Pure and Practical Science

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Throughout history, many unique individuals have left their touch on the world. The impact of most people, when observed from the comfortable armchair of modern historical research and analysis, is neither startling nor far-reaching. The same can not be said for two specific individuals discussed here, Benjamin Franklin and Henry Augustus Rowland. Many historians, especially those of the non-scientific or technological focus, would classify both Franklin and Rowland into the same group, according to the particular views of each historian, Franklin and Rowland's impact on the world, both in the scientific world and the society at large, is more than identical. Where Franklin's efforts tended towards political manipulations to advance the education and enlightenment of his colonial society, Rowland's more traditional scientific career and research projects tended towards more concrete scientific accomplishments. However, such a broad generalisation is unfair to each, as both men participated in both of the aforementioned activities.

"A life without cause is a life without effect," says a common proverb,

and indeed, the great influence Franklin and Rowland had on their world is not devoid of cause. Before we delve into an analysis of the lives and scientific impacts of these two men, it is worthwhile to explore the origins and influences each of these men received in their childhood and early years, to provide a greater understanding of their thoughts and motives, before observing their actions as adult scientists.

Henry August Rowland, born on November 27, 1848 in Honesdale, Pennsylvania, was the end of a long line of Protestant theologians. For three generations back, his father, grandfather, and great-grandfather were all clergymen. As was customary for the time, young Henry was expected to follow in the footsteps of his fathers, first by attending Yale University in New Haven, Connecticut, and then by entering into the ministry. Henry, who was more interested in his amateur experimentation in chemistry and electricity than theology, strongly resisted his family's desire for his education as a minister. Eventually his family yielded, so in 1865, at the age of 17, Rowland enrolled at the Rensselaer Polytechnic Institute. After graduating in 1870 with a civil engineering degree, and a two year stint with unsatisfying jobs in surveying railroads and teaching at Wooster College in Ohio, Rowland returned to Rensselaer where he was offered a job as a professor of natural philosophy.[1]

Rowland soon became quite frustrated with the state of physics research

[1]Adapted from Weart, Spencer and Patrick McCray. "Selected Papers of Great American Physicists - Henry Augustus Rowland", American Institute of Physics. <http://www.aip.org/history/gap/Rowland/Rowland.html> (24 Oct. 2005)

in America. After spending all his spare time working on his personal research in electromagnetic properties, specifically magnetic permeability, his summary paper was not well received. He sent his disappointing paper to his colleague James Maxwell in London. Maxwell was impressed and had the papers published in the *Philosophical Magazine*, but few scientists in America noticed the publication. A significant source of Rowland's frustration with physics research in America was the apparent lack of support and research space in American universities. This frustration was soon eliminated when Rowland was recruited to be the first professor of physics at the newly formed Johns Hopkins University in 1876.[2]

Benjamin Franklin, youngest son of seventeen, was born in 1706 to Josiah and Abiah, in Boston, Massachusetts. Similarly to Rowland, Franklin was initially destined for a life in the ministry after enrollment in grammar school. However, being the father of seventeen, Josiah Franklin could not afford the expense of a college education for his youngest son, so Benjamin was transfered to a school for arithmetic and writing, where he enjoyed great success at writing, but had troubles with the arithmetic. At the age of 10, he returned home to assist his father with his business of as a "tallow-chandler and sope-boiler," where he was was assigned to menial tasks such as "cutting wick for the candles, filling the dipping mold and the mods for cast candles, attend the shop, going of errands, etc."[3] Throughout his childhood

[2]Hendricks, Melissa. "Spectral Illuminations." Johns Hopkins Magazine. April 2000. <http://www.jhu.edu/ jhumag/0400web/02.html> (24 Oct. 2005

[3]The Autobiography of Benjamin Franklin. Mineaola, New York: Dover, 1996.

and adolescence, Franklin showed a great tendency towards self education and leadership of the other boys. Franklin recollects how, "...all the little money that came into my hands was ever laid out in books." Later in his adolescence, Franklin became an apprentice to his brother, who had gone into business as a printer. As notable members of Boston's society stopped by his shop to drop off article and letters for the newspapers, Franklin, now about 16 years of age, became fascinated with the new ideas being tossed around. Eager to try his hand writing, but being still merely a boy and unable to write for the paper, Franklin left his letters on the floor of the shop. They were printed to great critical acclaim, but as his hubris grew, the plot was eventually revealed, but not without first leaving a great mark of confidence and arrogance in the young Benjamin Franklin. Eventually the relationship between Franklin and his brother led to Benjamin's quitting of his brother's employ. After his brother spoke ill of him to the other printers in Boston, Franklin travelled to Philadelphia, where he took employ with both major printers in town.[4]

As noted above, both Franklin and Rowland were influenced towards a life in the ministry. Neither ended up in this career. The manner and reasons for their pursuits of other careers are important influences on their individual contributions to science and society.

As two of the most influential scientists of their respective eras, both

[4]Adapted from Franklin, Benjamin. The Autobiography of Benjamin Franklin. Mineaola, New York: Dover, 1996.

Franklin and Rowland have had a significant impact on science in America. Benjamin Franklin was more focused on raising funds for colleges and various other education and community improvement projects, while Rowland was more of a 'pure' scientists in his determination and ingenuity in his research and development of various improvements in scientific equipment.

In terms of direct, concrete contributions to the scientific community, both of these men have contributed significantly. After selling his printing business to a company partner, Franklin began to experiment in the science of 'electrical parlour tricks,' and other such novelties. However, the novel aspect was not enough to satiate his thirst for knowledge and deeper understanding, so Franklin began tinkering, often with his own homemade equipment. This is in sharp contrast to the institutional research performed by Henry Rowland. After his hiring as professor of physics, Rowland embarked on a tour of Europe, both to participate in research at the laboratories of famous scientists, but also to procure lab equipment for Johns Hopkins. During a visit to Helmholtz's laboratory in Berlin, Rowland performed a very important experiment about how a magnetic field is generated by a charged, spinning disk. According to the historians with the American Institute of Physics, "The experiment was difficult in the extreme, demanding extensive mathematical calculations as well as measurements at the edge of detectability, but Rowland carried it off."[5] After returning to Johns Hopkins, "the university's

[5]Weart, Spencer and Patrick McCray. "Selected Papers of Great American Physicists - Henry Augustus Rowland", American Institute of Physics. <http://www.aip.org/history/gap/Rowland/Rowland.html> (24 Oct. 2005)

facility obtained one of the finest collections of research instruments in the world at that time."[6] Overall, Rowland's greatest contribution to science, and the contribution for which he is best remembered, is the development of construction techniques for extremely high precision diffraction gratings. These gratings are created by carving thousands of minuscule grooves in a surface, which are then used to deconstruct light into the individual components, creating what is called a spectrograph. The spectrograph is used to identify the chemical and thermal properties of the object that emitted the original light. Rowland's breakthrough was in the creation of a ruling engine that utilized a screw of almost perfect pitch. He did this through a very slow process, often requiring over two weeks for a 12 inch screw, utilizing supplies such as a 1°Celsius ice bath, as well as emery, oil, and silica powder. This screw is the component of the ruling engine that advances the grating a small fraction after each line is etched. He also pioneered using a curved plate for diffraction gratings, instead of the previously standard flat plate. This had a two-fold effect, firstly that the curved surface naturally focused the light, thereby eliminating the need for the light-absorbing lenses used previously, and secondly, the observation of spectra was much simpler due to the optical properties of the spherically-curved surface, which enabled scientists to take a large number of observations is a much shorter time duration.[7] Rowland

[6] "Henry Augustus Rowland: 1848-1901" The American Physical Society. <http://www.aps.org/apsnews/1198/119806.cfm> (27 Oct. 2005)

[7] Kevles, Daniel J. The Physicists - The History of a Scientific Community in Modern America. Cambridge, London: Harvard UP, 1995, pp. 25-27

won a gold medal and grand prize at the Paris Exposition in 1890 for his work with diffraction gratings and his subsequent revision of the solar spectrum[8]

Franklin also won great accord from colleagues and noblemen through his work with electricity. More often than not, his explanations for natural phenomenon were absurdly simple, which is a reflection of his simple upbringing. His greatest contribution in electrical theory was the 'single-fluid' model for electricity, which he defined to be a fluid that was conserved and was not attracted to itself. A substance could have an excess of this electrical fluid, resulting in a 'positive' charge, or a substance could have a deficiency of the fluid, leading to a 'negative' charge. In terms of practicality, the Franklin Lightning Rod was a wondrous invention. Using his knowledge of the 'electric fluid,' Franklin suggested that perhaps lightning could drawn out of a thundercloud. His hypothesis was proved correct in an experiment first done in France. This invention has saved many lives and buildings from fire damage in the past 250 years.[9]

When Benjamin Franklin started his printer's career in Philadelphia, he had no idea the number nor the extent of the dramatic and long-lasting changes he would create in his city. Franklin was an expert of the pen, and could craft words to influence almost any person to contribute to almost any

[8] "Henry A. Rowland, Class of 1870" Rensselaer Alumni Hall of Fame. <http://www.rpi.edu/dept/NewsComm/sub/fame/inductees/henryroland.html> (26 Oct. 2005)

[9] Weart, Spencer and Patrick McCray. "Selected Papers of Great American Physicists - Benjamin Franklin", American Institute of Physics. <http://www.aip.org/history/gap/Franklin/Franklin.html> (24 Oct. 2005)

cause. Franklin was master of the subscription method of supporting a worthy cause, where citizens would donate an initial sum, and then yearly quotas for a pre-specified time after that. He successfully influenced the residents of Philadelphia and the rest of the country through editorials and articles in his very popular newspaper. When he combined his very astute writing skills with the wide distribution of his papers, Franklin had the potential to effectively influence the thoughts, opinions, and most importantly, the pocketbooks of a great many men and women of the colonies. A subscription library, a public non-denominational meeting house, a 10,000 member militia, an academy at Philadelphia, and a public hospital were all results of Franklin's subtle manipulation of public opinions, and subsequent request for subscriptions to establish and provide support for the aforementioned causes.[10]

Henry Rowland was not merely a man of research alone, but also an activist and outspoken supporter of 'pure science', even at the expense of innovations in technology. In a famous vice-presidential address to the American Association for the Advancement of Science in 1883, Rowland explains,

> *I here assert that all can find time for scientific research if they desire it. But here, again, that curse of our country, mediocrity, is upon us. Our colleges and universities seldom call for first-class men of reputation, and I have even heard the trustee of a well-*

[10]Franklin, Benjamin. The Autobiography of Benjamin Franklin. Mineaola, New York: Dover, 1996.

known college assert that no professor should engage in research because of the time wasted.[11]

When Rowland choose the path of higher education, somewhat rare for the time period, but almost unavailable in Franklin's time, he set himself up for an illustrious career in pure, research science. Franklin, however, did not have the opportunity to attend a college or university, so he was forced to educate himself, primarily in non-scientific realms. Spending nearly his entire life in practical business, most of Franklin's scientific discoveries and inventions were of a practical use. Despite the differences between the focus of scientific contribution for Franklin and Rowland, they both held the same ideals concerning education and science.

[11] "Henry Augustus Rowland." The Hebrew University of Jerusalem, Institute of Chemistry. <http://chem.ch.huji.ac.il/ eugeniik/history/rowland.html> (27 Oct. 2005)