p. 25.

[77]Bright describes Brush as having "solved some of the most pressing problems of the European models of arc lights" These included making it possible for the entire system not to go out if one light when out, as well as making improvements on "regulators, copper-plated carbons, multiple carbon arc lamps for all night burning, a series of shun winding for dynamos,

inventor formed the Brush Electric Company, and began introducing his arc to the American public.[78] Brush was also the forerunner of Edison in developing a central generating station for distribution of electricity to customers, constructing the first one for the San Francisco Electric Light Company in June 1879.[79] By 1880 a number of other companies, such as Weston Electric Company, Thomson-Houston Electric Company, and Maxim's United States Electric Company were formed in the wake of Jablochkoff's successes and competed to install arc lights across the United States.

In America the arc light caused a sensation similar to that which occurred in Europe. The brilliant fire-like quality of its light astonished the public wherever it appeared. The sight of an artificially created light that burned in the manner of the sun, with an illuminating power of a single arc sometimes reaching up to 4000 candles, was greeted with enthusiasm and wonder. Its capability of lighting up an entire street as if by daylight struck 19th century society as miraculous. Sarah Pressey Noreen explained its tremendous social impact:

> Electric arc lighting, a far brighter medium than gas, brought about so many changes in the lives of both city and country dwellers that the natural allocations of hours of light and hours of darkness became meaningless for the first time in history.[80]

While it caused a sensation, the arc was in a sense more believable than the incandescent light that would shortly follow. The arc was literally a fire that emitted heat and violently

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and an improved storage battery." Bright, pp. 30-31.

[78]Silverberg, p. 79.

[79]Silverberg, pp. 79-80.

[80]Noreen, p. 23.

crackled. As such, society never saw it as defying nature by disrupting the association between fire and light. As David Nye explains, the arc light was "what people believed light should be - it flickered, its carbon elements burned down like candles and it got quite hot."[81] The arc was a brilliant light, a symbol of progress and science, but it did not appear to break the established barriers of nature.

Commercial application of arc lighting was moderately widespread in 1879 and well into the 1880's. In fact, in a premature panic, gas industry stocks briefly crashed at the beginning of the early installations.[82] In 1879, 6,800 Brush arc lights were installed in Chicago, news which the Chicago Times called "a blessing to mankind."[83] By 1882, the Brush company had installed arc lights for street illumination in commercial sections of Manhattan and supplied lamps for the illumination of both Union and Madison parks in New York city.[84] During the same period other arc installations by the Brush company and its rivals occurred in Cincinnati, Boston, New York, and Wabash, Indiana.[85] No form of electric illumination looked more promising than the arc on the eve of 1880.

Because of the quality and power of its light, the arc could only be used for outdoor purposes, such as street, park, building, or lighthouse illumination. Indoor use was restricted to large department stores, theaters, or other enormous rooms. It posed no challenge to gas in the

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[81]Nye, p. 3.

[82]Platt, p. 16.

[83]Platt, p. 2.

[84]"Electric Lighting in New York City" Journal of Gas Lighting (July 18, 1882).

[85]Clark, p. 79.

domestic market. However, gas was susceptible to competition for outdoor lighting because of its small range of illumination. To equal the power of the arc, the gas burners would have to be put together in a cluster, producing an enormous amount of heat and increasing the danger of fire.[86] Because of this, the arc light, if not for incandescence, could in time have dominated the outdoor lighting market. This was a scenario that the gas industry regretted but was willing to concede in the late 1870's. At its zenith, arc lighting remained a nuisance, but not a threat to the indoor gas lighting monopoly. More importantly, in 1880 arc lighting constituted only 10% of the outdoor illuminating business which it was meant to dominate.[87]

The failure and fall into obscurity of the arc was caused by the inherent limitations of its light. This light embodied the qualities of a bonfire. It crackled violently, had an unpleasant color, and emitted a blinding glare, in some cases up to 3000 or 4000 candle power. It also required an extremely high and hazardous voltage. The cost of such power was an enormous burden. Moreover, arc lights, with the oxidation of their carbon points, produced smoke and an unpleasant odor.[88] As a result of these deficiencies the gas monopoly remained secure. They were awakened by the arc, but never severely damaged or challenged by it.

Historians on the subject of electric illumination seem habitually either to overstate or understate the importance of the arc light. It was not "destined for greatness"[89] as some would

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[86]Platt, p. 16.

[87]Bright, p. 43.

[88]The qualities of the arc light are frequently discussed in the following: Wells, p. 146; Bright, p. 34; Sharlin, pp. 150,154; Clark, p. 89; Josephson p. 179; Silverberg, pp. 73-74

[89]The words "destined for greatness" are quoted from Silverberg, p. 73, but they express a sentiment of many historians in the field.

suggest, nor was it as insignificant as its virtual historical disappearance would indicate. When Harold Platt refers to arc lighting as a "transitional technology"[90] he arrives closest to a correct definition. "Transitional technology" suggests that an artifact remained in use as long as a superior replacement was not introduced. As the decline of arc lighting was the result of its inherent limitations and the superiority of incandescence, this definition appears valid. Nonetheless, clarification is required concerning the question of nineteenth century social perspectives of arc light in relation to incandescent light.

In many ways arc lighting developed as a twin technology of incandescent, its successor, and therefore it would be inappropriate to classify it as purely an independent "transitional technology." The use of electricity to produce light was a revolutionary possibility in both arc and incandescent light. As such, the incandescent light was not the only artificial illuminant to have social impacts and to generate sensational ideas and future visions. When nineteenth century society spoke of electric lighting it was as a single force or entity in any form or application. Naturally, in specific articles (especially in trade journals), when a particular aspect of an illuminant was being discussed (e.g. the pleasantness of the incandescent light for domestic use), distinction is made, but as a whole, and as a phenomenon, "electric lighting" implied both the incandescent and the arc light. For these reasons the arc light should not be judged purely as an independent, failed predecessor of the incandescent light.

Incandescent lighting has been said to have had its beginning in the "cradle of enthusiasm born by the electric arc."[91] No statement could be more valid. The commercialization of arc

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[90]Platt, p. 15.

[91]Luckiesh, p. 127.

lighting, in a paradoxical sense nearly destroyed incandescent lighting but in the process of its own introduction inadvertently created it. Despite its limitations, the arc light was a genuine wonder to nineteenth century society. It gave vision to a society that had hitherto been incapable of seeing through the soot of its gas-lamps. Future visions of the incandescent light were equally those of the arc light in the nineteenth century, as both technologies promised a future of measurable light.[92] The arc light proved that electric lighting could eventually succeed, and that this light, once perfected, would be superior to that of gas. This inspiration even touched Edison, and prompted him to enter the field of electric illumination.[93]

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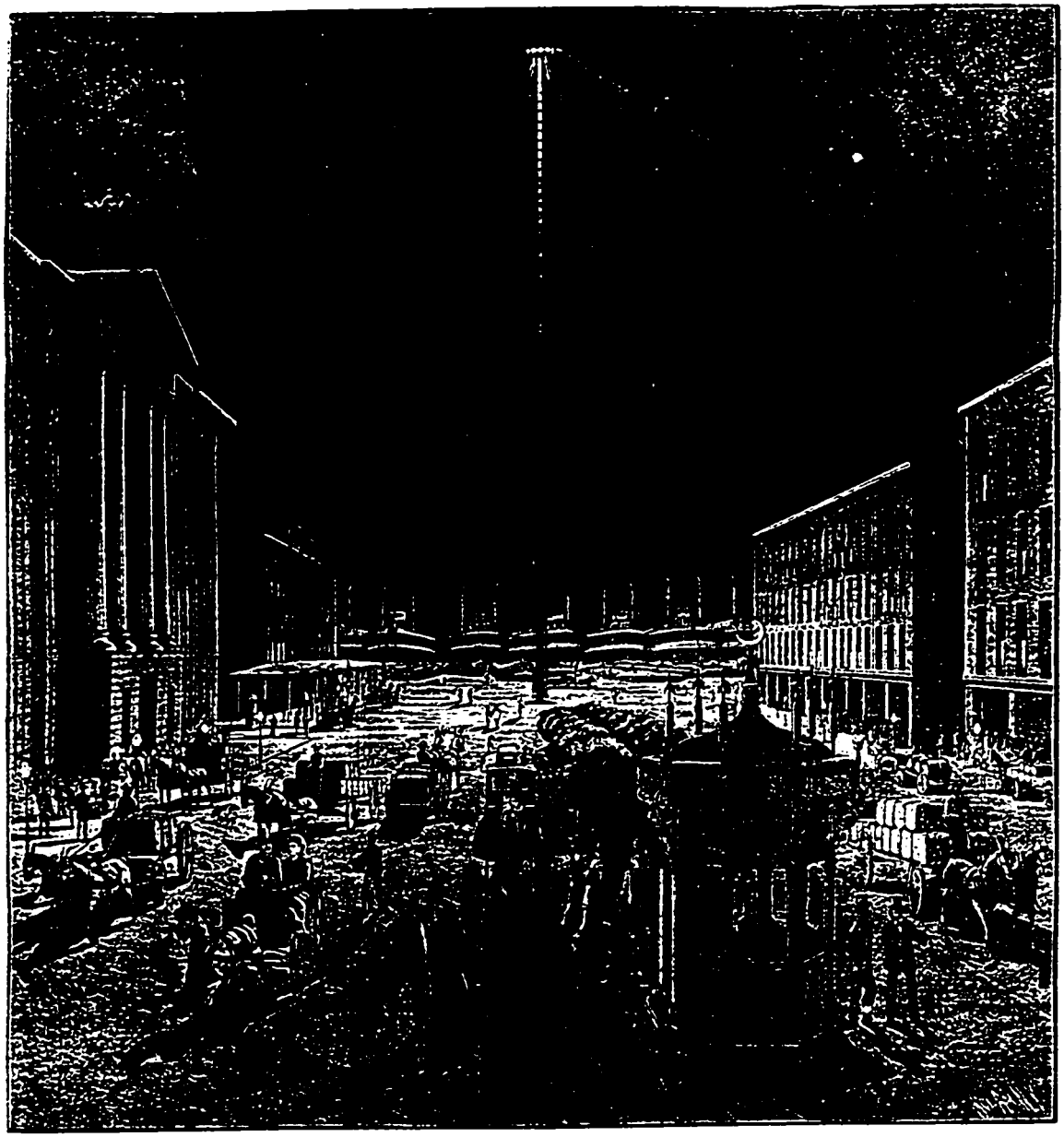
[92]See illustrations on the following pages. The first is a depiction of the application of arc lighting for night-work. The second is an illustration of a proposal for an electric tower in New Orleans, similar to one built in San Jose in the previous year. With the construction of the San Jose electric tower the image of artificial miniature suns hovering above a city twenty-four hours a day emerged. E. Hospitalier, Modern Applications of Electricity (New York: Appleton, 1882) pp. 437-438.

[93]Edison decided to work on incandescent illumination after witnessing a demonstration of arc lights by William Wallace. Indeed Edison is said to have marveled at Wallace's electrically produced arc lights for hours, and commented that he felt that electric illumination was the future, but that Wallace was going in the wrong direction. Neil Baldwin, Edison: Inventing the Century (New York: Hyperion, 1995) p. 105.

Imagined Future Uses of Arc Lighting



An Electric Tower

Scientific American (March 18, 1882)

NIGHT-WORK BY ELECTRIC ILLUMINATION.

Harper's New Monthly Magazine (October 1870) p. 358

Development of the Incandescent Light

By 1878, the idea of a practical incandescent light was by no means a novelty - it carried with its name a century's worth of repeated failures. Since Davy's demonstration in 1808 a number of renowned inventors and scientists had attempted to solve the problem of developing a practical incandescent light. Early inventors such as Grove and Bunsen failed because of inadequate power sources, while those of later years such as Moses Farmer, Hiram S. Maxim, St. George Lane-Fox, William Sawyer and Albon Man, and Joseph W. Swan failed because the lamps they produced were unreliable, costly, and had short light-lives.[94]

While limited and expensive energy sources inhibited the advance of both lighting

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[94] Howell & Schroeder, p. 41.

technologies, the incandescent light was plagued by more serious, seemingly unsolvable problems. This was essentially that the glowing platinum or carbon rods would work only minutes before oxidation.[95] Freidel and Israel describe the solution sought by inventors as "finding the means of heating an element to glow without destroying it."[96] This involved finding a material or substance, and the favorable circumstances under which it would burn long enough to make an incandescent light practical for commercial application.[97] In 1860, the failure of Joseph W. Swan's low resistance lamp resulted in the virtual abandonment of the field.[98] It was not until 1878, precipitated by the arc light sensation and Edison's announcement of entry into the field of electric illumination, that research was revived, and serious work resumed on principals of incandescence.

During 1878 and 1879 numerous patents were applied for claiming to have made serious improvements on the lamp design so that it would be economical and fit for domestic use. Sawyer-Man patented a lamp in 1878 claiming to have solved the problem "by charging the lamps with pure nitrogen, and by providing for the fixing of any residual oxygen." Sawyer argued in an article in Scientific American that earlier lamps had not failed because of the "vaporizing" of the carbon, and referring to the notion as "an absurdity since the carbon is not even fused."[99] Scientific American reported that "the light it produced is pure, strong, and yet soft, like sunlight.

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[95]James A. Cox, A Century of Light (New York: Benjamin Company, Inc., 1979) p. 25.

[96]Freidel and Israel, p. 8.

[97]This involved questions of atmosphere, encasement, and overall design.

[98]Howell & Schroeder, p. 35. Sharlin, p. 151.

[99]"The Sawyer-Man Electric Lamp" Scientific American (Dec. 7, 1878).

It is, moreover, steady and cool."[100] Still, despite the favorable coverage, the Sawyer-Man lamp was unsuccessful, failing to glow for any considerable amount of time. Similarly, Joseph Swan and Moses Farmer each patented high-current, low voltage lamps in 1878, though both resulted in disappointing failure.[101] Even Edison patented a platinum lamp early in 1879 that failed.

Thomas Alva Edison

Edison entered the incandescent lamp "race" rather late, after many talented inventors had spent their lifetimes devoted to the quest for electric lighting. "The electric light is the light of the future - and it will be my light," he claimed in October 1878.[102] The young inventor was just past his thirtieth birthday, but as a result of his incredible inventions, most notably the phonograph, he was already a celebrity, seen by the public as a inventive genius and revered as the "Wizard of Menlo Park." He announced his intention in brazen style, confidently boasting that he would have the problem of incandescent lighting solved in "six weeks," and then proceeded, "to spend a year making almost every mistake that past inventors had made, not to mention many more original ones."[103] Nonetheless, through perseverance and a number of critical advantages, fifteen months later Edison would introduce the first practical incandescent light to the world.

Thomas Edison "invented" the first practical incandescent light because of a number of

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[100]Ibid.

[101]Catalog of the Exhibition, Edison: Lighting a Revolution (Washington, D.C.: National Museum of History and Technology, Smithsonian Institution, 1979) p. 38.

[102]Baldwin, p. 107.

[103]Catalogue of the Smithsonian Exhibition, p. 10.

critical advantages he held over other inventors. Aside from the fact that, as Freidel and Israel suggest "no one before him was even close to introducing a successful lamp"[104] no individual in the 19th century had the reputation, resources, vision, and financial backing required to achieve what Edison did. Historiographical debate over the precise moment or place of the "invention" are for these reasons trivial and futile. Edison's accomplishments in the electric industry, especially in regard to the construction of electrical systems,[105] so greatly surpass those of his competitors or rivals, that there is no party more deserving or worthy of the title of "inventor" of the incandescent light.

The problem that Edison publically promised to solve was that of the "subdivision of the current."[106] It was a bold statement, which most scientist and inventors ridiculed as being impossible. Professor Silvans P. Thompson, a leader in the electric field, swore that anyone who attempted to invent the incandescent light, including Edison, was "doomed to failure" and that Edison's attempt to "subdivide the electric light" showed "the most airy ignorance of the

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[104]Freidel and Israel, Preface, xii & xiii.

[105]The development of the incandescent light was a trivial matter compared to the process by which it was to be distributed. While there is evidence to support Edison's claim to have invented the first incandescent light, Edison's work on a "system of electrical distribution" for lighting and other purposes greatly outweighs the lamp in significance. Thomas P. Hughes's, Networks of Power: Electrification in Western Society, 1880-1930 (1983) throughly describes the importance of the construction of electrical systems.

[106]Subdivision of light literally entailed dividing the intense 3000 to 4000 candle-power light given off by the arc into a great many small lights which would be suitable for domestic use. Unlike the arc light, Edison's "divided light would be capable of turning one light off without effecting the entire system." Josephson, p. 179.

fundamental principals of electricity and dynamics."[107] Another electrical expert, W.H. Preece denied the possibility of subdivision as "as an absolute ignis fatuus."[108]

However, it would be a mistake to assume that such negativism was dominant regarding Edison's electric quest. This skepticism came mostly from scientists, competitors, and vested gas-interest spokesmen, while the majority of society and the press praised and hailed Edison as a "Wizard" capable of inventing anything he chose. An article printed in the American Journal of Science in January 1878, discussed the near impossibility of subdivision, but concluded: "this would not be half so absurd an expectation as it would have been three years ago, for some visionary to have predicted that the talking phonograph would succeed in embalming speech."[109]

It is likely that in no other instance has an inventor been as glorified as Edison was. Nonetheless, even his supporters and admirers grew restless when his rash promise to produce an incandescent light in six weeks passed by, and delay followed delay, failure followed failure. The pressure on Edison to succeed was enormously increased by the rapid growth in arc lighting.

Meanwhile, the gas industry, whose stock crashed in value with Edison's entry into the

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[107]Josephson, p. 186.

[108]Silverberg, p. 95 Accounts of the admiration and praise that so often followed Edison's name and achievements was as common in the 1879 as it is today, yet historians often fail to comment on the scepticism and reproach that followed the young inventor. An article in the NY Herald on April 27, 1879 entitled "What has Mr. Edison Discovered" was highly critical of the inventor and his claims of having solved the problems of "subdivision." The article demanded a demonstration or else warned that the trust the public placed in Mr. Edison's word could be lost. Josephson p, 203. Scientific American echoed a similar sentiment in writing in its Feb. 15, 1879 issue, "if Mr. Edison wishes public faith in that electric light of his to remain steadfast, he will have to give an early demonstration of the truth of his claim that it is a practical success." Silverberg, p. 112.

[109]"On the Economy and Subdivision of the Electric Light" American Journal of Science Vol. XVII, No. 97 (Jan. 1879) pp. 65-66.

field,[110] began to recover with each passing day.[111] Less promising still was news that a demonstration of a working platinum light before J.P. Morgan in April 1879 had failed, resulting in a steep decline in the unstable Edison Electric Lighting Company market shares. When Edison abandoned platinum as a suitable filament mid-way through 1879, it appeared as if he had over-estimated his talents and resources, and in one brazen statement tarnished a reputation which on the heels of the phonograph once seemed impregnable.

Although Edison worked under a great deal of pressure he also held a number of advantages that other inventors did not. The first and most important of these advantages was his laboratory at Menlo Park. Like the inventor, the workings and significance of Menlo Park laboratory are subject to historiographical debate. Largely as a result of disgruntled workers later complaining that Edison failed to credit them for original ideas, the notion of Menlo Park as a collective "invention factory" or primitive "think-tank" inside which a number of marvelous minds worked to create the Edison legend emerged. To these revisionist interpretations, Freidel and Israel write: "The workshops and men at Menlo Park did not constitute a technical laboratory of the corporate type, nor did their leader bear any resemblance in style or action to the successful technocrat of a later day."[112] There was only room for one man's ideas in Menlo park. However, what Menlo Park did legitimately provide was the instant availability of nearly any needed

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[110]Josephson, p. 201. News of Edison's success with the platinum bulb resulted in a steady decline of gas stocks: Manhattan Gas Light fell from 187 ½ to 147 ½; Metropolitan Gas Light 132 ½ to 106 ½; New York Gas Light 92 ½ to 80; Mutual Gas Light 74 ½ to 60; Municipal Gas Light 97 ½ to 85; Harlem Gas Light 72 ½ to 39. Silverberg, p. 108.

[111]The direction of gas industry stock was very much dependent on news received from Menlo Park.

[112]Freidel and Israel, Preface, p. x

resources Edison should require. To construct and apply his ideas Edison also had some of the best electrical engineers in the world working at Menlo Park, including William S. Andrew. Charles, L. Clarke, E.G. Acheson, and Frank L. Sprague.[113] Whatever school of interpretation one follows, the resources of Menlo Park provided an inestimable service to Edison's endeavors.

Edison's second important advantage was the financial backing he received, primarily from Western Union and Drexel-Morgan financiers like W.H. Vanderbilt and Eggisto Fabbri (partner of J.P Morgan). Their financial support made the extensive research and elaborate experiments of Menlo Park possible.[114] The initial invested capital of $300,000 allowed for the creation the Edison Electric Lighting Company, and further grants made possible the high cost of maintaining Menlo Park. Josephson writes that Edison's research laboratory at Menlo Park, because of this financial backing, "marked a new state in the relations of capital and technology."[115]

Edison's third great advantage, his fame and reputation, is more intangible but equally significant. Edison received the public attention necessary to flame social eagerness for the introduction of the incandescent light. By name alone Edison created a revolution in public illumination. By no means did the incandescent light enter society by the force of its own conception. It continually faced industrial and public opposition, and its relative success or failure rested as much on the stature of its inventor and his supporters as it did on the inherent uses and quality of its light.

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[113]Josephson, p. 198.

[114]Josephson, pp. 188-190; Silverberg, pp. 104-105.

[115]Josephson, p. 190.

Edison and Public Perception

Copy of Illustration from Freidel & Israel, p. 83

Edison's 'Bottled Sunshine'

The question of "What did Edison actually invent?"[116] has been posed by most historians on the subject of incandescent lighting. Essentially, Edison's public demonstration at Menlo Park on December 31, 1879 exhibited a long-lasting incandescent light suitable for domestic lighting. The small lamp glowed with a power equal to that of a standard gas light, without flickering, and free of the ill qualities associated with gas burning. Unlike an arc light, it was pleasant and mild.

Edison's solution to the problem of "subdivision" was the development of a high resistance lamp that would consume less current.[117] He had arrived at this solution, the need for a high-resistance burner, after experimenting on numerous substances, such as platinum, titanium, rhodium, and carbon, to find a suitable "filament".[118] To insure that the carbonized filament would not disintegrate, it was encased in an evacuated bulb, a solution made possible by improvements to the Sprengel vacuum pump (1865). Under such circumstances the carbonized substance would glow with little current.[119] What Edison achieved was the solution of the

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[116]Brights answers "Thomas Alva Edison was the first inventor to discover a substance in a form which could satisfactorily be used in a commercial Incandescent lamp" He was not the first to 'invent' the idea of an incandescent light, but rather the first to produce a practical and workable version of it. Freidel and Israel write, "The simple fact is that before Edison began his search in 1878, the world had nothing even resembling a practical electric lamp, and, when that search was largely over by the end of 1879 (and certainly by the time Edison's lamp was commercialized in 1882), the principals and form of the modern incandescent lighting system were established." Preface, xii. In the opinion of Thomas P. Hughes, the successful development of the incandescent lights is a secondary feet of Edison's, of much less importance the construction of system (such as Pearl Street) to supply power to lamps and other electrical appliances. Hughes, pp. 18-30.

[117]Silverberg, p. 97.

[118]Silverberg, p. 113.

[119]Catalog of the Smithsonian Exhibition, p. 11.

problem of "subdivision" and the creation of a lamp that would glow brightly for more than 400 hours.

Through his demonstration at Menlo Park on December 31, 1879 Edison secured the title of "inventor" of the incandescent light. People flocked to the "Wizard's" laboratory and marveled at the steady glow of the posted lamps that had, it was said, shone for days on end. In the eyes of the public, Edison delivered what he had promised: a mild, long-lasting, incandescent light. Newspapers such as the New York Herald and New York Times ran headlines praising the accomplishment, and in the months that followed mainstream journals offered accounts, summaries, and discussions of the invention and accolades for the inventor.

What is most important to understand is that after the Menlo park demonstration, the American public, whether rightly or wrongly, believed that Thomas Edison was the first individual to introduce an incandescent light. The general populace in 1880 saw the incandescent light as "his" light, the like of which only the "wizard" could have delivered. Its brilliance was too grand for any other man to have produced. The heart and soul of public perception and future visions emerged from Edison's words and deeds.

In a World of Conflicting Lights

Edison could not rest in the aftermath of the Menlo Park triumph. The incandescent light displayed on the eve of 1880 gloriously signified progress and the future of illumination, but the way to this future was not drawn by the mere existence of a few shining bulbs. It had to be created. Public illumination had a number of established interests working in competition with one another, and room would not be made for incandescent by the sheer force of its conception

alone.

In 1880, arc lighting offered predominantly by the Brush Electric Company and the Thomson & Houston Electric Company enjoyed widespread growth and success in the United States, especially in large cities such as New York, Philadelphia, San Francisco, and Cleveland.[120] In December 1880, Brush's electric system was installed on Broadway for three-quarters of a mile and was closely followed in the NY Times, as "destined to supersede gas lights on Broadway."[121] In 1881, at Garfield's inauguration in Washington D.C., arc lights were displayed and met with glorious acclaim. The Washington Star reported that "None of the numerous scenic events of the day or evening surpassed" the light emitted by the temporary illuminants.[122] In the following year Congressman Murch of Maine demanded before the House that arc lights replace gas lamps for street illumination.[123] In 1883, the Brooklyn Bridge was lit by fifty arc lights, and in 1884 there were three-hundred United States Electric Company arc lights illuminating New York city parks.[124] In Chicago, on the eve of 1886 the Sperry Company installed arc lights atop the Chicago

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[120]Silverberg, pp. 184-185.

[121]See The New York Times: "The New Broadway Lights" (Dec. 18, 1880) p. 6; "New Lights in Broadway" (Dec. 20, 1880) p. 4; "Lights for a Great City" (Dec. 21, 1880) p. 2. "The Electric Light in Broadway" Engineering News (Dec. 25, 1880) p. 442.

[122]Noreen, p. 24.

[123]Congressman Murch argued, "In this modern age of progress, the old gas lamps should be done away with entirely. Let any member of the House walk along F street and see the line of magnificent illuminators in that street, equal almost to broad light." Noreen, pp. 25-26.

[124]Silverberg, p. 194.

Board of Trade building.[125] This steady growth in arc lighting was an early obstacle to the diffusion of the incandescent light. At the same time incandescent lighting was challenged by the gas companies, recently galvanized into action by Edison's achievements. They began to improve their products, lower prices, and aggressively re-assert themselves as the dominant light source in the country.

Within the incandescent field competition emerged during the months that followed Edison's demonstration. Rival companies and patents immediately surfaced throughout the country and abroad. In England, Joseph Swan declared that he was not only a rival of Edison's but a predecessor in inventing the electric light. Early in 1880, Swan formed the Swan United Electric Lighting Company, and patent battles erupted between the two until they merged in October 1883 to form Edison and Swan United Electric Company.[126]

Other incandescent lamps followed claiming to be original alternatives to Edison's light. The difference between two rival lamps was often minute and reduced to technical specifics. Examples include incandescent lights designed by Sawyer and Man and Hiram Maxim, the latter of which Edison referred to as "a clean steal" of his own lamp.[127] The field expanded to such an extent that by the end of 1880 there were six companies preparing to introduce various forms of electric lighting into New York: Edison Illuminating Company, Brush, Maxim, Jablochkoff.

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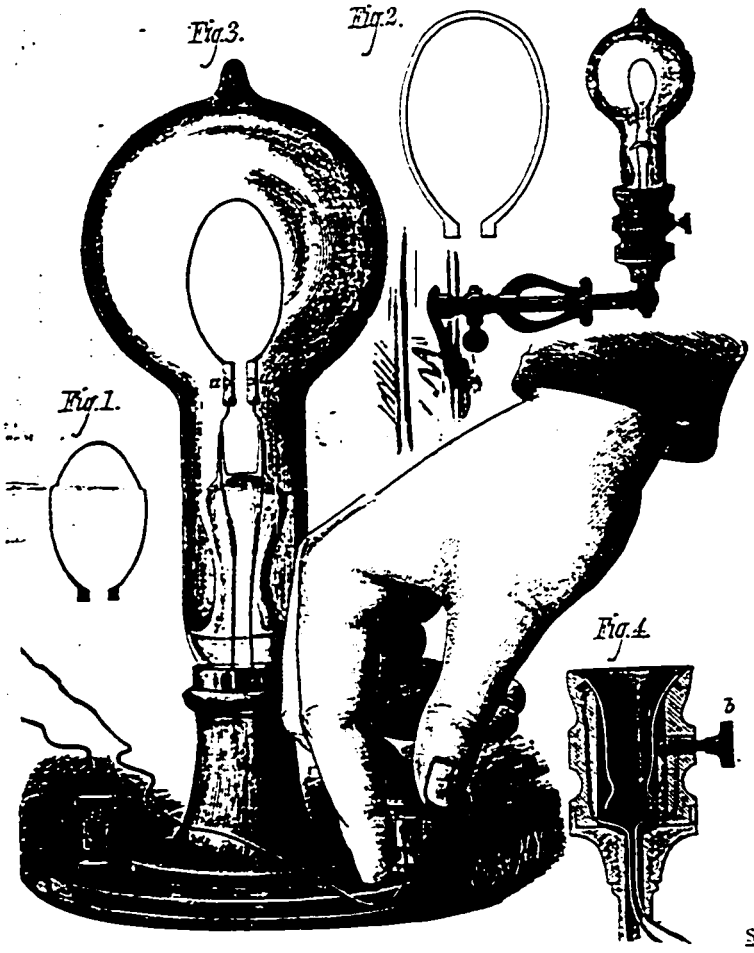
[125]Thomas P. Hughes, Elmer Sperry: Inventor and Engineer (Baltimore: The John Hopkins Press, 1971) p. 31.

[126]Clark, p. 103.

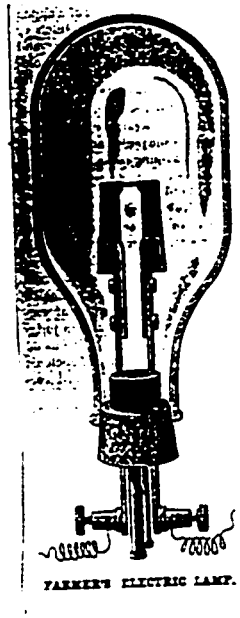
[127]Clark, p. 108.

Sawyer, and Gramme.[128] With the beginning of commercialization in 1882 a number of new electric companies had been formed, and with more frequency arc and eventually gas companies began to include incandescent lighting on their service lists. By 1884 Chicago alone had eleven competing electric companies.[129]



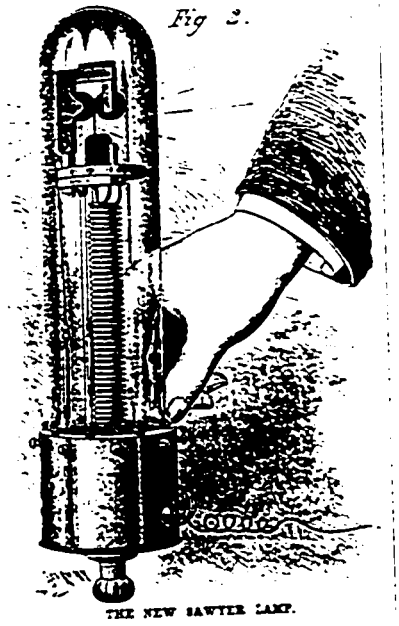
EDISON'S LATEST ELECTRIC LAMP.

Scientific American (January 10, 1880)



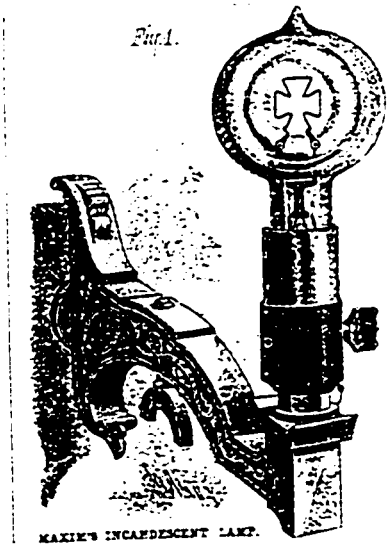
FARMER'S ELECTRIC LAMP.

Scientific American February 28, 1880



THE NEW SAWYER LAMP.

Scientific American April 10, 1880



MAXIM'S INCANDESCENT LAMP.

Scientific American (October 23, 1880)

Edison's Lamp and Its Competitors

[128]Clark, p. 108.

[129]Hughes, Elmer Sperry p. 24.

Systems Construction

Wild-eyed contemporaries of Edison's viewed his incandescent lamp as a challenge or rival to the sun. The idea that Edison had invented "a radiant sister of the day"[130] by which all that hitherto had passed beneath the shroud of darkness would pass no more, was popularly voiced. In reality, Edison shared in no such visions.[131] To the contrary, he had decided at the outset that his system of incandescent lighting should be patterned after, imitate, rival, and eventually replace that of the much resented gas industry.[132] "All parts of the system," he wrote, "must be constructed with reference to all other parts since, in one sense, all the parts form one machine."[133] To imitate gas in all respects Edison needed to construct a system of electrical distribution that would provide electricity for lighting as well as for other purposes over a large geographical area. Edison was well aware, as were others, that the incandescent lamp in itself was only a fragment of a much larger picture.

Shortly after Edison announced his intentions in the field of electrical lighting, his concept

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[130]Thomas Commerford Martin, "Gilbert's Fables" North American Review vol. 146 (1888) pp. 405-415.

[131]Edison frequently spoke in public about his visions of the future of lighting after the destruction of the gas industry. His close associate, Francis R. Upton, writing in an issue of Scribner's in 1880 explained "the crowning discovery of Mr. Edison - the electric light for domestic use - is at last a scientific and practical success. A mistaken idea has been afloat that this new light was intended to be a rival of the sun, than what it really is - a rival of gas." Francis R. Upton, "Edison's Electric Light" Scribner's Vol. 19 (March 1880) p. 530.

[132]In his laboratory notebooks no. 184 "Electricity versus Gas" (1878) Edison wrote of his objectives: "To effect exact imitation of all done by gas, to replace lighting by gas by lighting by electricity. To improve the illumination to such and extent as to meet all requirements of natural, artificial, and commercial conditions." Josephson, p. 181.

[133]Balwin, p. 103.

of an electrical distribution system was met with fervent scepticism and doubt. In fact, educated contemporaries denied the possibility of designing a system even more ardently than they doubted the possibility of subdivision. John T. Sprague, an English electrical engineer, wrote: "Neither Mr. Edison nor anyone else can override the well-known laws of nature, and when he is made to say 'the same wire which brings you light will also bring you power and heat' there is no difficulty in seeing that more is promised than can possibly be performed." Later Sprague concluded, "we know also that to talk about 'cooking food' by heat derived from electricity is absurd."[134] Even after the Menlo Park demonstration, while many followed developments at Pearl Street with genuine enthusiasm and anticipation, others grew impatient, fearing that too much faith had been placed in the artificial technology. An editorial in the New York Times argued that while the invention of the incandescent light was a glorious achievement, one which the author supported and admired wholeheartedly, its practical introduction remains in the distant future because of its requirement for enormous power plants. The author lamented "how gas stocks are made to suffer. Innocent people are frightened into selling when there is really nothing to warrant any such fluctuations or depreciations."[135] In the eyes of many, the electric light was a marvelous achievement, but faced too many challenges for society to embrace it so recklessly.

Nonetheless, on January 28, 1880, less that a month after the Menlo Park demonstration, Edison applied for an patent for his "System of Electrical Distribution" and spent the next two years over-seeing its construction on Pearl Street in New York city. These years reflect a

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[134]John T. Sprague, Electric Lighting: Its State and Progress and Its Probable Influence Upon the Gas Interests (London: E & F.N. Spon, 1878) p. 21.

[135]"Doubts about the Electric Light" NY Times (Jan. 6, 1880) p. 2.

relatively dormant period in the history of incandescent light, an interlude between invention and commercialization, during which Edison labored to perfect the incandescent light and successfully build the Pearl street power station.[136]

Limited application of the incandescent light did occur during the construction of the Pearl Street station. Installations were provided by The Edison Electric Light Company as well as rival companies. During these years, as a result of Edison's preoccupation with the system, pressure from financial backers, and the cost of incandescent lighting, the trend towards small isolated plants to service single homes, businesses, or ships, developed.[137] In 1880, the steamship Colombia became the first structure to be supplied with incandescent light through the construction of an isolated plant by the Edison Electric Lighting Company. Later that year Maxim and the U.S Electric Light Company installed 50 lamps in the New York Safe Deposit Company[138] and 100 in New York's Equitable Insurance Building.[139] These early installations were the first of many isolated applications which dominated incandescent lighting throughout most of the nineteenth and early twentieth centuries.

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[136]Sarah Pressey Noreen mistakenly writes that "Edison refused to release his incandescent light for almost three years (after Menlo Park)." Noreen, p. 23. To the contrary, Edison did not "hold back" his invention from the public, as Noreen suggests, but rather worked to obtain the means by which wide-spread commercialization would be possible.

[137]Silverberg, p. 184.

[138]Bright, p. 70.

[139]"Electric Lighting By Incandescence" Scientific American (November 27, 1880) p. 330.

The Electric Light Versus Gas

The way the public perceived the incandescent light was strongly influenced by accounts written by overly zealous representatives of either gas or electric lighting interests. Public perceptions of what an electric world would be like as opposed to a gas-lit world were often skewed by such voices. The feud was belligerent, at times dishonest, and in some cases bordered on the absurd.[140]

In many ways it was Edison himself who ignited the battle between the two industries at the very outset of his incandescent experimentations by the highly publicized statement concerning his plan to copy the gas industry in all respects, and replace it with a superior electric light. Ever aware of the importance of public perception, Edison and his associates were more than willing to discredit and challenge the gas industry publically long before a practical electric rival was in place. Later illustration of this can be found in Edison's boastful statement, shortly before the opening of the Pearl Street station that he would now "seal the fate of the barbarous and wasteful gaslight once and for all."[141]

The announcement of Edison's practical incandescent light sparked a belligerent war of words (and often lawsuits) between the two competing lighting industries. The gas industry, which for years had enjoyed a virtual monopoly in the field of "modern" illumination, and at one

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[140]See for example "Gas-Light the Cause of Baldness" in The Electrical World (October 9, 1886) p. 176. Or A. Hickenlooper, Edison's Incandescent Electric Light for Street Illumination (Cincinnati: Robert Clarke & Company, 1886) in which he reads an anonymous account of Denver's failed electric light system, "Latterly the lights have been most wretched, and in some instances a full-fledged glow-worm of the Maryland species could be trusted to outshine the Denver incandescent loop." pg. 24.

[141]Balwin, p. 137.

time saw the arc light as its only threat, by 1880 found itself seriously challenged through the combination of electric lighting technologies. Initially, though, word of Edison's entry into the field of electric illumination met with a calm reaction from the gas companies. They reminded their customers and associates that the statements coming from Menlo Park were from "a man who had been addicted to electricity for many years," and concluded by describing Edison as a man "who had invented too many things and almost without exception they were things of the most deleterious character."[142]

A campaign to publically defend gas light's superiority to the electric light began in late 1878 as a result of a rapid decline in the value of gas company stocks.[143] The arguments presented by the gas companies were often met with sympathy by a public that had yet to see any proof of the possibility of an efficient incandescent light. Educated nineteenth century American society believed in progress, and believed even more in Edison, yet in 1878 the notion of gas lighting being made obsolete in a single day by invention or even miracle was deemed impossible. Even if Edison solved the problem of subdivision, which on its own looked very doubtful in 1878 and early 1879, successful commercialization of the incandescent light rested on an efficient electrical distribution system, which most believed was decades away. An article in Scientific American lamented what they felt was an unjustified and premature decline in the value of gas company stocks. "Whether Mr. Edison has overcome all these obstacles to the economical use of electricity in small lights remains to be proved," the article read, and further urged that "the enormous capital

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[142]Phillip McGuire, "Technology and Commerce: The Gas Light Industry's Response to Edison's Electric Bulb" Potomac Review vol 6 no. 2 (1973) p. 70.

[143]McGuire, p. 71.

invested in gas works and street mains is in no danger of being made useless. Whatever may come out of the electric light, the demand for gas is sure to increase enormously."[144] After Edison's successful Menlo Park demonstration, the number of sceptics began to wane, and having awakened the slothful gas industry, a war of technologies began.

The battle that ensued between gas interests and electric interests was much publicized and very well documented. Scientific books were written by electrical engineers and inventors in an attempt to describe the ingenuity and superiority of incandescent light.[145] Edison and his associates continually wrote articles for mainstream journals advertising the advantages of their light over gas.[146] Francis Upton wrote in an article for Scribner's that, "the light is equal to gas in brightness and whiter in color; it is enclosed and, consequently, perfectly steady; it gives off no appreciable heat; it consumes no oxygen; it yields up to no noxious gases, and, finally, it costs less

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[144]"The Electric Light and the Gas Companies - Remarkable Effect of A New Invention in the Stock Market" Scientific American (November 2, 1878) p. 272.

[145]T DuMorcel & William H. Preece, Incandescent Electric Lights (and other articles) (New York: D. Van Nostrand, 1882); E. Hospitalier, The Modern Applications of Electricity (New York: Appleton, 1882) Edwin J. Houston & A.E. Kennelly, Electric Incandescent Lighting (New York: W.J. Johnston Company, 1896); L.H. Latimer, Incandescent Electric Lighting (New York: D. Van Nostrand, 1890); Franklin L. Pope, Evolution of the Electric Incandescent Lamp (Elizabeth, NJ: Henry Cook, 1889); George Prescott, The Speaking Telephone, Electric Light, and other Electrical Inventions (New York: D. Appleton, 1879); William Sawyer, Electric Lighting by Incandescence (New York: D. Van Nostrand, 1881).

[146]Perhaps the most famous article on this matter was "The Success of the Electric Light" by Edison published in the North American Review vol 131 no. 287 (October 1880) In it Edison wrote that "The light is designed to serve precisely the same purposes in domestic use of gas light" and explains "but the light is steadier, and consequently less trying to the eyes. It is also a pure light than gas, being white, while gaslight is yellow." And further explained, "Again this light, unlike gas, is always of uniform quality." And in defending the safely of the electric light, "even by the most inexperienced domestic servant nor can the most careless person do injury to himself, to others, or to property, through not understanding the mechanism." pp. 297-298.

than gas."[147] The debate was also touched upon in mainstream journals, where in one case, gas was depicted as the lighting source of the past and the aged, while the electric light was seen to signify the future and youth. A humourous story in Lippincott's entitled "Gas Burning and its Consequences" pitted a young chemist against an elderly gentleman (with a fortune invested in the gas industry) in a debate over the benefits of the electric light. The younger man stressed the aesthetic beauty and superior quality of the incandescent light, in contrast to the dim, dirty, and unhealthy gas light. The elderly man argued the opposite, doubting that gas lighting was actually the cause of ruined books. He stubbornly concluded that all arguments aside, established industries do not change so rapidly and that gas still had a great many decades before it.[148]

Trade journals such as Electrical World and Electrical Review were also vehement advocates of electric lighting. They argued that the incandescent light was, put simply, a better light than that produced by gas (and later arc lighting.)[149] It was also cleaner, safer, and cheaper.[150]

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[147]Francis Upton, "Edison's Electric Light" Scribner's vol. 19 (March 1880) p. 531.

[148]George J. Varney, "Gas Burning and its Consequences" Lippincott's Vol. 28 (Dec. 1880) pp. 734-742.

[149]As a rule, during the early years of the commercial introduction of incandescent lighting such trade journals equally supported arc lighting against the gas industry. These journals printed numerous article praising arc lighting. See for example "The Success of the Telephone and Electric Light" Electrical Review (Oct. 11, 1883) p. 8. Articles on the development of both forms of lighting are also common during the early to mid 1880's. Yet by the latter half of the decade such electrical journals are not as kind in regard to arc lighting, and criticism intermittently occurs. See, "The Bad Odor of Arc Lights" The Electrical World (September 10, 1887) p. 141.

[150]Articles in trade journals often read a bit like artistic propaganda, but the following articles all make good and valid arguments in support of the electric light in cleanliness and health: "Electric Lighting Considered from a Sanitary Point of View" Electrical Review (November 15, 1884) pp. 8, 9; "Pure Air and Electric Lights" Electrical World (March 16, 1889) p. 161; "The Artificial Light - The Different Kinds - Its effect on the Human Eye" Electrical

William Sawyer wrote that the electric light was suitable for "every respect of domestic light" and "in steadiness it is comparable only to the light of the sun."[151] The electric light was praised for its "aesthetics qualities - its lack of heat, smell, or noxious products; its great safety, its cheerfulness and healthfulness; its peculiar applicability to novel emergencies; its moderate cost and the simplicity of the generative plant"[152] In other cases, trade journal articles argued that turning to the incandescent light as an alternative light source was a health necessity: "How many cases of obstinate neuralgia, indigestion and more serious diseases result from daily confinement during business hours, in gas-lighted and usually ill-ventilated crowded commercial quarters, cannot be readily computed."[153]

These trade journals seldom failed to criticize anyone that dared question or criticize their industry. In "What the Critic Doesn't Know About an Incandescent Light" The Electrical Review disparaged the Wall Street Journal for its "unjust and unmerited attack on the Edison incandescent light." The Wall Street Journal had published an article which questioned the value and merits of Edison Electric Light Company stock, and based the slow trading of it on recent "unfortunate experiences" and the fact that it had "yet to pay a dividend." The trade journal article defended the incandescent light on a number of logistical points and concluded: "It is enough to say that

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Review (April 26, 1884) p. 10. On cost: The Economy of the Electric Light The Electrical World (January 3, 1885) p. 6. On safety: "The Dangers of Gas" The Electrical World (Aug. 9, 1884). p. 44.

[151]William Sawyer, Electric Lighting By Incandescence and its Application to Interior Illumination (New York: D. Van Nostrand, 1881) p. 168.

[152]"Is the Electric Light a Commercial Success?" The Electrical World (June 30, 1885).

[153]"The Hygiene of Artificial Light" Electrical Review (January 3, 1884) pp. 8, 9.

they (critics of the incandescent light) were sordid."[154] In "Dishonest Foes of Electric Lighting," The Electrical World similarly criticized a California paper, Alta California, over printed "attacks" on the electric light.[155] Such rebuttals, most commonly in the form of philippics, were a regular item in electric trade journals.

As indicated above, the dawn of the electric age saw the gas companies in denial. In 1878 and 1879 they argued that the perfection of an incandescent light suitable for domestic lighting was years away,[156] in the meantime pointing out the self-evident flaws of the arc. Yet with Edison's success, the gas industry found itself on the brink of new age of instability and uncertainty. When Edison announced and demonstrated a small incandescent light with a mild candlepower between 8 and 16, and others quickly followed, the gas industry referred to the "invention" as a charade and scam by schemers and nefarious corrupt individuals searching for profit and nothing more.[157] Even if the incandescent light did partially work, as demonstrations tended to indicate, light produced by gas remained superior, according to gas companies. While

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[154]"What the Critic Doesn't Know about an Incandescent Light" Electrical Review (December 27, 1883) p. 8.

[155]"Dishonest Foes of Electric Lighting" The Electrical World (May. 17, 1884) p. 160.

[156]The Journal of Gas Lighting (London) reported on the development of the incandescent light, "at the present time, the whole thing in a fog, and intelligible particulars are much wanted...We know that at the present time they are laughed at in the States, notwithstanding the fact that Mr. Edison has unquestionably done some very wonderful work. But he has not abolished gas companies, and, to speak with utmost candor, we doubt whether he ever will." (April 15, 1879) p. 549.

[157]The Journal of Gas Lighting vehemently doubted the veracity of the claims by the NY Herald describing Edison's "perfected lamp", and reminded its readers that "We have experience of Mr. Edison and it teaches us to doubt him." The article later described attempted to down-play "this wild assertion to be told of 'the wizard's by-play'" and the "outrageous promises being made." (January 13, 1880) p. 52.

accepting that an incandescent light might exist, gas advocates rhetorically asked, "if it required forty years of patient research and investigation to bring this light to its present condition, how long will it still take to fulfill the prophecies of its enthusiastic promoter?"[158]

Gas supporters continued to argue that electric lighting was not superior to gas lighting, or even yet a proven successful light. They argued that gas was cheaper, more reliable, and safer. They emphasized cases of electrical accident, power failures, the unfair and deceptive "cost" of electric lighting, and the fact that "gas light would be just as beautiful and as perfect in a few years."[159] The Journal of Gas Lighting sarcastically remarked that, "perhaps the most positive and abiding result of the rage for electric lighting in public streets is the increase of gas consumption which inevitably follows the removal of the electric lamps." The article optimistically concluded that "the modern demand for better means of lighting is capable of being amply satisfied by ordinary coal gas alone."[160]

A telling source in relating how the gas interests objected and attempted to thwart the commercial introduction of incandescent lighting is found in A. Hickenlooper's Edison's Incandescent Electric Light for Street Illumination. The work is a script of the debate which occurred before the Cincinnati Committee on Light in 1886 over a proposal to install electric lights in the city. Hickenlooper began his argument with a moral point, one that was a common issue in large American cities. What did a city do when it had signed a contract with a gas

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[158]A. Hickenlooper, Edison's Incandescent Electric Lights for Street Illumination (Cincinnati: Robert Clarke & Company, 1886) p. 24.

[159]McGuire, p. 72.

[160]"Effect of Electric Lighting on the Demand for Gas" Scientific American. (February 2, 1882) p. 74.

company (prior to the recent developments in electric lighting) to light its streets and public places for a specified period of time?[161] Wasn't the city obliged to abide by this contract? Hickenlooper maintained that, all other questions aside, the city must comply with their agreements, and recent Supreme Court decisions in Louisville and New Orleans supported this argument.[162] He then attempted to prove that the electric light would fail nonetheless, and its advocates were either liars or thieves.[163] He insisted that the electric light supporters had made false and inaccurate statements: the electric light was not cheaper and not reliable. The prices charged were purposely deceptive, and that in order to obtain the business of customers the electric companies ran at a loss for a few years before raising prices.[164] The quality of the electric light was also greatly over-stated by members of the industry according to Hickenlooper. It really lasted for 400 not 600 hours and gradually deteriorated until reaching the power of four candles.[165]

N.H. Schilling provided another critical examination of electric lighting by a "gas

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[161]The city of Cincinnati had signed an ordinance with the gas companies in 1849 to light the streets for a period of forty-five years. Hickenlooper argues that this contract was binding, provided that the company complied with its agreement, which the gas companies had done. Hickenlooper, pp. 3-6.

[162]Hickenlooper, p. 4.

[163]Hickenlooper refers to the electric light as not "America's most wonderful achievement", but rather "America's most wonderful farce." Hickenlooper, p. 1.

[164]There is some truth in Hickenlooper's suggestions that the early electric lighting companies were deliberately charging below cost to secure clients and customers. They continually functioned in the red in the hope that public introduction of the incandescent light would show its superiority, and in the years to come people would pay for its evident worth. During the early years of commercialization, Edison companies were charging .40 cents per bulb when the manufacturing cost was $1.40. Clark, pg 140.

[165]Hickenlooper, pp. 20-21.

technologist" in The Present Condition of Electric Lighting, concluding that "what must be fought against is the undue laudation, the excitement brought forth by unhealthy speculation, which puffs itself up unduly and injuriously to others." He further complained that:

> Circumstances are disfigured and misrepresented, and gas lighting is described as a defective, unbearable method of illumination injurious to health, - and all this in order to glorify the sanitary advantages of the electric light. The unhealthy growths of the business must be pruned away; and the sooner and more thoroughly this takes place, the sooner will the meritorious efforts of science and technology be once more recognized and credit returned to legitimate industries.[166]

Both sides greatly exaggerated the benefits of their light and the failure of others. A glimpse of non-aligned opinions only appears in rare passing articles and sources. An article in the American Journal of Science concluded after extensive experiments that the electric light was in fact the more efficient[167] of the two lighting systems, but also more expensive.[168] Scientific American discussed the future of incandescent and gas lighting and determined that, in their opinion, electric lighting would grow, but both methods would endure for many years to come. An article, while praising the naturally beautiful qualities of the incandescent light, noted that "the introduction of the electric light had stimulated invention in gas lighting, and there had been recently introduced new methods of gas lighting which bade fair to retard the universal

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[166]N.H. Schilling, The Present Condition of Electric Lighting (Boston: Cupples, Upham and Company, 1886) p. 55.

[167]By "efficiency" the journal was referring to the quality and the amount of light per unit of energy expended.

[168]H.A. Rowland, "On the Efficiency of Edison's Electric Light" American Journal of Science Vol. 113 (May 1880) pp. 337-342.

introduction of the electric light for domestic use."[169]

As to cleanliness and health, the majority of the non-aligned public praised the electric light as relieving "the mischief done to books, wares, and furniture" by gas.[170] Discussion of the dirtiness and ill effects of gas lighting concluded that the dawn of the electric age was also the dawn of a cleaner, purer, more aesthetically pleasing age. The consensus, however, though predominately favoring the incandescent light, was not entirely clear over the question of the health qualities of each type light of lighting. Scientific American published conflicting medical opinions on the effect of the incandescent light on the eyes.[171]

Safety was naturally a major public concern during the incipient years of commercial electric lighting. The electrical force that produced the magical incandescent light mystified and frightened the majority of society, and as such, any accident or failure involving the industry was promptly met with scepticism and criticism.[172] The mayor of Chicago expressed the sentiments of many when he said before a group of various electric company representatives that "as the father of over 600,000 people, all looking to me for protection, I say we want electricity, but we do not

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[169]"Artificial Light" Scientific American (August 25, 1883) p. 121.

[170]"Some of the Beneficial Effects of Electric Lighting" Scientific American (May 13, 1882) p. 288.

[171]"A Medical Opinion of the Electric Light" Scientific American (Dec. 23, 1882) p. 401 The author concludes that, "Something must be done, for as it is, the electric light is 'trying to the eyes', which means that it is in danger of injuring them, and already, there reason to believe, mischief has been wrought by its use. For true comfort there is nothing like the light given by the old-fashioned pure wax candle." For a conflicting opnion see "Electric Light Good for the Eyes" Scientific American (January 22, 1881) p. 49.

[172]For a discussion on perceived and real dangers associated with electricity see Joseph P. Sullivan, "Fearing Electricity: Overhead Wire Panic in New York City" Technology and Society Magazine vol. 14, no. 3 (Fall 1995) pp. 8-16.

want death dashing like a horrid monster through our streets."[173] To allay such fears, Edison personally wrote an article for the North American Review describing the limited dangers of electric lighting.[174] An article on the "Dangers of the Electric Light" in Scientific American discussed a fire in Philadelphia reportedly caused by electricity. In the article, the Philadelphia Bulletin was quoted as caustically warning, "It is a serious business thus to have life and property at the mercy of their scintillations."[175] The Boston Journal of Chemistry down-played the danger by suggesting that "the least of all objections to electric lighting is that of the danger from the conductors" as the "difficulty can be easily met, and will be when companies are compelled by law to place their conductors in the ground."[176] In the end, the most telling evidence in support of electric lighting was given when, in 1890, insurance companies concluded that it was a safer form of illumination than gas.[177]

As far as the over-all quality of the light, incandescence was superior, and only the most radical gas advocates argued to contrary. In fact, the single greatest objection concerning the incandescent light was its cost.[178] An article in Popular Science Monthly expressed this sentiment:

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[173]Hughes, Elmer Sperry p. 35.

[174]Thomas A. Edison, "The Dangers of Electric Lighting" North American Review vol 149 (1890) pp. 625-634.

[175]"Dangers of the Electric Light" Scientific American (November 5, 1881) p. 291. It should be mentioned that Scientific American also documented stories of gas accidents. See "Remarkable Explosion of Gas." Scientific American (August 21, 1880) p. 113.

[176]"Progress of Electrical Lighting" Boston Journal of Chemistry (February 1883) p. 20.

[177]Nye, p. 243.

[178]Thomas Commerford Martin, "Gilbert's Fables" North American Review Vol 146 (1888) p. 410.

"practical difficulties have been for the most part resolved, and the question reduced down to one of cost simply."[179] Engineering News reiterated this opinion by skeptically suggesting that "it is hard to see yet how the new mode of illumination can compete with gas for cheapness."[180] Meanwhile electric interests continued to claim that "incandescent electric lights can be furnished at prices far cheaper than the cheapest gas ever sold,"[181] but this was simply incorrect. In the nineteenth century, the electric light was undoubtedly more expensive than gas, and most people accepted this as fact.[182]

Early Commercialization of Incandescent Lighting

The opening of the Pearl Street power station on September 4, 1882 appeared to put Edison on the threshold of realizing his dream of widespread commercialization of the incandescent light. Before this time the world had only known his system of lighting as displayed in demonstrations, public illumination, electrical exhibitions, (such as in Paris in 1881), or in the rare instances when a home or business could afford to install an isolated plant. A few weeks after its opening, Pearl Street was supplying the power to light a quarter mile stretch of businesses in lower Manhattan.[183] The press characteristically glorified Edison's triumph. Incandescent lighting

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[179]C.M. Lungren, "Electric and Gas Illumination" Popular Science Monthly (September 1882) p. 579.

[180]"Edison's Light" Engineering News (Dec. 25, 1880) p. 443.

[181]"Electricity and Gas" Electrical Review (November 1, 1884) p. 5.

[182]See "Relative Costs of Street Lighting by Electricity and Gas in New York" Scientific American (April 20, 1883) p. 256.

[183]Catalog of the Exhibition, p. 13.

never looked more promising, and yet once the excitement generated by the opening of Pearl Street subsided, the new invention entered a new period of technological normalization. Although improvements were continually made to the incandescent lamp, its novelty began to wear away. It became simply another competitor in the lighting market, and because of cost, technological problems, and competition, mass commercialization of the incandescent light was relatively slow. In this sense the incandescent light did not take over the cities in a day or by the act of one man. The nineteenth century proved to be an era of slow public acceptance and integration of the incandescent light, and largely because of cost, it remained a product of private and public "conspicuous consumption"[184]

Edison's Electric Company grew, but not at a dominating pace. Once the success of Pearl Street was known, a number of additional electric companies entered the market.[185] At the same time electric arc companies and the revitalized gas industry vied to retain their already established positions in the lighting market. Gas companies proved themselves to be more focused on providing service and improving their product than they had been in the past, and they also displayed a willingness to merge in a concerted stand against electric lighting, as occurred in New York in 1884.[186] Eventually, competitors of incandescent lighting conceded that the new technology would inevitably play a role in the future, and by the latter half of the 1880's, arc companies began to offer incandescent lights. Brush Electric Company obtained the rights to the

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[184]Nye, p. 242.

[185]Catalog of the Exhibition, p. 13.

[186]Silverberg, p. 194.

Lane-Fox lamp in 1880 and the Swan lamp in the US in 1883,[187] and in 1887 gas companies across the country regretfully opted to add electric lighting to their services.[188]

Advertisements by Electric Companies

Electrical World (October 6, 1883) & Electrical Review (September 24, 1887) (below)

[187]Silverberg, p. 195. Bright, p. 72.

[188]"Gas Companies and Electric Lighting," Electrical World (Oct. 29, 1887) p. 234.

Yet despite the fact that incandescence promised to be the lighting method of the future, its distribution was by no means an unqualified success in the nineteenth century. Statistical indications are deceiving. For example, although by 1883 the Edison Electric Lighting Company had installed 334 lighting plants around the world,[189] only Pearl Street was a central station; the others were isolated plants.[190] This sort of growth was contrary to Edison's goals and to the dream of widespread commercialization of incandescent lighting. Edison constantly battled his financial investors over the direction that incandescent lighting should take. Those who financed the inventor supported small isolated lighting plants in commercial buildings or wealthy homes for those who could afford the exorbitant price.[191] Early customers included the Vanderbilts, J.P Morgan, and John W. Doane. Financiers felt that small isolated plants were the most efficient and fastest way of seeing a return on their investments. Edison, opposed to such a course, preferred more global lighting schemes. As a result, by 1884, disillusioned by the course of incandescent lighting, he withdrew from playing an active involvement in the industry he had created.[192] Without the famous inventor, incandescent lighting grew at a slower pace, which favored small isolated plants. This direction greatly inhibited the wide-spread commercialization of incandescent lighting. In 1892, New York, the city that was meant to be first graced with incandescent light in its entirely, had only 1,200 Brush and Edison electric lights combined, as

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[189]Nye, p. 33.

[190]Silverberg, p. 184.

[191]One bulb cost half a day's wages of a common man. Nye, p. 242. Luckiesh notes that even by 1894 the electric light cost a family the equivalent of food expenses. Luckiesh, p. 219.

[192]Josephson, p. 192.

opposed to 27,000 gas lights.[193] The dream of an incandescent world seemed to be momentarily lost.

Conclusion

The slow pace at which the incandescent light entered society played a major role in the creation of perceived social impacts and future visions. So few people experienced incandescent lighting first hand, that they merely dreamed of the favorable influence it would have on their lives in the future. While most of society could not afford electric lighting, this did not mean they could not admire it on the streets or in commercial buildings or read of its application in the homes of the very wealthy. From the Menlo Park demonstration to public displays throughout the 1880's, all forms of electric lighting were popular attractions.

To nineteenth century society electric lighting was a future waiting to happen. The miracle of its soft, mild, fire-less, but steady and brilliant light promised incredible improvements in the way the world lived and dreamed. Carolyn Marvin suggests, semi-echoing Nye's theme of the electric light "bordering on the supernatural," that it was as if at first the electric light did not belong in the "prosaic order of things" but rather in a world of "fairylands, ghostly pointing fingers, and otherworldly, dreamlike settings."[194] This illusionary land was the future, and society forecasted and dreamed of the wondrous form in which this electric world would arrive.

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[193]Nye, p. 33.

[194]Marvin, p. 163.

Future Visions and Social Expectations of the Electric Light

THE PROGRESS OF SCIENCE.

Electrical Review (September 13, 1884)

The Electric Light and Public Safety

"And this is the Condemnation, that light is come into the world, and men loved darkness rather than light, because their deeds were evil"

New Testament
John, iii, 19

THE ELECTRIC LIGHT AS AN AID TO CIVILIZATION.

The New York Graphic (February 1885)

In few places in this world has the dream of eternal light been realized. Even in our modern age of immeasurable light we at times endure intervals of darkness. Because of these moments we remain aware of what there is to fear in the shadows, and how degrees of darkness may effect the safety or danger of our streets. In this manner, any hope Edison had of the electric light obliterating darkness remains lost to our generation.

Yet despite the failure of this far-fetched vision, modern society no longer remembers the extent to which darkness ruled city streets before the electric age. That which today we consider darkness is undoubtedly a much lighter shade by our ancestors' standards. Every North American city has the electrical means to illuminate its streets, and we seldom need travel far before finding "a clean well-lighted place" to fit Hemingway's description.[195] The modern age understands darkness in relation to isolation and solitude, such as can be found in a remote cabin or in the rural countryside, but not in the congested, noise-ridden, intimidating atmosphere of a dimly-lit city. The widespread application of electric illumination has redefined and mitigated where and under what conditions we experience fear. This is not to suggest that cities in general have become safer; a discussion of objective levels of safety rather than subjective impressions of safety would require a separate sociological approach, but certainly the image of darkness in its association with crime has been altered by the electric light. What the modern world suffers from as a result of criminal activity is considerably different from what pre-electric nineteenth century cities had to endure.

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[195]For an account of imagery of electric light in American literature, see Bert A. Bender, "Let there Be (Electric) Light! The Image of Electricity in American Writing" Arizona Quarterly, vol 34 (1) : pp. 55-70. Our belief in the technology of artificial light is so devout that we appear as direct descendant of the old man who in search of comfort sits "in the shadow the leaves of the tree made against the electric light."

Future visions and perceived social expectations of the role of the electric light as a crime deterrent during the nineteenth century, as in most other respects, were influenced by the limited availability of the new technology. In the areas where electric lights were installed for street illumination, namely business or wealthy districts, public safety was not threatened as much as it was in the poorer quarters.[196] As a result, future visions of crime and the electric light were shaped by the fact that the districts in which its commercial application could prove most beneficial had yet to experience the technology first-hand, and in some cases were not even in the areas serviced by the gas companies. In many areas the electric light promised to bypass gas-lighting and provide public illumination in streets which for years had only known the inadequacies of flame and oil lamps. In this regard electric lighting was not necessarily seen as being a superior substitute for the existing gas technology, but rather a savior that would resurrect forsaken districts from chaos and criminal unrest.[197]

Unfortunately, realization of the social visions associated with the electric light was generally dependent upon its wide-spread application. Yet the harsh truth of the matter was that the areas to obtain electric lighting during the nineteenth century for the most part did not require it for reasons beyond prestige, aesthetics, and business. Its application to street illumination, as in other early uses, acted as an indicator of the status of a district or city more than serving any

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[196]Electric lighting in the late nineteenth century was in most cases a commercial endeavor, and installations occurred inside and outside department store or business establishments, with a belief in the idea the "trade follows light." Mark J. Bouman, "The 'Good Lamp is the Best Police': Metaphor and Ideologies of the Nineteenth Century Urban Landscape." American Studies vol. 32 no. 2 (Fall 1991) p. 64.

[197]In fact, few articles when discussing the future effects of the electric light on crime even mention the replacement of gas-lighting.

practical need. In areas where the electric light could have legitimately improved public safely, such as in the poorer districts of a city, it was not applied during the nineteenth century. Nonetheless, utopian visions are more conducive to hope than reality, and the idea that the electric light would one day revolutionize the concept of public safety found recourse in the imagination and ambitions of many.

Accounts of the dangers of city streets in darkness have been common since such social observations were recorded. For these reasons the relationship between crime and darkness is clearly defined. Light has always been considered safer than darkness. The better a street, park, city, or district was illuminated the safer it was thought to be. Criminal activity flourished under obscurity, and relied heavily on the element of surprise and intimidation. Darkness made these conditions favorable.

A history of public street illumination can be divided into five periods: the Ancient, Medieval, Oil Light, Gas-light, and Electric Age. These definitions are based on the source of illumination used, their effectiveness, and widespread availability. A brief overview of the history of public illumination will be presented to place the significance of the dawn of the electric age in its proper historical context, and to illustrate to what extent the history of illumination before this period was one of limitation, inefficiency, and failure. The construction of future visions with idealistic hopes always occurs in the context of an unmemorable or imperfect present or past.

In ancient times, most of what could harm a respectable citizen disappeared under the sun or a suitable artificial alternative, and for lack of the latter, centuries passed during which most of society remained at risk and were forced to stay in their homes after dusk. Travel in the evening was impossible unless one had substantial protection or possessed impetuous courage. Juvenal

wrote in an account of Imperial Rome, a city with no form of public illumination, that "to go out to supper in Imperial Rome without having made your will was to expose yourself to the reproach of carelessness."[198]

There is evidence to suggest that a form of public lighting existed as early as the forth century. The inhabitants of the Syrian city of Antioch appeared to have enjoyed a primitive form a public street illumination, as described by a contemporary scholar, Libanius:

> The light of the sun is succeeded by other lights, which are superior to the lamps lighted by Egyptians on the festival of Minerva of Sais. The night with us differs from the day only in the appearance of the light; with regard to labor and employment everything goes on well.[199]

In the Spanish city of Cordova, the Arabs were also said to have lit miles of streets during the tenth century.[200] However, these are rare exceptions, and public street illumination by fire, torch or other means remained practically non-existent throughout the civilized world until well into the Middle Ages.

No other era in history has been more linked in popular imagination with darkness and danger than Medieval times. Across Europe, cities shrouded in darkness were acknowledged to be infested with violence, crime, and depravity. Street illumination by torch or lantern proved inadequate, and measures taken up to the seventeenth century were commonly meant to curb crime rather than combat it.[201] Edward I (1272-1307) forbade public wandering in London at night

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[198]O'Dea, p. 93.

[199]Luckiesh p. 153.

[200]O'Dea, p. 93.

[201]Luckiesh describes the futility of the struggle by writing, "Lawlessness was hatched and hidden by darkness, and even the lantern or torch served more to mark the victim than to protect him." Luckiesh, p. 153.

in a statute that read: "None be so hardy as to be found going or wandering about the streets of the city after curfew."[202] In other instances the public was obliged to participate in public lighting in an attempt to solve the problem of crime on city streets. In the sixteenth century, citizens of Paris were instructed to "keep light burning in the windows of all houses that fronted on the streets."[203] This policy had been practiced in London since 1416, and was renewed as late as 1668 when London citizens were ordered "for the safety and peace of the city to hang out candles duly to the accustomed hour."[204]

Lighting by oil lamps first appeared at the end of the seventeenth century. Despite their poor light and unpleasant smell, oil lamps provided a marked improvement on candles, torches, and lanterns. By the latter half of the seventeenth century their application for street illumination was considered the best available alternative to reduce crime in city streets, and they had been introduced in London, Paris, Amsterdam, Hamburg, and Vienna.[205] In America, New York (1762), Norfolk (1765), and Albany (1771) were the first cities to illuminate streets by oil lamps. In the opinion of Jon Teaford, "by the close of the colonial period, America's municipal leaders had accepted the necessity of public illumination and had progressed substantially toward the

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[202]O'Dea p. 94.

[203]Luckiesh, p. 154.

[204]Helen Douglas-Irvine, History of London (New York: James Pott & Company, 1912) p. 281.

[205]W.H. Preece, "Recent Wonders of Light" Scientific American Supplement (April 24, 1880) pp. 3582-3583; O'Dea, p. 98.

objective of safe, lighted streets."[206]

The advent of gas lighting in 1807 in London marked the beginning of the age of modern public street illumination. The centrally controlled system of gas lighting promised for Europe, and later for the United States, a safer, brighter, future at the hands of improved public illumination. This promise was expressed in a resolution by Cincinnati city council in 1827: "the interest as well as the safety of the city will be advanced from the introduction of gas lights into general use."[207] Yet as discussed in previous pages, street lighting by gas, though an improvement on other sources was by no means an ideal lighting source. It faced many difficulties in cost, quality,[208] in the reliability of the light it provided, and in availability.[209] Nonetheless, in areas where the luxury could be afforded, the system of gas-lighting was seen to have greatly improved the safety of city streets.

Like many new technologies, the electric light promised salvation, in this case through the

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[206]Jon Teaford, The Municipal Revolution in America: Origins of Modern Urban Government, 1650-1825 (Chicago, 1975) p. 55.

[207]Mark J. Bouman, "The Good Lamp is the Best Police" p. 68.

[208]According to Kate Bolton street lighting by gas lamp followed a "moonlight schedule"in that "lights were not turned on during nearly full and full moons." The reason for this, as explained by Bolton, was not merely economic rationale, but also because "street lighting was so poor it was easily outshone by the moon, and what light was produced when the lamps were first lit diminished as the evening wore on, as smoke and soot from the gas flame darkened the enclosing globe." Kate Bolton, "The Great Awakening of the Night: Lighting America's Streets" Landscape Vol. 23 (1979) p. 41.

[209]Limited availability not only in reference to geographical location, but also in duration. Gas lamps for street illumination were always extinguished by midnight. Bolton, p. 41.

improvement of public safety. Early applications of arc lighting and later incandescent lighting[210] gave hope to the notion that in the future both crime and the darkness on which it thrived would be obliterated. What the electric light promised was the supply of an illuminant that was both superior to gas lighting and capable of more widespread public application. This vision was to be realized through the installation of electric streets lamps over every city street, most importantly in the poorer districts of the city. It was thought that this measure would revolutionize law enforcement and drastically reduce crime in cities.

This sentiment was expressed in the conclusions of city councils meetings, in literature, and in newspapers and journal reports. According to Mark J. Bouman the distinction between light and darkness in city streets was one of the predominant themes and symbols in "social expectations" or "sunshine and shadow" literature. Titles such as New York by Sunlight and Gaslight (1881) and Darkness and Daylight: Lights and Shadows of New York Life (1892)[211] marked the difference between those living serene and content in the well illuminated districts of the city and those left in darkness to suffer from squalor, vice, poverty, depravity, and crime. James McCabe in New York by Sunlight and Gaslight emphasized this light/dark motif in writing,

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[210]During the nineteenth century when describing street illumination, and the replacement of gas lighting with electric, the author is likely referring to the arc. In fact, according to William O'Dea, before 1885 street lighting in America was exclusively provided by the arc. Its powerful light, despite disadvantages such as its loss of light upward and constant need of adjustment and mechanical attention, made it superior to the incandescent in outdoor lighting purposes. O'Dea, p. 100. This is understandable as the incandescent light was intended for use indoor. Still by the 1880's, in particular after the opening of Edison's Pearl Street station, use of incandescent lighting in outdoor purposes became more common, despite the comparative weakness of its light. Luckiesh explains one of the reasons for this being that the incandescent light "had the advantage of being installed on a small bracket." Luckiesh, p. 160.

[211]Bouman, "The Good Lamp is the Best Police," p. 70.

"There [on Broadway] everything is bright and cheerful. Here [poorly lit districts such as the east-side of New York] every surrounding is dark and wretched. The streets are narrow and dirty, the dwellings are foul and gloomy, and the very air seems heavy with misery and crime."[212] Stephan Crane in Maggie: A Girl of the Streets (1893) similarly makes this distinction when Maggie, after being drawn into prostitution, fails one evening to find a customer and descends from the streets where "electric light, whirring softly, shed a blurred radiance on the glittering avenues" into darkness where "afar off the lights of the avenues glittered as if from an impossible distance."[213]

Other individuals looking into the future in the 1880's offered a number of future visions and social expectations of how the relationship between crime and darkness could be altered by the introduction of the electric light. One commonly held idea was that every street would improve a city's relative safety by the equivalent of an extra policeman.[214] With the beginning of commercial application of the electric light during the mid 1880's, this image had even emerged in reference to the electric light as an artificial policeman that would not sleep or grow tired, and a miniature sun that would not hide or be extinguished. In 1885, the New York Daily Graphic wrote, "Crime has no bosom for the bright rays of the mid-day sun, but revels amidst the shadows

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[212]Mark J. Bouman, "The Good Lamp is the Best Police" p. 72. From James McCabe, New York by Sunlight and Gaslight (Philadelphia, 1881) pp. 399-400.

[213]Bouman, "The Good Lamp is the Best Police" p. 73.

[214]See "Worth an Extra Policeman," The Electrical World (August 2, 1884) p. 36. For an example of the depiction of electric lights and policemen see illustration on page 74. Electrical trade journals attempted to advertise and exalt this imagery. In one case, on reporting on the Commission for Lighting the Streets in New York, The Electrical World reported that the Alderman almost passed a resolution to apply the electric light on "'principal streets as far as possible.'" and quoted a police superintendent as saying, "'greatly as we esteem "the finest" we would rather see more electric lamps put up than additions made to the force.'" Ibid, p. 36.

of night. The electric arc turns the night to day, tears off the cloak of darkness, and thief and thug skulk to their dens." and concluded that, "No one ever heard of a person being clubbed by a robber under an electric light!"[215] In Canada, the Canadian Electrical News echoed this theme when it argued that public installation of electric lights in Montreal was a dire necessity. Among the reasons given were that "the police force desire them as an aid in their work, because they save the city more than their cost in the pay to policemen, because the thieves loafers, garrotters, and evil-doers desire their discontinuance."[216]

Electric trade journals, eager to flame these visionary perceptions, frequently contained editorials or articles advertising the advantages of using electric lighting in the fight against crime. Electrical Review quoted a New York City police captain who praised the effectiveness of electric light: "Formerly (criminals) could easily escape recognition at night in the dim light. The shade of an old slouch hat was sufficient to conceal their features from identification. Now we spot them very easily and promptly."[217] In other cases, municipal authorities showed themselves aware of the benefits of electric lighting in poor districts of a city. An 1885 report of the Tenement House Commission of New York City stated that "the electric light in the poorer quarters of the city could be very beneficial in banishing crime."[218] Municipal and civic authorities in Boston

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[215]"The Electric Light in its Moral and Social Aspect." Electrical Review (March 7, 1885).

[216]"The Street Lights" Electrical Review (May 10, 1884).

[217]"Objecting to the Electric Light: Thieves Don't Like it - It Discourages Immorality - Corner Loafers Against it - It Disturbs the Policeman's Dream's" Electrical Review (December 19, 1885) p. 3.

[218]"The Electric Light in its Moral and Social Aspect" The Electrical Review (March 7, 1885). This gives credence to the argument that nineteenth century society was aware that the

came to similar conclusions about the value of street lighting for the identification of criminals.[219]

Inventors also conceptualized other systems by which electric lighting could play an active role in making city streets safer. Plans were devised by which electric light could be integrated into a signaling system to aid policemen in pursuing criminals. In "Electricity and Crime" the Electrical Review described the proposed construction of a system of electric signals in New York which would, through the illumination of colored lights on lamp-posts, mark the direction of the fleeing criminal. In essence, the article suggested a form of what modern policemen have through radio contact:

> Such signals will no doubt in the future be fixed so as to enable policemen on their beats to communicate quickly with each other. At present when a policeman gives chase to a robber at night, the chances are always in favor of the robber. If by some system of signals, suggested by call boards, for instance, the pursuer could notify all the patrolmen in the district where he was, and by touching buttons on lamp-post give them the direction of the chases, the escape of the mid-night thieves would be less frequent.[220]

The reality of the matter was that dreams of safety were over-stretched; crime continued. Nevertheless, in the limited areas where adequate electric lighting was provided, safety was said to have been markedly improved. Police authorities in Hartford, Connecticut admitted that crimes and offenses had greatly diminished with the introduction of street lighting, especially in places where the electric lights remained on all night. In Bushnell Park, it was suggested that "nocturnal

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application of the electric light in only wealthy districts would have no immediate effect on crime in the cities. The article concludes by describing the poorly lit district of east-side New York where "crime and iniquity are so rampant.".

[219]"Worth an Extra Policeman" The Electrical World (April 2, 1884) p. 36.

[220]"Electricity and Crime" Electrical Review (November 26, 1887) See also, "Electric Protection Against Thieves." Electrical World (March 21, 1885) pp. 112 & 113.

misdeeds" had dropped by ninety percent.[221] In Jacksonville, Florida the Jacksonville Times-Union reported that "the city needed fewer policemen than have been necessary in the past since the brilliant illumination of the city by electric lights," and that "there has been less thievery, less burglary and less thuggery in the city of Jacksonville since the city was lit by electricity than there had been in almost any corresponding period of the city's history."[222]

The perceived role of the electric light in the future, actively functioning to benefit society as a crime deterrent, must be seen as legitimate because to suggest otherwise would contradict the axiomatic association between darkness and crime. Safer streets were, as always in the public eye, synonymous with proper illumination. This dependancy could be measured by the source of lighting used in the area in which crimes had occurred.[223] Nineteenth century public perception of the degree to which city streets were dangerous or safe often focused not on geographic location, class, wealth, or character of the community, but rather the light which illuminated the streets, or lack thereof. Future visions of the electric light expressed this sentiment and the hope that, with the global application of the electric light, the rampant crime in the poorer districts would be erased.

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[221]"The Electric Light and Crime in Hartford" Electrical Review (March 21, 1885) p. 9.

[222]Cited in Marvin, p. 37. Electrical Review (Oct. 9, 1885).

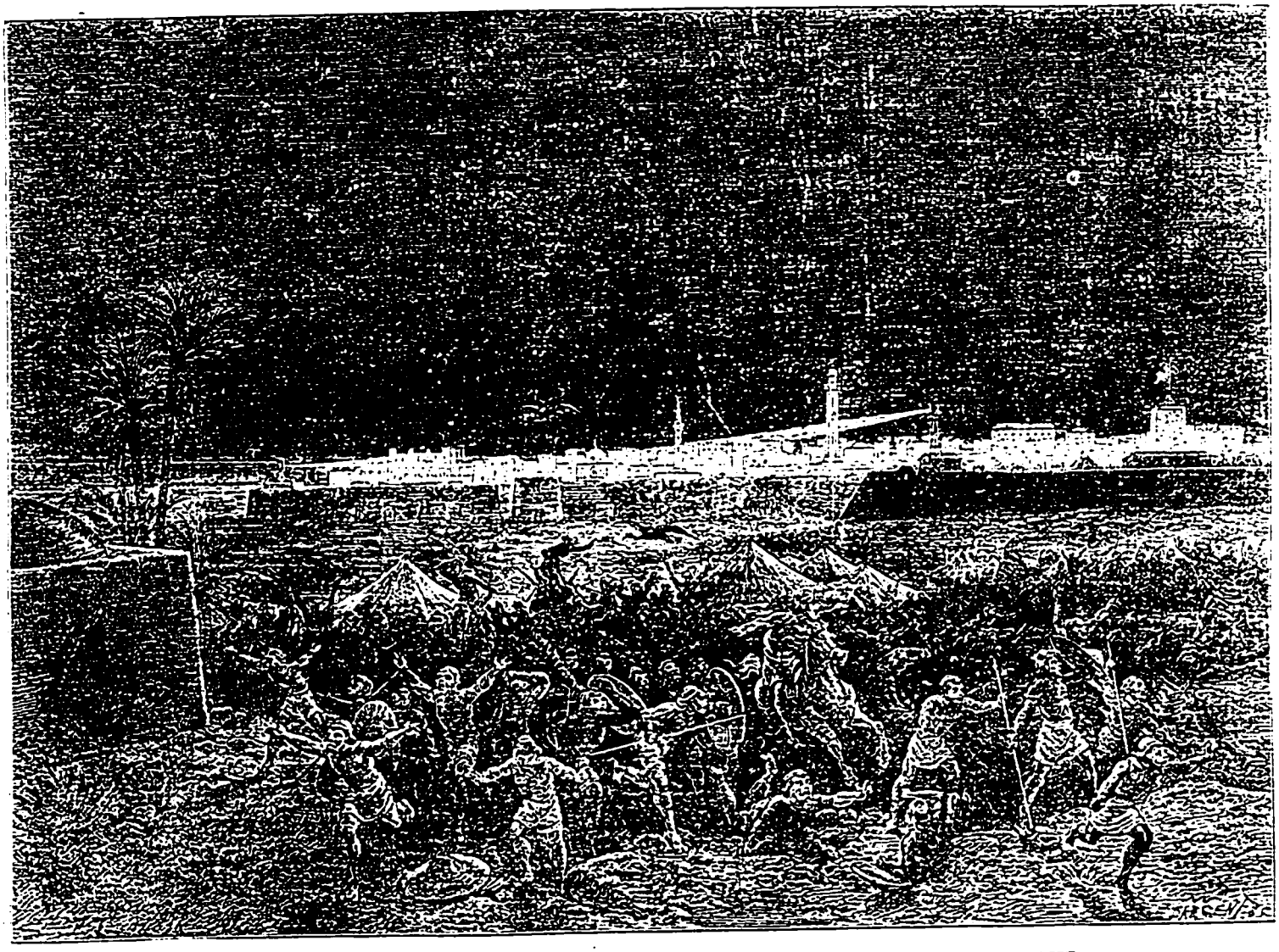
[223]If the relative safety of city streets could be based on the source of illumination used, (for example streets light by oil lamps were the most dangerous and those lit by the electric light the safest) was this dependent upon the functioning light or social conditions of the district? Oil lamps existed in the poorer districts because they were the cheapest source of illumination, and all that could be afforded. Poor sources of illumination did not create the criminal activities of the these districts, but remained incapable of combating it. Public perception of the electric light in the future saw the possibility of its superior light, especially after Edison's incandescent light, being made available because of its inexpensive costs, to a population and areas where it would best serve society.

As a result of this awareness of the differences between the well illuminated and poorly illuminated districts, the hope emerged that crime would decrease significantly with the widespread application of electric lighting. In fact, many believed that crime would become an outdated misfortune only suffered by those living before the electric age. As is often the case, these dreams were premature, and once again, technological reality distinguished itself greatly from idealistic hopes. For decades use of the electric light was limited, and faced intrinsic problems of cost, competition, and slow public dissemination. In the 1880's instances of public street illumination by electric lights were rare, and did not apply to any of the poorer districts of American cities. In fact by 1892 there were only 1,539 electric street lights in New York as opposed to 27,083 gaslights.[224]

As a result, the public was reduced to speculation and the construction of favorable future visions. With one random success however - under the safety of one light - people began to ask, "What if Edison really succeeded in lighting the entirety of New York as he promised?"

[224]Sullivan, p. 13.

The Electric Light and Warfare



A NIGHT ATTACK FRUSTRATED AT SUAKIN, EGYPT, BY THE ELECTRIC LIGHT.

The Electrical World (August 2, 1884)

Historically, many new technologies were applied to military objectives and warfare years before they served to benefit civilization. Commercial and public application of a science-based technology almost always occurred years after its introduction in military practice and strategy. Examples of this would included the airplane, radio, and telephone, and the trend is equally apparent in the history of electric lighting. At the outset of advances in electric light technology, forms of artificial illumination were immediately applied to improve military capabilities. Moreover, ideas for future military applications of electric lighting were pursued with more diligence than ideas for its commercial diffusion. For example, when arc lighting[225] was just entering the period of commercialization with its adoption in the 1880's for city street illumination, it had already been applied for many years to military purposes.

The subject of early applications, perceptions, and social expectations of the electric light in warfare is an important aspect of the history of the technology regularly left unmentioned by historians of the electric light, technology, and warfare.[226] The reasons for this are unclear, as

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[225]Military application of electric light was the exclusive domain of the arc method, mainly because of the necessity of an extremely powerful light. The arc light's brightness in Candles per square inch was somewhere between 250,000 to 350,000 while that of an incandescent lamp was 750 to 1,200. Luckiesh, p. 187

[226]David Nye fails to discuss the subject, only mentioning one case cited here in one brief example concerned with the integration of electrical technologies into society. Nye, p. 145. Carolyn Marvin attempts to review the role of the electric light in warfare, but her analysis is brief and included among the other electrical technologies addressed in the book. Marvin, p. 145-149. Historians of the development of military technology (Bernard & Fawn Brodie, From Crossbow to H-Bomb (Bloomington: Indiana University Press, 1973; Martin van Creveld, Technology and War: from 2000 B.C. to the Present (New York: The Free Press, 1989); George W. Gray, Science at War (Freeport, NY: Books for Libraries Press, 1943); William H. McNeill, The Pursuit of Power: Technology, Armed Force, and Society (Chicago: The University of Chicago Press, 1982) all fail to mention the role of the electric light in nineteenth century and twentieth century warfare.

there exists an abundance of nineteenth century published literature on the subject. In fact, electrical and scientific journals included accounts and editorials on the application of the electric light in warfare with more frequency than the vast majority of other perceived present and future uses.

Warfare was also the subject of some of the earliest and most frequent future visions concerning the potentials for electric lighting.[227] Yet unlike other topics discussed herein, where the role of the technology in the future was based almost entirely on speculation and imagination, electric lighting in the military was discussed in the context of early practical applications. In other words, future visions were based on nineteenth century reflections of what early military applications implied for the future of warfare. In this sense, the future arrived earlier in the military.

Military uses of the new technology, in the present and future, were given much public consideration during the nineteenth century. Most popular scientific journals and many books on the practical application of the electric light included articles and chapters on military applications of the electric light.[228]

Future visions of the role of electric lighting in warfare were based on the transformation and modernization of the time and manner in which battles were fought. Historically, military conflict after dusk was avoided, but by the nineteenth century land and sea battles were more

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[227]This disappointment of such telling irony however was not lost to the nineteenth century, who remained aware of the phenomenon, described in Scientific American as a "sad commentary on our modern civilization that so many of the prominent scientific inventions and applications derive from their main importance from the part they play in warfare."

[228]See for example, "Maritime and Military Applications" in Paget Higgs, The Electric Light in its Practical Application (London/New York: E & F.N. Spon, 1879) pp. 217-227

frequently fought under the cloak of darkness, conditions under which surprise and secrecy of action and movement played a vital role.[229] Yet future visions of warfare in the electric age delineated a much different picture, one in which the application of electric lighting would remove conditions associated with darkness and alter the manner by which military forces and planners conducted themselves. Naval warships would no longer be capable of furtively drawing near to an enemy before engaging in battle, movements of armies would no longer go unwitnessed during the evening hours, areas where amphibious landings were to take place could be illuminated from a distant point, and forts or towns no longer needed to wonder from what direction and with what strength an assault would arrive. In essence, what the electric arc light proposed was well-illuminated warfare.

The military application of electricity was not novel by the time the arc light was introduced in armies and on naval ships. Already in 1841 Colonel Samuel Colt invented the electric torpedo. The telegraph and later the telephone were both used to improve communications, organization, and increase the speed of mobilization.[230] Beginning in 1855, the military in various European nations and the United States also attempted to employ electric arc lighting in military warfare. In that year, the French navy used a primitive form of the arc light in its siege of Kinburn, and similar applications occurred in the American Civil War in defense of Ft. Wagner in Charleston, during the Franco-German war (1870-1871), and in the defense of the

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[229]William O'Dea explains that before the nineteenth century "at night a battle was broken off. Armies might possibly march by the moon, but battles could hardly be fought by it." O'Dea, pp. 126-127. Still in nineteenth century, during the American Civil War, the Franco-Prussian war, and the Crimean war, conflict after the fall of darkness did at times occur.

[230]"Electricity in Warfare" Journal of the Franklin Institute (January 1886) pp. 61-69.

British fortress at Suakin in Egypt in 1881.[231]

The electric light added a new dimension to warfare. Military personnel envisioned it playing an increasingly important role in the operations of both the army and the navy. Possible uses of the electric light in warfare considered by military leaders included the use of search-lights for enemy surveillance and in lighthouses to aid navigation of friendly ships; illumination of battlefields and entrances to forts to avoid surprise assaults; the use of powerful flares to illuminate strategic points; the detection of torpedo boats; and the illumination of coastal cities

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[231]"Science and Superstition" Electrical World August 2, 1884 & Luckiesh p. 185. The electric light was also cited by contemporary writers as an example of the superiority of Western Civilization, especially in reference to military technology. Scientific superiority remained a common theme to society which equated scientific advance with progress. This theme has been adequately addressed by both Nye and Marvin. Nye explains, "Electrification thus became embedded in a social Darwinist ideology of racial superiority. Only the most advanced societies had electrified machines and lighting. Darkness was a metaphor for the primitive; light was the exemplification of Christianity, science, and progress." Nye, p. 36. Also see Marvin, p. 19-21; 35-39. Nineteenth century examples of this racist, chauvinist, and elitist ideology include: Robert Hammond in his introduction to The Electric Light in Our Homes suggested that the relative degree of advanced civilization in the modern world could be based on mode of illumination used by the society. pp. 2-3. A similar sentiment, written with an air of nineteenth century western condescension, is expressed in an article in The Sanitary Engineer entitled "The New Guinea Natives and the Electric-Light," (February 5, 1885) p. 216. In the article, an account of the reaction of the natives to the electric lights illuminating the coastal towns from anchored positions is given: "the natives thought the two electric lights to be the eyes of some great monster." The use of electric light by the British military at Suakin remains one of the more famous instances were a new technology was used in warfare to a reception of general shock from what were deemed savage, uncivilized infidels. The article "Science against Superstition" explains, "Darkness fell, and the Arabs came on in hordes, shouting when they arrived with a few hundred yards of the wall, firing their guns randomly, and waving their spears defiantly. At the right moment, the electric light plant was put in motion, long beams of dazzling white light shot out suddenly, upon the howling, rushing mass of Arabs, and in a few seconds the attack had by this means been turned into of the strangest routs imaginable." Electrical World (August 2, 1884).

from a docked naval ship.[232] Military scientists of the nineteenth century accepted that these advances would play an important role and were unwilling to allow their respective nations to fall behind.

Use of the electric light in warfare depended on the construction of an effective electric lighting apparatus, commonly referred to as a projector. An efficient electric light projector had to be capable of illuminating a given area from a far distance, from either a land or a sea position, to serve military illumination aims. Primitive forms of such devices had been used in lighthouses as early as 1862, in Dungenness, and 1863, in LaHeve, France.[233] The most important early application of electric lighting projectors to warfare was by the German army during the siege of Paris in 1870-1871. Arc lights played a critical role in allowing the German army to direct their fire and monitor French movement in the evening.[234] The Franco-Prussian war greatly illustrated the extent to which electric illumination could play a role in future warfare and acted as the impetus for other nations of Europe and the United States to invest heavily in research and

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[232]See "Electric Apparatus for Military Purposes" Scientific American Supplement, no. 488 (May 9, 1885) p. 7790; "The Electric Light in the Navy" Scientific American Supplement (April 22, 1882) p. 5248;"The Electric Light in the German Navy" Scientific American Supplement (December 18, 1880) p. 4130; "Electricity in Warfare" Western Electrician (April 18, 1891) p. 221; Luckiesh, p. 185. H. Fontaine, in his work on electric lighting wrote, "It is incontestable that when a light of great intensity is required at a certain point, as, for instance in a fort for watching the enemy, in ports for preventing the destructive effects of torpedo-boats, in lighthouses for guiding the navigators, electric light is not only the most economical of all, but often the only practicable one." Hospitalier, pp. 455-456.

[233]E. Hospitalier provides a good discussion of the early application of electric lighting in lighthouses, pp. 357-373.

[234]O'Dea, p. 128. A similar model developed by French military innovators in 1870-1871 saw no practical application during the war suffered from many flays and inadequacies, namely its limited illumination power, range, cost, and size. "Electric Lighting for Siege Purposes" Scientific American (March 25, 1882).

development of improved lighting devices for warfare.[235] Eventually, the inefficient Alliance machines, which had up to this point powered the arc lights, were replaced by the Gramme dynamo, and a perfected reflector was invented in 1877 by Colonel Mangin of the French army. The result was the prototype lighting apparatus for use in the nineteenth century. It comprised a Gramme machine, a Mangin reflector, and a field boiler.[236]

The powerful arc lighting apparatus was applied to many military purposes. Already in 1875, two years before the Jablochnoff lamp was introduced, experiments on using an electric arc as a military signal were being conducted in Berlin. Scientific American described, in its October 30, 1875 issue, an apparatus which would reflect a powerful ray of light into the clouds to be used in the future by the German army for night signaling.[237] In 1880, Scientific American Supplement reported on mock battles conducted by the German Navy to gain practice in the detection of torpedo boats with the aid of a powerful electric lamp.[238] The attention given by American publications to the research activities of the German military indicate a clear aversion to the prospect of the U.S. military falling technologically behind the growing European power.

Another article in Scientific American Supplement in 1882 reported that the need for

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[235]See Walter S. Hughes, "Electricity in Naval Warfare" and John Millis "Electricity in Land Warfare" both included in C.F. Brackett, Electricity in Daily Life (New York: Scribner's, 1890).

[236]"Electric Light Apparatus For Military Purposes" Scientific American Supplement (May 9, 1885) p. 7790.

[237]"The Electric Light as a Military Signal" Scientific American (October 30, 1875) p. 281.

[238]"The Electric Light in the German Navy" Scientific American Supplement (Dec. 18, 1880) p. 4130.

properly outfitting U.S. Naval war-ships with the best possible lamps and dynamos was so great and so urgent that it had occupied the Minister of the Navy for some years.[239] By the middle of the 1880's, use of the electric light in military operations, especially in naval warfare, was considered not only an advantage, but a necessity.[240] In 1884, the U.S. navy equipped the frigate Trenton with a generating plant and powerful arc searchlights,[241] and later that year a similar installation occurred aboard the Colossus at Portsmouth. The Electrical Review referred to the electric lighting system and arc search-lights on the Colossus, overseen by representatives from the departments of the Comptroller of the Navy and the Director of Naval Ordinance with great eagerness and applause, as the "most perfect and comprehensive installation which has yet been introduced on board a ship of war."[242]

The principal use of the electric arc light in naval warfare was for the detection of approaching torpedo boats.[243] These dangerous boats, which in the past had been able to reach within firing distance of an enemy ship under the cloak of darkness, were more easily detected with the aid of powerful arc lights. The electric light was also applied to illuminate towns from anchored coastal positions for purposes of surveillance, bombardments, and amphibious landing,

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[239]"The Electric Light in Navy" Scientific American Supplement (April 22, 1882) p. 5248.

[240]In an article for Revue Militaire Belge, Lieutenant A. Cuvelier, suggested that based on its use in recent wars, the electric light will be an invaluable necessity in the future. "Electric Light Apparatus For Military Purposes" Scientific American Supplement (May 9, 1885) p. 7790.

[241]Marvin, p. 145. Electrical World (Feb. 22, 1890).

[242]Untitled, Electrical Review (Nov. 15, 1884) p. 9.

[243]Higgs, p. 224.

as was the case during the French occupation of Sousse.[244] While naval use of electric lighting was limited and experimental during the nineteenth century, expectations drawn from speculation and evidence of early application indicated that the electric light would play a decisive factor in the success or failure of future operations. With this image in mind the most powerful nations sought to have all their warships equipped with electric lighting apparatus.

The future role of the electric light in land warfare was similar to that of naval warfare. A portable light apparatus, as illustrated on the following page, was to be used for the surveillance of enemy movements, direction of artillery fire, and general illumination of advance, battle, or defensive positions. The French military, eager to avoid the failures and embarrassment of the Franco-Prussian war, were at the forefront of military research and application of the electric light in warfare. In 1881, the French military bought forty Mangin projectors and electric light plants for installation in fortifications and in coastal defense positions.[245] This application of the electric light at coastal defense positions was imitated by the United States which, by the mid 1890's, had a majority of its Atlantic forts in New York, Philadelphia, Savannah, and Boston equipped with electric light devices as strategic defense measures.[246]

Other developments in the application of the electric light with respect to land warfare were in improvements and new uses for the portable electric lighting apparatus. By 1884,

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[244]"The Electric Light in the Navy" Scientific American Supplement (April 22, 1882) p. 5248.

[245]"Science against Superstition" The Electrical World (August 2, 1884) & "Electric Light for Siege Purposes" Scientific American (March 25, 1882).

[246]Marvin, p. 145. Electrical World (Feb. 22, 1890) & "Electrical Wiring in Harbors" Western Electrician (April 16, 1898) p. 227.

experiments were being made as to the possibility of the development of an electric search light to aid in locating wounded soldiers. In England, an apparatus was designed that was less cumbersome than previous models. It was powered by a Gramme dynamo which could produce a brilliant light of 6000 candle-power. The portable device was said to be capable of illuminating an area 100 yards in diameter at a distance of two miles to such an extent that not only could a soldier be located, but also the seriousness of his wounds determined.[247]

ELECTRIC LIGHT APPARATUS FOR ARMY USE.

Scientific American Supplement (May 9, 1885)

In the following year, Scientific American Supplement described a similar device which was meant to be used in warfare to locate an enemy advance or the location of their artillery. The article emphasized the future role of the electric light in land warfare, and suggested that successful armies would rely heavily on its use.[248]

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[247]"The Electric Light on the Battlefield" The Electrical World August 23, 1884 p. 61.

[248]"Electric Light Apparatus for Military Purposes" Scientific American Supplement, no. 488 (May 9, 1885) p. 7790.

Use of the electric light in warfare was viewed as an enigmatic testimony to the morality and values, necessity, and progress of the nineteenth century western world. It was considered a necessity because it was seen as a step in the natural progression of improving military capabilities to ensure the safety of a nation's citizens as well as the nation's status as a "civilized" member of the western world community. At the dawn of an age where military failure was attributed to technological inferiority, military powers were continually required to innovate. In naval warfare, once one nation's ships were equipped with powerful electric search-lights, others were inclined to follow. In a military world one must always match the deeds of one's opponents.

Nineteenth century perceptions of the application of electric lighting in warfare are predominantly reflections on current western military advances. In other cases, editorials commented on the role of electric lighting in triumphant successes over infidels, or how it shocked the "uncivilized world". In these instances electric lighting was often depicted as a symbol of cultural and racial superiority. There also appeared articles that described the value of electric lighting in battles of the future. References to the blatant contradiction of light and destruction - progress and warfare - are infrequent, but some articles do comment on the sad state of nineteenth century western morals and values. This view was often accompanied by the pessimistic sentiment that all great inventions would one day be applied by the military for protection and warfare.

The irony in the topic of the electric light and warfare is that it is mainly about actual applications. Military advances in electric lighting technology appeared to have occurred almost as a natural consequence of "progress". More space was spent on recording present and past advancements of electric lighting in the military than was spent on future speculation. The irony

of this scenario is that at the same time there was little practical application of electric lighting in contexts that could have legitimately improved living conditions, health, safety, and travel. In these aspects of everyday life the electric light was a technology for the future, and was predominantly depicted this way through the reflections of a few visionaries. In this sense the military was an anomaly. It was as if it had already entered the future, and was nervously looking over its shoulder at the present. Meanwhile the rest of society was left behind and waited for their future to arrive.

The Electric Light and Aesthetics & Health

In 1883, an article in the Louisville Courier-Journal predicted that "the electric light will educate us to a refinement of which we do not dream." The author explained that the application of the electric light in homes and theaters would "disclose shams and pretenses, compel us to be true, and educate us to a refinement of which we do not now dream."[249] In expressing these sentiments, the article made reference to a popular topic of the day - the probable influence of the incandescent electric light[250] on aesthetics and health.

The nineteenth century image of the future of domestic and indoor electric illumination was a product of not only the intrinsic qualities of the light itself, but also the circumstances and places in which it first appeared. The electric light was predominantly displayed in public spaces, spectacles, events, exhibitions, balls, or in the homes of the very wealthy. Carolyn Marvin explains that "Lighting for special occasions was indeed the most visible and aesthetically indulged side of the new electric revolution."[251] As a result, public perception of the electric light as a technology occurred in the context of the grandeur of its surroundings, and it began to be

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[249]"The Electric Light as an Educator" The Operator and Electrical World (Feb. 3, 1883) p. 66.

[250]A description of domestic electric lighting nearly always referred to the recently perfected incandescent lamp. The arc light, for all the praise it received for outdoor lighting, lighthouses, at sea, or on the streets, was discarded as not suitable for indoor illumination, except in enormously spacious rooms. Robert Hammond noted that "the light itself is popularly called a blue light, and does not, I must acknowledge, show off to the advantage the natural beauty of the Anglo-Saxon race." He also noted that because of its unpleasant glare, the arc light when used at a ball resulted in the following: "two or three noble ladies preferred to sit in the shade during the whole of the evening rather than dance in the full effulgence of the arc light." Hammond, pp. 84-85.

[251]Marvin, p. 158.

associated with the promise of better living standards, comfort, and leisure. An individual imagining the electrification of his home saw in the electric light not only a superior illuminant, but also a glimpse of a future age in which the indoor environment would be cleaner, healthier, and more aesthetically pleasing. Synonymous with progress, the hope of widespread application of electric lighting seemed to indicate that this "modern" world would be painted with the extravagant characteristics displayed in exhibitions and advertisements.

In reality, domestic incandescent lighting was rare in the nineteenth century, a luxury afforded by only the most privileged members of society. According to David Nye, because of its exorbitant cost, the electric light was only "displayed in the most prominent place of a wealthy home," and was installed not out of practicality, but with an aim to "enhance social status."[252] A similar contemporary observation was made by W.H. Preece, an English electrical expert, shortly after visiting America. Describing the electric light as a social status symbol, he explained, "A man would, for the sake of outshining his rival, put the most flickering arc light outside his door...(Yet) the man who would have it in his store would not think of using it at home to make it more comfortable, because it cost too much."[253]

To the common man, the notion of electric lighting in the home was hardly considered, let alone in its application as a technology to improve aesthetics. In 1888, Arthur's Home Magazine made no mention of the possibility of electric lighting in "modern city homes." In an article on interior decoration, the magazine examined the task of improving the dimly-lit areas inside the entrance doors: "For the dark entries little can be done unless the owner is able and willing to let

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[252]Nye, p. 243.

[253]Rose, p. 13.

in light by cutting a suitable window or by **burning lamps** or **gas** through the day."[254] Other mainstream and women's journals such as Peterson's Monthly, Ladies Home Journal & Practical Housekeeper, Overland Monthly , and Woman's World likewise made no reference to the possibility of electricity being a practical lighting source during the nineteenth century.

Accepting that the electric light would not achieve widespread application for some time,[255] its advocates attempted to advertise it as a decorative luxury or an aesthetic wonder.[256] In particular they emphasized its beauty, healthiness, and impeccable cleanliness. In 1884, Electrical World wrote, "the electric light is playing its part as an accessory and as a stimulus in domestic aestheticism."[257] The result was that the attention given to aesthetic trends, fads, and, fashions - some that quickly failed and others that endure to this day - greatly increased. Despite occasional oddities, these examples all illustrate how a technology can be created for one purpose in mind, and eventually be adapted, molded, and applied to serve the many needs and wants of society. In the case of aesthetics and beauty, the electric light once again diverged from its path toward a practical solution to darkness, and emerged throughout much of its early history as a status symbol and pretentious ornament.

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[254]"Interior Decoration" Arthur's Home Magazine (July 1888) Vol 58 pp. 305-307.

[255]By 1883, even Edison had admitted that the electric light under present conditions was a luxury. Edison explained, "as it is, he does not find that it is even necessary to come down to the exact level of gas, as people are willing to pay more for the light than for gas light." "Mr. Edison on Electric Lighting" The Electrical World (Feb. 10, 1883) p. 84.

[256]This departure on the part of the electric light industry from a course which had earlier attempted to market the incandescent light as a populist measure to achieve widespread illumination was undoubtedly greatly influenced by the increasing tendency for small isolated plants, rather than centralized wide-spread application of the electric light.

[257]"The Incandescent Light in Interior Decoration" The Electrical World (Dec. 13, 1884).

The wealthy classes took great strides to show that their lives had taken electric turns for the aesthetic betterment. A couple could visit the electric ballet,[258] at which the players were fitted with tiny incandescent lamps attached to their dresses[259] or be entertained at a theater play that used electric lighting in the set or for special effects.[260] A gentleman could purchase an "electric hat" on which tiny lights were powered to glow by a small battery pack.[261] A society lady could decorate herself with "electric jewelry" - either hair or scarf pins, or brooches often surrounded by rubies or diamonds - as most notably developed by a Parisian, Gustav Trouve.[262] Yet as a whole,

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[258]The electric ballet had been enjoyed as a sensation or popular fad since Edison wired a stage in such a manner that when the ballerina stepped on the metal floor plates their dresses lit up. Nye, p. 244. Carolyn Marvin quotes an observation of an electric ballet in London, from the Pall Mall Gazette (1884): "Never before has such an effect been seen as a stage darkened for a moment only to be instantaneously illuminated with hundreds of ballet girls in armor, and every point in their stage harness picked out with stars of electric lights." p. 176.

[259]"The Electric Ballet" Electrical Review (July 5, 1884) p. 5.

[260]The Paris Opera House in 1849 was the first theater to use the arc light on stage, in its imitation of a rising son in the play, La Prophete. J. Baile, Wonders of Electricity (An Illustrated Library of Wonders) (New York: Scribner, 1872) By 1886, thirty theaters in the U.S. were lighted by electricity. Marvin, p. 176.

[261]"An Electric Hat" The Electric Review (October 23, 1886).

[262]Although devised for artistic decoration, Trouve's electric jewelry soon found use for practical purposes, such as in mining and evening street labor. "Trouve's Jewelry" Electrical Review (June 27, 1885) p. 2 & "Application of Trouve's Lamps" Electrical Review (January 24, 1885) p. 3 The case illustrates the manner in which ostentatious show did not necessarily mean a complete void of utility. "Electric Jewelry," was said also to be practical because it "would permit one to read the newspaper in darkness" "Electric Jewelry" Scientific American (February 2, 1884) p. 71 Battery powered lamps were also applied to work in mines and evening street work, and depicted in the picture on page 76. The advantage of a portable light was also applied to evening travel, in which a wealthy couple could travel under the comfort and safety of electrically illuminated carriages "Electric Lights for Carriages" January 30, 1886) Electrical Review p. 8 & "Electric Lighting of Carriages" Scientific American Supplement (June 13, 1885).

bodily adornment by electric light was an early passing fashion, practiced only rarely at balls or galas by idle people to impress and amaze their guests or society companions.[263]

Those with the financial means could also express their aesthetic superiority by placing the electric light on display in their homes. Smaller versions of electric fountains, first displayed at exhibitions such as the Health Exhibition in London or the Electrical Exhibition in Philadelphia[264] began to appear in very exclusive homes, such as the Vanderbilts or J.P. Morgan.[265] In one case, it was proposed that the installation and illumination of an electric fountain in the middle of a large dining room table, as was illustrated at the Paris exposition, could do much to bring out the colors in the room and improve its comfortable setting. The Electrical World explained that "the admiration produced by the luminous fountain at the Exposition, an admiration truly justifiable, will certainly have an influence on the imagination of the artists charged with the decoration of

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[263]This point is emphasized because both David Nye and Carolyn Marvin overstate the extent to which the electric light entered wealthy homes as amalgamation of fashion and utility through the hiring of "electric girls" as servants. Both authors state that "electric girls" were frequently used in the homes of the very wealthy to provide both service and lighting. Nye, p. 244 & Marvin, p. 138. Yet the source they rely on to make such claims was a single article "The Use of Illuminated Girls" in the Electrical World (May 10, 1884) p. 151, which humourously discusses the formation and functions of a recently formed company: The Electrical Girl Lighting Company. The article was in fact, a summary of an article that appeared in the NY Times on April 26, 1884 by a Mr. Arden. After further research, with the assistance of the Bakken Library and the New York Historical Society it can be maintained that such a company most assuredly never existed, let alone actually conducted business. It does not appear in the New York City Directory, or the New York business directory for the years 1870-1890. The Mr. Arden, who wrote the article for the NY Times was most likely C. Arden, a columnist and humorist of the nineteenth century.

[264]"Illumination of Fountains by the Electric Light" Scientific American Supplement (May 2, 1885) p. 7774. "The Illumination of Fountains by Electricity" The Electrical World (November 8, 1884).

[265]Nye, p. 242.

both public and private parks and gardens."[266]

An Electric Ballerina

Scientific American (February 2, 1884)

Mr. Hammer of Newark, N.J., for a New Year's evening ball, took fashion to an extreme by holding an entirely electric occasion. Among others electric oddities, Mr. Hammer had the front of his house wired in such a fashion so that when a guest rang the doorbell, three electric lights were illuminated instantaneously. His daughter dressed as the Goddess of electricity, "with

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[266]"A Luminous Fountain on a Dinner Table" The Electrical World (October 26, 1889) p. 275.

tiny Edison lamps in her hair, also an earring and breastpin, and held a wand surmounted by a star containing a tiny lamp."[267]

Scientific American Supplement (June 13, 1885)

Electrical Review (January 24, 1885)

On Christmas Eve 1884, E.H. Johnson, President of the Edison Company for Electric Lighting, lighted a tree in residence with small electric lights, initiating a modern tradition.[268] The news of Mr. Johnson's illuminated tree was met by a fascinated and curious public, and was cited in many ensuing electric articles and books as evidence proving the safety of the electric light. Professor George F. Barker of the University of Pennsylvania noted in discussing the safety of the electric light in the home that children were allowed to happily play with the 120 tiny bulbs hanging from the tree.[269]

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[267]"An Electric Supper" The Electrical Review (Feb. 9, 1886) p. 56.

[268]"In and About the City" New York Times (December 27, 1884) p. 5.

[269]"Electricity in the Household" Electrical Review (April 11, 1985) p. 8. This analogy of a child being able to work an electric light was common, as were analogies to ignorant servants

The notion of the electric light and aesthetics was one of the most important and frequently discussed topics of the nineteenth century regarding the new technology. Electric lighting was easily proven to be superior in all forms to gas lighting, especially in its cleanliness, but because of its cost and unavailability to a majority of society, after 1883 it was momentarily lost as a utilitarian technology to its role as a play item or symbol of the very rich.

If the wealthy home would not install electric lighting for aesthetics, pretense or ostentatious show, electric trade journals pleaded that they do so out of health and hygiene concerns. The noxious fumes emitted by gaslights were blamed for headaches, lassitude, and the slow poisoning of an enclosed room's occupants. Electrical World complained, "people are hardly alive to the deleterious influence of gas-jets on the health."[270] In the "Hygiene of Artificial Light" the editors of Electrical Review warned of the dangers of leaking gas-pipes, air unfit to breathe, and filthy walls and furniture. The electric light, they explained, would provide an unparalled step forward in the field of "sanitary sciences"[271] A similar article in the Chicago Commercial Bulletin argued that the necessity of clean air for health was largely overlooked, and complained that a candle, oil, or gas flame did not only "waste the oxygen of the air, and thus rob it of its life-supporting virtue, but it actually soils it with noxious vapors, the product of

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or housemaids. Attempts to convince the skeptical public of the safety and ease by which electric light could be operated and controlled were common. Robert Hammond, in The Electric Light in Our Homes spent a great many pages of his lecture proving that the incandescent light would not be a source of danger in the home, showing that if covered by a cloth, and broken the light still would not catch fire. pp. 57-73, 90.

[270]"The Electric Light in the Home" The Electrical World (June 30, 1883) p. 407.

[271]"The Hygiene of Artificial Light" Electrical Review (January 3, 1884) p. 8.

combustion."[272] Scientific American, although not always directly supporting electric light technology, expressed similar sentiments in the majority of its most serious articles.[273] An article in 1882 blamed gas-lighted rooms for causing people to become "blanched and sickly" and emphasized the "mischief done to books wares, and furniture" by gas lighting.[274] The Boston Journal of Chemistry saw the need for the electric light in libraries and reading rooms, because of the damage done to books by gas-lighting, and danger of gas which "increases fatigue, impairs the working powers, and in the long run undoubtedly shortens life."[275] Robert Hammond, in likely the most well-read book on domestic lighting of the day, The Electric Light in Our Homes (1884) made a considerable effort to describe the qualities of what he felt would constitute "the perfect light for our homes." He cited three of the seven most important qualities as being that it "should

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[272]"Pure Air and Electric Lights" The Electrical World (March 16, 1889) p. 161 A similar sentiment was expressed in "Electric Lighting Considered from a Sanitary Point of View" Electrical Review (November 15, 1884) p. 8.

[273]I write "serious articles" here, because the nineteenth century Scientific American (or even Scientific American Supplement, which was known for its highly scientific content) editors do not appear to have been averse to including a sensationalist, even humourous article. See for example, "The Artificial Light of the Future" reproduced from an article in Gentleman's Magazine, in which the argument is made for the future of lighting being found in the "machinery of the glow worm." The article explains,." "Now, suppose a room to be hung with curtains dipped in a solution of glow-worm fuel, so that every fiber of the drapery shall radiate as much light as a corresponding surface of glow-worm lamp. Such lovely radiance, diffusible at pleasure, would by comparison render the electric light a glaring, intolerable, barbarism Scientific American Supplement (December 1, 1883) p. 6591.

[274]"Some of the Beneficial Effects of Electric Lighting" Scientific American (May 13, 1882) p. 288.

[275]"The Electric Light in Libraries" Boston Journal of Chemistry (October 1882) p. 111. Another article in the journal noted that :The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel are now being recognized." "Th Electric Light and Gas" Boston Journal of Chemistry (December 1882) p. 136.

not rob the air of out rooms of oxygen, nor add noxious fumes to the air, nor be a source of danger in the house."[276]

A great deal of consideration was also given to the debate on whether the electric light was good or harmful to the eye. Electrical trade journals provided favorable accounts of the influence of electric light on all aspects of health[277] including its beneficial effects on the human eye. The Electrical World reported on a paper read before the American Opthhalmological society by Dr. J. Alfred Andrews, Ophthalmic surgeon to the Charity Hospital of New York which cited that "so far as I have been able to ascertain, no case of accident to the eye has been reported as having been caused by the incandescent light." Scientific American in "Electric Light Good For the Eyes" described a Dr. Cohn of Breslau who was said to have done extensive research on the effect of the electric light on the eye and determined that not only was such a "dazzling" light not harmful, but helpful in its improvement of "visual perception"[278]

As a health-related topic, the electric light was also examined for possible uses in medicine and surgery. As early as 1879, Trouve had invented a polyscope which he used to illuminate the interior of a pike. Soon the electric light was applied to improve medical procedures on

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[276]Hammond, p. 14.

[277] See "Artificial Light: The Different Kinds - Its Effect on the Human Eye." In this article a meeting of the Society of Natural Sciences in Buffalo New York was reported at which a Dr. Lucian Howe concluded that his research had shown that the incandescent light was the illuminant of the future and not injurious. Electrical Review (April 26, 1884) p. 10. See also "The Electric Light not Injurious to the Eyes" Electrical Review March 14, 1885, which summarizes an article in the Chicago Tribune "The Electric Light and Eyes: Bright and Beautiful but a Good Thing for the Oculist."

[278]"The Electric Light and the Eye." The Electrical World (October 16, 1886) p. 186

humans.[279] In October 1881, Scientific American wrote a lengthy article on the Gastroscope (an electric light for the human stomach), an invention perfected in Vienna to illuminate the inside of the stomach.[280] Popular Science News reported in its May 1883 issue on experiments in Europe for lighting up "internal cavities of the body by means of electricity." The article suggested that the idea of "letting daylight shine through" a person was old, but was finally being successfully applied with an apparatus used in Vienna capable of "rendering the body transparent."[281] An account was given by Thomas Oliver in an English medical journal, in which an apparatus was used during an operation to light up a patient's liver through an abdominal incision.[282] In 1886, the Electrical Review reported on a new invention called the electro-osteotome, developed by Dr. Milton J. Roberts, used to illuminate the cavity of a bone. The device made up of a tiny incandescent electric lamp in a cylinder of hard rubber, about eight inches long and three inches in diameter was reported to have been successfully used in an operation to determine the cause of a patient's hip pain.[283]

Unlike other electric medicines,[284] deeply rooted in charlatanism, early application of the

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[279]E. Hospitalier, The Modern Applications of Electricity (New York: D. Appleton and Company, 1883) Volume I, p. 454.

[280]"The Gastroscope - An Electric Light For the Stomach" Scientific American (October 29, 1881) p. 281.

[281]"The Electric Light in Surgery" Popular Science News (May 1883) p. 62.

[282]Ibid.

[283]"The Electric Light in Surgery" Electrical Review (February 6, 1886) p. 3.

[284]The application of electricity to cure or serve medical purposes was popularly-discussed and practiced during the nineteenth century. See for example, William R. Kraft, Electrotherapy, A Curative in Acute and Chronic Diseases (New York: Pusey & Rooney, 1885) Electric shock for revitalization and electrodes to be attached to areas of affliction were popular

electric light in medical and surgical procedures was generally legitimate and vastly beneficial to physicians. Equally so, with the exception of the occasional humorous tale of individuals believing that the artificial light would cure their ills,[285] the electric light in medicine was discussed as a serious topic and deemed a great stride in the progress of science and health.

Examples of early uses and future visions of the electric light in reference to aesthetics and health aptly illustrate to what degree a technology may diverge from it original path, and be molded for the future by its use in the present. In this case, some of these uses were transient and sensationalist, but others endured and furthered development of the electric light to serve diverse social goals. Its introduction led to close examination of health conditions in the home environment, and did indeed result in the eventual arrival of cleaner, healthier living and working spaces. Use of the electric light in medicine and surgery became a helpful tool to the physician. Even aesthetics accelerated the dissemination of electric lighting by glorifying its use. In this manner it became popular to equate gas-lighting with poverty, dirt, and unhealthiness, which hastened adoption of electric lighting.

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alternatives to the ailing patient. For a discussion of electric medicine in the nineteenth century see Nye, pp. 163-166.

[285]See for example, "Electric Cure for a Cold" Electrical Review (January 28, 1888) p. 3.

IV

Conclusion

While electric lighting has emerged as a technology that grew to serve the needs which brought about its conception, its past reflects a period, particulary in the late nineteenth century, during which its role in the future remained unclear. The technologies of electric lighting were developed and introduced with the prospect of replacing gas-lighting in the areas which it serviced, and bypassing it in areas which it did not. As such, at the most basic level, electric lighting was expected to further expand the proliferation of artificial light.

Yet in the decade that followed Edison's Menlo Park demonstration, electric lighting failed to live up to the expectations of its inventors, advocates, and the general populace. Electric lighting designs proved to have been hastily introduced and marred by technical flaws[286] so that during the nineteenth century it held few advantages over gas-lighting. Arc lighting could not overcome the inherent limitations of the exceedingly bright and harsh light it produced. It failed to materialize as a genuine competitor of the gas industry because the quality and power of its light made it unsuitable for domestic use. Outdoor arc lighting achieved more success, though it continued to suffer from technical flaws, limited power supply, and public fear of electricity. Meanwhile, the incandescent light, which promised to be the lifeline of the electric revolution, suffered from imperfections in design, cost, and power supply, and from divisions between

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[286]This thesis has shown that during the decade between 1879-1890 both forms of electric lighting were far from perfect alternatives to gas lighting. They were technologies which suffered from high production costs, imperfect designs, and the limitations of underdeveloped power systems.

inventors and investors as to what sort of market for electric lighting should be pursued.[287] As such electric lighting did not immediately live up to the expectations of its original design.

As a consequence of this failure, commercial application of electric lighting was limited in the 1880's. Incandescent and arc lighting entered an era of public uncertainty during which for all practical purposes it was found only in public spectacles, exhibitions, or in the streets and homes of commercial and wealthy districts. The result of such failure and indecision was that a technology which had been intended to bring about revolutionary change in the world, and had been eagerly anticipated for such reasons, was placed in an uncomfortable role as an elitist item of "conspicuous consumption"[288] Scientifically, the technologies underwent a period of improvement and innovation, in which electrical systems were designed and improvement on the duration and quality of light were made. Yet the image of electric lighting remained, for most, that of a technology for future generations.

These limitations of nineteenth century electric lighting had an immense impact on the way it was viewed by the public. The notion of an artificial light with the unique qualities of either the arc or incandescent light had for years fascinated American society. When, during the 1880's, electric lighting was finally commercially introduced, the impact of its relative failure,

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[287]It is maintained here that the case of the incandescent light illustrates a telling example of how early commercialization may follow a substantially different course from that intended by inventors. In the case of incandescent light, while Edison developed a "practical" lamp with the intentions of competing with the gas-lighting, his ambitions concerning systems of electrical distribution show a much more populist goal. In effect, Edison's goal was to begin with New York city and proceed to light the world. This conflicted with the opinions of his financial supporters, who favored the isolated plants of servicing a small area rather than centralized systems.

[288]This term was used to describe the role of the incandescent light in the nineteenth century. Nye, p. 242.

coupled with continued public appearance in circumstances of exhibitions and spectacles, resulted in the image of an expanding electrically-lit future. Future visions and expectations emerged in the context of the grandeur in which electric lighting first appeared. Although Edison had very practical intentions for electric lighting, after the initial failure of commercialization it emerged as an elitist technology. Accordingly, the public then viewed it with elitist expectations, and with their eyes focused on the wealthy and the future they appeared to be living. In essence, the inventive and imaginative spirit which saw in electric lighting a replacement for gas, but more importantly the present illumination of areas hitherto left in obscurity, was reinterpreted into future visions of the coming electric age, or in the eventual "conquest of darkness."[289]

There are a number of principal reasons why future visions and expectations emerged and endured, many of which explain why every appearance of electric lighting was deemed to be such a monumental event. At the most basic level there existed a social awareness of the natural relationship between light and darkness. The notion of an artificial light that would disrupt this natural order promised extraordinary consequences. More importantly, it strengthened the nineteenth century belief in scientific progress leading to social development and betterment. In fact, electric lighting promised to be the definitive argument in support of scientific progress, as the shrouded symbol and fear historically associated with darkness for the first time seemed fragile and vulnerable.

On another level, public anticipation of an electrically-lit future was flamed by the inventors and commercial interests behind the new technology. In fact, in most cases the origin of

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[289]From the title and major prevailing them in Matthew Luckiesh, Torch of Civilization: The Story of Man's Conquest of Darkness (New York: Putnam, 1940).

future visions and expectations can be traced to the men and interest-groups behind the development of electric lighting technologies. Inventors, attempting to gain public support for their endeavors, frequently speculated on the significance of the forthcoming electric revolution and advertised their comments years before any practical design or means to achieve widespread electrification were available. In this regard commercialism played a major role in the image of electric lighting acquired by the public.[290] The reputation of Thomas Edison also greatly influenced public perception of electric lighting. The persona and legend of Edison as a wizard and inventive genius intuitively creating the future led many to believe that whatever the inventor imagined was destined to become the future.

With the failure of early applications and commercialization, hopes of wide-spread application of the electric light subsided among inventors and visionaries. Yet the impact of its introduction was not easily lost on nineteenth century society, the majority of whom were aware of, but could not obtain electric lighting in their homes, or even in the streets and commercial buildings of their town or city districts. During this period, public perception of the electric light was influenced by no greater factor than this lack of availability. Few people could witness the wonders of the new technology within the confines of their homes or in an environment of familiarity. Rather they continued to work, read, and function by means of natural light, lantern, oil, and gas light. While expectations and future visions did emerge as a result of the public awareness of the installations and applications already having begun in the country, most of nineteenth century society did not presume to think that electric lighting was designed for them or

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[290]Bernard Finn expresses this point in writing that the incandescent light was "born in an age of mass promotion." Finn, p. 248.

their time. Most settled on admiring the new technology from afar or under the auspicious conditions of an exhibition, spectacle, or affluent areas in the country.

Because of these circumstances, the electric light became the subject of some of the most extravagant early uses and future visions. The wealth and grandeur which surrounded any application of electric lighting in the 1880's appeared to be an indication of what the promising future held for society as a whole. Accordingly, the image of electric lighting became disassociated from being merely a substitute for gas lighting, but acquired an idealistic grandeur as a technological savior. Its image delineated a future of universal abundance, calm, safety, and hopes of a twenty-four hour day. All that the sun could bring, many believed, could be brought as well by electric lighting. Incandescent lighting seemed to insure a clean, safe, opulent home. The powerful arc light was seen as instrumental in defending city districts from the crime that thrived off darkness. In the military, electric lighting was seen as the ultimate sign of progress. In effect, as a result of the circumstances surrounding the technology, its inventor, its symbolism, its lack of availability, and applications in surroundings of wealth and grandeur, electric lighting evolved into an icon of the future and the quintessential indication of man's imminent victory over darkness, poverty, and fear.

A nineteenth century social history of electric lighting remains a history of speculation, perceptions, and predictions. Indeed application of electric lighting was so rare that the historian is inclined to concentrate more on what was believed and hoped, rather than on what actually transpired.

In a sense electric lighting was introduced into society before its time. It was a flawed and imperfect technology which took decades of innovation before reliable and widespread application

was possible.[291] Yet during this period, particularly in the first decade following Edison's Menlo Park demonstration, society familiarized itself with the new technology in its own manner, through expectations and future visions. Society was aware of electric lighting, but only witnessed or read of it on a very limited and sensationalist level. Accordingly, the imagined role and impact of electric lighting in future was created on the basis of these early applications and the perceptions which subsequently emerged.

This thesis has attempted to describe how the American public viewed electric lighting from 1879-1890. It has chosen three major aspects of nineteenth century society - war, crime, and health & aesthetics - to illustrate perceived social impacts and future expectations for the new technology. Upon arriving at the conclusions noted on the preceding pages the issue is raised as to how important these future visions and expectations were in the developmental history of electric lighting. What standing should public perception of social impact have alongside the more established fields of systems, economic, and technical electric lighting history?

Assessing the impact of technological future visions and expectations is a complex and difficult issue to address. To begin with, the question involves, like the subject itself, a preponderance of speculation and supposition. Conclusively stating that a prophecy directly led to a reality does little justice to other factors that may have been at work. Yet at the same time future visions should not be discarded as being invisible and inconsequential footnotes in the developmental history of technology. This study, in addressing the early history of electric lighting, has determined that public perceptions and expectations primarily act as reflectors for

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[291]One could even speculate that if it had not been for Edison's reputation and resources, incandescent lighting would have been introduced a number of years, if not decades, later.

better understanding the needs, wants, fears, and hopes of a past generation. The case of electric lighting illustrates what a segment of late nineteenth century American society felt about science and technology, the specific artifact introduced, and the future. It teaches us that future visions were shaped by comparison with prior technologies, such as gas lighting. It also provides insight into other aspects of late nineteenth century American society. The near immediate transformation of electric lighting into an elitist technology shows a society accepting of stratification at nearly every level.[292] At the same time it delineates a society that was devoted in its belief to scientific progress, and the future it was thought to be creating. In the this manner the future was given precedence over the present.

On a secondary level, more precise impressions of the social and scientific consequences of future visions may be included. In this study, social expectations for electric lighting depict an era in which social and urban problems were obscured or neglected as a consequence of the late nineteenth century devotion to scientific progress and technological innovation. Joseph Corn refers to the situation as the hope for a "technological fix", by which science itself would overcome social problems.[293] These false ambitions were reflected in the manner in which electric lighting was seen as a solution to crime, poverty, and destitution that plagued much of nineteenth century American society. According to Corn, because of this belief in technological fixes "support for real social change was undermined."[294] In economic and commercial aspects Nathan

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[292]Nineteenth century literature on electric lighting illustrates a public awareness of elitist applications, but it does not dispute or object to this trend.

[293]Corn, p. 227.

[294]Corn, p. 227.

Rosenberg suggests that expectations could slow the rate of diffusion.[295] Rather than impacting favorably, these interpretations suggest that future visions and expectations act as a deterrent to technological diffusion. This conclusion is not altogether accurate in the case of electric lighting.

When suggesting in apparent contradiction of his analysis of "technological fix" that "utopian expectations" play a role in bringing about "workable innovations," Joseph Corn proposes that inventors and scientists may be influenced by public expectations.[296] Such an interpretation, if it is accepted that scientists do not work in a vacuum, oblivious to the wants and demands of the society for whom they work, would suggest that future visions and expectations, though expressed by a minority, directly influenced the development of an artifact. In this regard expectations for electric lighting were absorbed during the period of innovation, in effect, acting as an impetus for technological innovation. In the end, successful commercial introduction of electric lighting occurred in a manner, design, and scale to match that of nineteenth century ambitions.

Still, determining the impact and importance of future visions relies largely on estimation and theory. What is more important in the early history of electric lighting is the images of nineteenth century American society it provides. In this sense, this study has not been a history of a technology as traditionally presented, but rather the reflection of a past society drawn from the impact of a newly introduced technology. Accordingly, the study of expectations and future visions should then be placed in a field where the relationship between technology and society is analyzed, and the impact of the introduction of specific technologies are utilized to study the

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[295]Rosenberg, Perceptions p. 195.

[296]Corn, p. 226.

perceptions and ambitions of a given generation.

The case of early electric lighting depicts a society which saw in the scientific progress and technological innovation the pathway to a glorious future. The public rarely deviated from imagining ways in which technology, almost effortlessly, could lead to the betterment of society. For these reasons technology, as well as the few inventors accepted to be behind it, were glorified as social saviors. The electric light served as the ideal confirmation of this belief in scientific progress and the future. The notion of an artificial light that could successfully overcome one the most stringent laws of nature was exalted as a glorious achievement. If darkness could be defeated, who was to say that poverty and disease would not also fall? The future looked promising, and future visions and expectations captured a world in which clean, powerful, mild, everlasting lights magnificently illuminated a more kind, safer, and brighter world.

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The Atlantic
Chicago Tribune
Electrical Review
Harper's New Monthly Magazine
Journal of Gas Lighting
Lippincott's Monthly
North American Review
The Sanitary Engineer
Scientific American Supplement
Van Nostrand Eclectic Magazine
Woman's Home Companion
Arthur's Home Magazine
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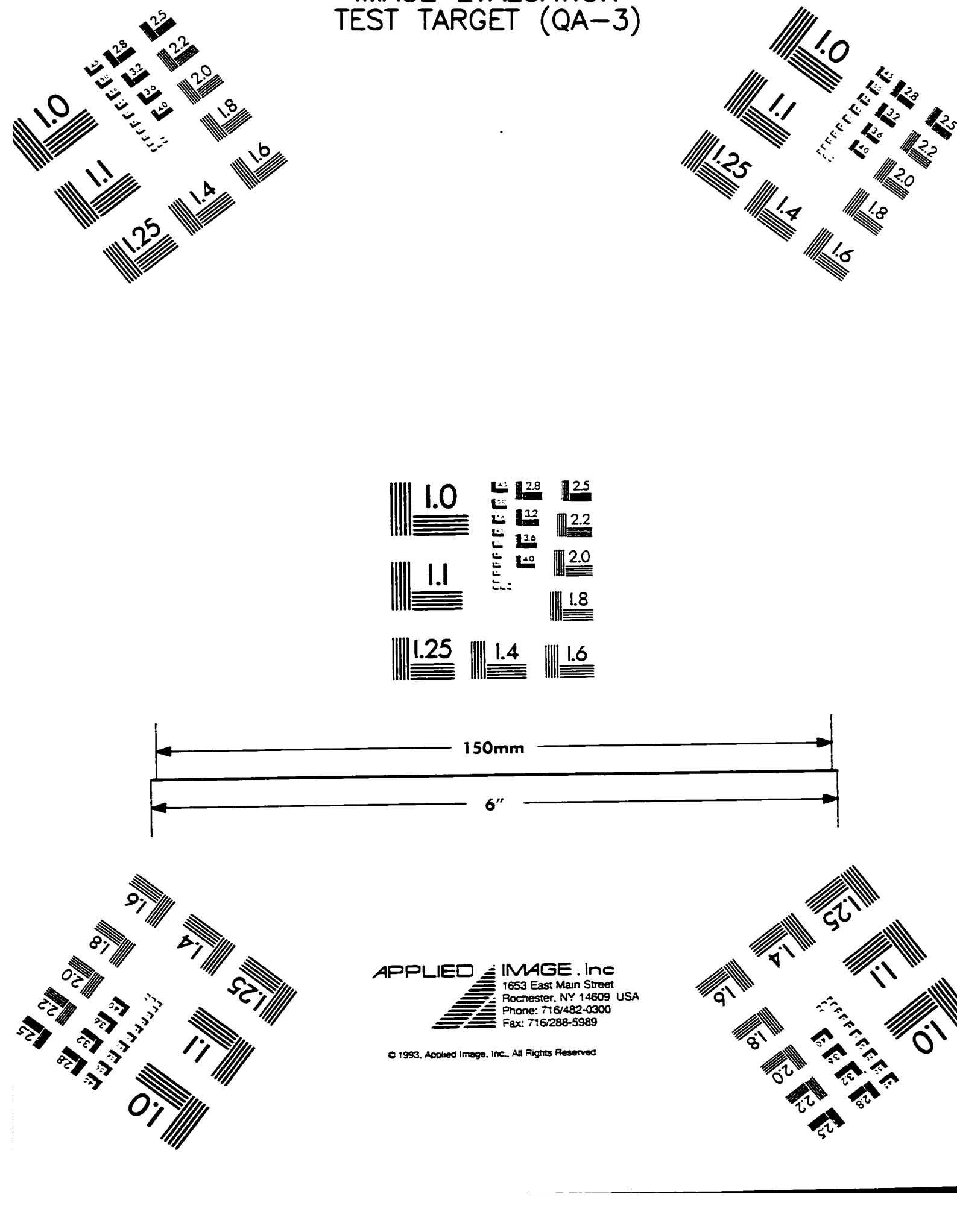
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